COOK MEDICAL

Zenith TX2®

TAA ENDOVASCULAR GRAFT

PATIENT GUIDE

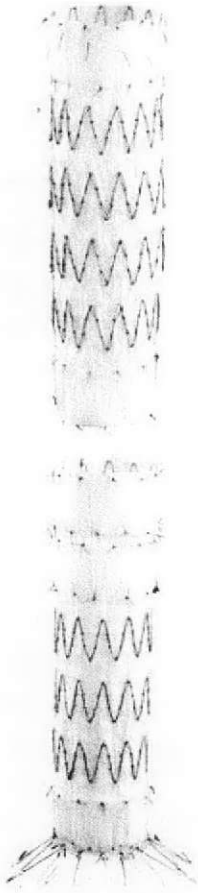
TREATING YOUR Thoracic Aortic Aneurysm

About this Patient Guide

This patient guide has been provided as a courtesy by Cook Medical Incorporated. It will help you learn more about **thoracic aortic aneurysms**. We hope this information will be helpful to you and your family.

For your convenience, a glossary of medical terms is included on pages 5 and 6. Words that are in **bold** throughout the text are defined in the glossary.

This patient guide is only a guideline. It provides basic information about **thoracic aortic aneurysms** and how they can be treated with the **Zenith TX2® TAA Endovascular Graft with the H&L-B One-Shot™ Introduction System**. It is not intended to diagnose a medical condition. The best way to treat a **thoracic aortic aneurysm** may depend partly on the patient's needs and the doctor's assessments. As with any surgery or medical procedure, your doctor is the best source for information and advice.



Zenith TX2 TAA Endovascular Graft

Table of Contents

Glossary

Aorta – the main artery that carries blood from the heart to the rest of the body.

Aneurysm – a bulge or ballooning (enlarging and thinning) of a weakened area of a blood vessel.

Angiography/Angiogram – an X-ray method that uses liquid dye injected into the bloodstream to show blood flowing through blood vessels. This type of image is called an angiogram.

Cardiac Arrhythmia – irregular heartbeat.

Contrast (dye) – a liquid dye injected into the bloodstream to show blood vessels under X-ray or CT scan.

CT Scan – a series of computerized X-rays that form a picture of your organs, blood vessels and aneurysm. The images look like slices of the body on a television screen. This is also known as a "CAT" scan.

Endoleak – blood flow into the thoracic aortic aneurysm after placement of a stent graft.

Endovascular – inside or within a blood vessel.

Endovascular Repair of a TAA – placement of a stent graft to seal off or re-line an aneurysm. Instead of opening up the chest, the doctor makes a small cut near the hip (near the crease between the belly and thigh) to get to the femoral artery (blood vessel). Through this small cut, a graft (metal and fabric tube) is inserted through the femoral artery and gently moved into place inside the TAA. The graft makes a new path through which the blood flows.

Femoral Arteries – two blood vessels that run down each leg and carry blood to the thighs and lower body. Doctors can use the femoral arteries as a path to reach arteries in the chest and belly.

Hemothorax – accumulation of blood in the pleural cavity (the space between the lungs and the walls of the chest).

Iliac Arteries – the two large blood vessels that connect the lower end of the aorta to the femoral arteries in each leg.

Ischemia – lack of blood in an area of the body due to mechanical obstruction or functional constriction of a blood vessel.

MRI (Magnetic Resonance Imaging) – a way of creating detailed pictures of the inside of the body. The MRI scanner uses magnetic fields and radio waves to create the pictures similar to the way a television works.

Open Surgical Repair of a TAA – a type of surgery performed to repair a thoracic aneurysm. To reach the aneurysm, a doctor cuts open the chest and repairs the aorta by replacing the aneurysm section with a fabric tube called a graft. The graft is sewn into place and acts as a replacement blood vessel.

Pleural Effusion – excess fluid that accumulates in the pleural cavity (the space between the lungs and the walls of the chest).

Pulmonary Complications – lung or breathing difficulties.

Rupture – when a blood vessel bursts causing serious internal bleeding.

Sheath – a long plastic tube with the stent graft collapsed inside. The sheath is advanced inside the blood vessel to where the aneurysm is located, and the stent graft is positioned in place.

Stent graft – a metal and fabric tube placed inside a diseased vessel without the use of open surgery. The graft makes a new path for the blood to flow through, re-lining the diseased vessel.

Stents – metal parts of the stent graft that spring outward toward the vessel walls and provide support to the stent graft.

Systemic – relating to or affecting the entire body.

Thoracic Aortic Aneurysm (TAA) – an aneurysm in the part of the aorta that runs through a person's chest.

Ulcer – a lesion that goes through the inner lining of the aorta.

Ultrasound – a way to create pictures of parts of the body using high-frequency sound waves.

Vascular – referring to the vessels that carry blood.

Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System (stent graft) – a device placed inside the aorta to seal off the aneurysm. The stent graft is made of polyester material. Surgical suture is used to sew the graft material to a frame of stainless steel stents. The stent graft has one or two parts that are put in the body through long tubes called sheaths. The H&L-B One-Shot Introduction System is the name of the system that allows placement of the stent graft in the body.

About the Zenith TX2® TAA Endovascular Graft with H&L-B One-Shot™ Introduction System

What is the Zenith TX2 TAA Endovascular Graft?

The **Zenith TX2 TAA Endovascular Graft** is a two-part fabric tube. It is sized so that it fits the part of the **aorta** that needs be covered to seal off the **aneurysm**. The **stent graft** is placed in the **aorta** across the **aneurysm** to keep blood from flowing into the **aneurysm**.

The **stent graft** is made of a polyester material like that used in **open surgical repair**. Suture material, like that used to close a wound, is used to sew the graft material to a frame of self-expanding stainless steel **stents**. These **stents** provide support. The **stent graft** has several gold markers placed around its top and bottom. Your doctor sees these gold markers using X-ray and uses them to guide placement of the **stent graft** in your **aorta**.

All the materials used to make the device have been used in medical implants for a long time. If you are sensitive or allergic to stainless steel, polyester, solder (tin, silver) polypropylene, nitinol, or gold, be sure to tell your doctor before treatment.

Zenith TX2 TAA Endovascular Graft

Indications for Use

The **Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System** is used for the **endovascular** treatment of patients who have:

1. **aneurysms** or **ulcers** of the descending thoracic **aorta**; and
2. the right anatomy for **endovascular repair.**

Contraindications

The **Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System** should not be used in patients:

- with reactions or allergies to stainless steel, polyester, solder (tin, silver), polypropylene, nitinol, or gold
- with a **systemic** infection which may be at increased risk of endovascular graft infection

General Warnings and Precautions

- The long-term performance of **stent grafts** is not fully known. Patients who have an **endovascular** repair must have regular medical follow-up for the rest of their lives. This follow-up will assess your health and how your **stent graft** is performing. **Regular follow-up with your doctor is important to make sure that your TAA does not require further treatment.**
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is not recommended for patients who cannot tolerate contrast agents necessary for intra-operative and post-operative follow-up imaging.
- Your doctor will determine your specific treatment needs and circumstances.
- You should keep your follow-up schedule even when you have no symptoms (e.g., pain, numbness, weakness).
- For more details, see your doctor or the Instructions for Use at www.zenithstentgraft.com.

Risks

Risks that may occur with the use of the **Zenith TX2 TAA Endovascular Graft** are listed below:

- If your **aneurysm** continues to become larger or is at risk for becoming larger due to a leak in the **stent graft** or movement of the **stent graft**, it may be necessary to perform further **endovascular** treatments or to have open surgery.

- If you have an infection in your bloodstream or other organs of your body, you may have an increased risk of developing an infection in the **stent graft**.

- No adverse events have been reported in patients who have had an **MRI** after having a **stent graft** implanted. However, testing supports the device being labeled as MR Conditional. If scanner's settings are outside of those provided in the IFU, there may be potential risks. Ask your doctor before having an **MRI**. (See page 14 for more information.)

- **Aneurysm** growth or **ruptures** are rare following **endovascular** treatment. However, they are still possible. Symptoms of **aneurysm** growth or **ruptures** are not always present. Common symptoms of **aneurysm** growth or **ruptures** include, but may not be limited to:

    - pain (back or chest)
    - persistent cough
    - dizziness
    - fainting
    - rapid heartbeat
    - sudden weakness

- Signs of **stent graft** occlusion include, but may not be limited to:

    - pain
    - pulse less legs
    - **ischemia** of intestines
    - cold arms or legs

If you have any of the symptoms listed above, call your doctor right away. For more details, please see your doctor or the Instructions for Use at www.zenithstentgraft.com.

Benefits

The **Zenith TX2 TAA Endovascular Graft** was studied in a clinical trial at 42 hospitals. The trial showed that benefits of receiving the TX2 device as compared to open surgery may include, but may not be limited to:

- quicker recovery following surgery, including:
    - shorter time in the intensive care unit – endovascular patients 2.2 days, surgical patients 9.4 days
    - shorter overall hospital stay – endovascular patients 5.0 days, surgical patients 16.1 days
    - shorter time to taking fluids – endovascular patients 0.7 days, surgical patients 4.0 days
    - shorter time to return to regular diet – endovascular patients 1.9 days, surgical patients 5.2 days
    - shorter time to return to ambulation – endovascular patients 1.6 days, surgical patients 5.5 days
    - less time on ventilator – endovascular patients 2.8 hours, surgical patients 53.1 hours
- fewer number of blood transfusions before discharge from the hospital – endovascular patients 0.3, surgical patients 1.7

In addition, the generally less invasive nature of endovascular repair offers the following potential benefits:

- much smaller surgical incision
- less frequent need for general anesthesia
- lower chance of cardiovascular complications within 30 days following surgery including, **cardiac arrhythmia**
- lower chance of **pulmonary complications** within 30 days following surgery including:
    - lower chance of the need for ventilation for longer than 72 hours
    - lower chance to require re-intubation
    - lower chance of the need for a tracheostomy or chest tube
    - less likely to have a **pleural effusion**
    - less likely to have a **hemothorax**

Before Procedure Information

Before the procedure you will meet with your doctor to talk about the possible treatments for your **TAA**. These may include **endovascular** treatment with the **Zenith TX2 TAA Endovascular Graft** (or another commercially available device), medical therapy, open surgery, or no treatment. Your doctor may ask you to have some further tests before your procedure.

Treatment of Thoracic Aortic Aneurysms (TAA)

How do doctors treat a TAA?

When an **aneurysm** is small, your doctor may want to watch it with periodic checkups. He or she may want to see if it grows and how much it grows. He or she may also suggest medicine to lower your blood pressure and reduce the pressure on the **aneurysm**.

However, if an **aneurysm** becomes larger, or is growing rapidly, it has more risk of **rupturing** (bursting).

If your doctor thinks there is a risk that the **aneurysm** may **rupture**, he or she may suggest treatment to keep the **aorta** from bursting or affecting blood supply to other parts of the body. There are two types of treatment for a **TAA**:

- **Endovascular Repair**
- **Open Surgical Repair**

Important Note: Not every patient is a candidate for **endovascular** or surgical repair. Both types of repair have pros and cons. The best repair will depend on your condition and needs. Talk about the pros and cons with your doctor.

What is endovascular repair?

Endovascular repair is a fairly new treatment. **Endovascular** means "inside or within a blood vessel." Instead of cutting open the chest, the doctor makes a small cut near your hip (near the crease where your belly meets your leg) to get to the **femoral artery**.

Through this small cut, a plastic tube (**sheath**) containing a **stent graft** is put into the body and placed inside the **aorta**. The **stent graft** is released in the **aorta** and detached from the **sheath**. The **stent graft** seals off the **aneurysm** and makes a new path for the blood to flow through. The **stent graft** stays inside the **aorta** permanently. **Endovascular repair** usually takes around two hours to complete.

The cut used for **endovascular repair** is much smaller than the cut used for **open surgical repair**, so patients may have less pain and a faster recovery. Patients may have to stay in the hospital for only a few days. They can usually return to normal activity after 4 to 6 weeks.

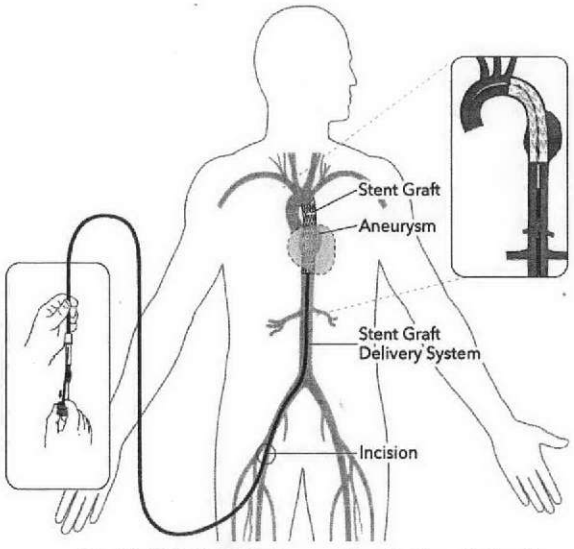
As with any medical procedure, **endovascular repair** has a risk of complications. You should talk about these with your doctor. **Endovascular repair** also requires routine follow-up visits with your doctor. During these visits, tests will be done to evaluate your health and the **stent graft**. There is also a chance that you will need further treatment or surgery after your **endovascular repair**. For more information, see page 13.

How is the stent graft put in?

Before the procedure, your doctor looks at pictures of your **aorta** using **CT scans** and **angiograms**. From these pictures, the doctor can choose the proper size of each part of the **Zenith TX2 TAA Endovascular Graft.** The **stent graft** will be sized to fit your **aorta** where the **aneurysm** is located. During the procedure, the doctor uses X-rays to see the **stent graft** and place it correctly.

Before the **stent graft** is put in, each of its two parts is contained in its own plastic tube (**sheath**) called the **H&L-B One-Shot Introduction System**. The tube allows the **stent graft** to be inserted and placed in the **aorta**. The plastic tubes are removed after the **stent graft** is in place.

To place the **stent graft**, your doctor makes a cut, near the hip (near the crease between the belly and leg) to get to the **femoral artery**. The doctor then inserts the **stent graft** through the cut into your bloodstream (see figure below). If the **femoral artery** is not large enough, the doctor may be required to insert the **stent graft** into your bloodstream through another graft (referred to as a conduit) that gets connected directly to either your **iliac artery** or **aorta** – this was necessary in approximately 10% of patients from the clinical study of the **Zenith TX2 TAA Endovascular Graft**. He or she advances the **stent graft** through your blood vessels until it reaches the **aorta**. The top of the **stent graft** is placed in the **aorta** above the **aneurysm**. The body of the **stent graft** extends down the **aorta** across the **aneurysm**. The bottom of the **stent graft** is placed at a point below the **aneurysm**. When the **stent graft** is released from its **sheath**, it opens up and hugs the inside of the **aorta**. Once it opens up, the **stent graft** prevents blood from flowing into the **aneurysm**. Sometimes, another smaller incision may be needed in the neck to help the doctor properly place the **stent graft**.



Zenith TX2 TAA Endovascular Graft and sheath inserted, and partially placed in the aorta

Zenith TX2 TAA Endovascular Graft partially placed in the aorta

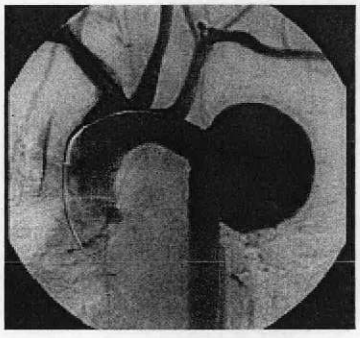
Zenith TX2 TAA Endovascular Graft implanted in the aorta

aneurysm.

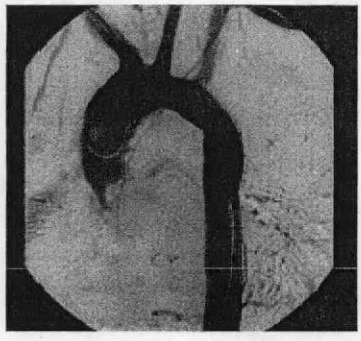
Before the procedure is finished, your doctor will take X-rays of your **aorta**. He or she will look to make sure the blood is flowing through the **stent graft** and not through the **aneurysm**. Your doctor will then close up the cut on your leg with stitches.

After the procedure, your doctor should give you a filled-out Patient ID Card. You should carry this card with you at all times. If you need to have other procedures, such as an **MRI,** be sure to show this card to your doctor(s) or other health care provider(s). For an example of the Patient ID Card, see page 15.

After Procedure Information



X-ray of an aorta with a TAA



X-ray of same aorta after endovascular repair.

Why is follow-up important?

If you receive a **Zenith TX2 TAA Endovascular Graft**, it is very important to have regularly scheduled follow-up appointments with your doctor. This is because the long-term results of **endovascular repair** are not fully known. Your doctor needs to look at pictures (X-ray, **CT scan**) of your **aneurysm** and **stent graft** on a regular basis. Your doctor may suggest further procedures and tests based upon this regular follow-up.

What kind of follow-up should I expect?

Recommended follow-up includes, but may not be limited to checkups at:

- 1 month
- 6 months
- 12 months
- yearly after the 12 month point*

* For additional information see "Risks" on page 9.

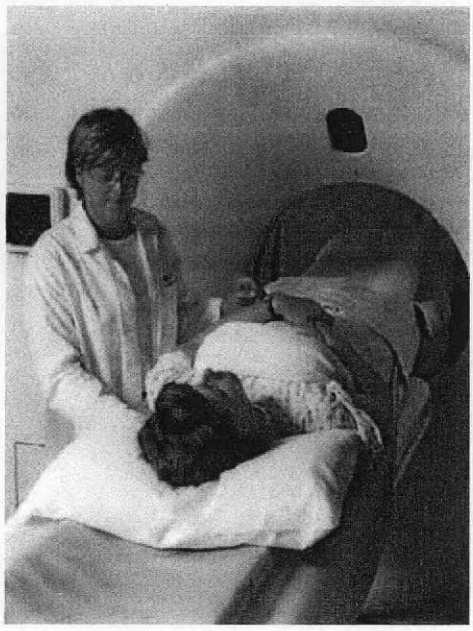
Follow-up exams usually include, but may not be limited to routine blood tests, X-rays, a **CT scan** and a physical exam. These tests carry a low risk of complications. For example, there is a slight risk of allergic reactions to the **contrast dye** used in the **CT scan**. However, the benefits of these tests are usually greater than the possible risks. Talk with your doctor if you are concerned about follow-up exams. He or she may suggest special precautions.

These exams should be part of your lifelong plan for health and well-being. They are needed to evaluate your treatment and to watch for any changes over time. Your doctor may ask for additional tests based on what he or she finds at the follow-up visits.

What if I need magnetic resonance imaging (MRI)?

The **Zenith TX2 TAA Endovascular Graft** met standard testing requirements for **MRI** safety supporting the labeling of the device as MR Conditional. This meant that testing indicates that a patient can be safely scanned within the scan parameter provided in the IFU and patient card. Additionally, six patients in the clinical trial had **MRI** after having a **stent graft** implanted. No adverse events were reported in those patients. Additional risks may exist if the MR scan is performed outside of the parameters provided. MRI labeling is primarily based upon *in vitro* testing performed per industry and FDA accepted standards.

If you receive a **Zenith TX2 TAA Endovascular Graft**, be sure to tell all of your health care providers that you have the **stent graft**. Show them your Patient ID card. This card contains information about **MRI** procedures for patients with this device. If you are concerned about **MRI**, talk to your doctor about potential risks and benefits of the test.



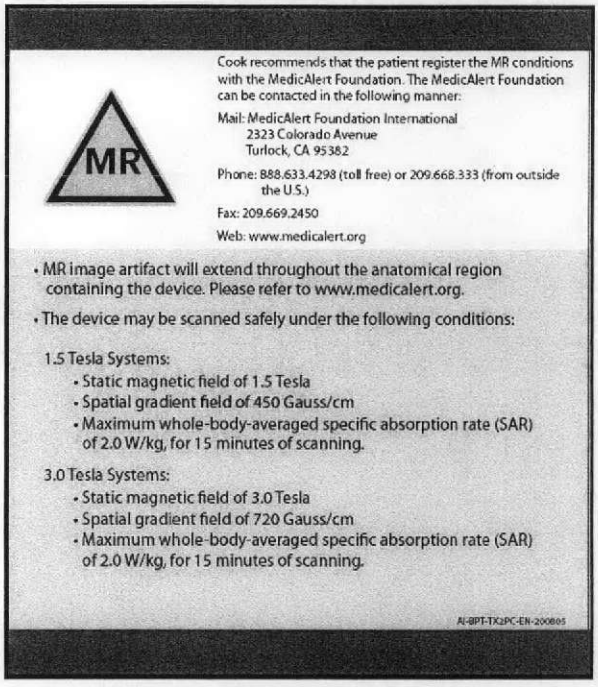
Magnetic Resonance Imaging

What should I do with my Patient ID card?

You will receive a **Zenith TX2 TAA Endovascular Graft** Patient ID card. The card provides valuable information about:

- the type of device you have implanted
- the date your device was implanted
- your doctors
- information about **MRI**

Be sure to tell all your health care providers that you have the **stent graft** and show them your Patient ID card. Keep the card with you at all times.



Patient ID Card

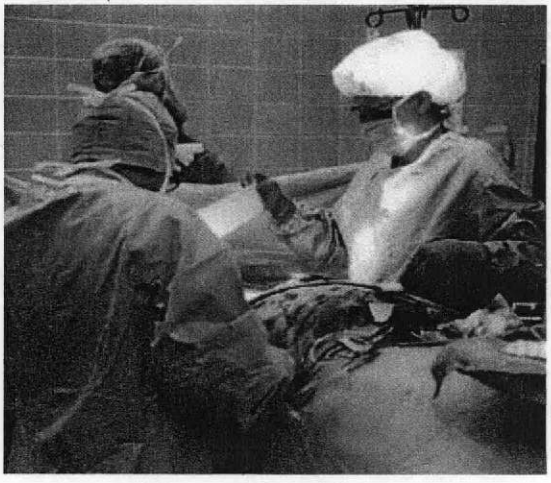
What is open surgical repair?

In this approach, surgery is performed to repair the section of the **aorta** that has an **aneurysm**. To reach the **aneurysm**, the doctor will cut through the breastbone or the side of the chest. The **aorta** is repaired by replacing the **aneurysm** section with a fabric tube called a graft.

The graft is sewn into place to serve as a "replacement" blood vessel. During graft placement, blood is stopped from flowing through the **aorta**. The surgery usually takes around four hours to complete.

Open surgical repair is a proven medical procedure. However, as shown in the clinical study comparing **endovascular** treatment with the **Zenith TX2 TAA Endovascular Graft** to **open surgical repair**, it also has a long recovery time. On average, patients usually stay overnight in the intensive care unit for nine days and may stay an additional seven days in the hospital before being discharged. Many patients cannot eat or ambulate for at least five days after the surgery. The overall recovery period can last up to 3 months.

Like any medical procedure, **open surgical repair** has a risk of complications. Talk to your doctor about these.



Open surgical procedure

Troubleshooting - When to Call the Doctor

If you have any of the symptoms below, please contact your doctor right away:

- pain
- cold arms or legs
- pulse less legs
- **ischemia** of intestines
- persistent cough
- dizziness
- fainting
- rapid heartbeat
- sudden weakness

Clinical Study

A clinical trial for the **Zenith TX2 TAA Endovascular Graft** (TX2) was conducted at 42 hospitals in the United States and other countries. The goal of the trial was to compare the safety and effectiveness of **endovascular repair** to **open surgical repair** in patients with descending **thoracic aortic aneurysms** or **ulcers**. The trial studied a group of patients who received a TX2 graft and a group of patients who had open surgery. Patients in both groups had to meet the same requirements to be included in the trial, except that patients treated with open surgery did not need to have anatomy agreeable to **endovascular repair** with the TX2 graft.

One hundred sixty (160) patients received the TX2 graft. Seventy (70) patients received open surgery. Patients treated with the **stent graft** received clinical assessment and X-ray follow-up before leaving the hospital, at 30 days, at 6 months, and at 12 months. They are also being followed yearly through 5 years. Patients who had open surgery received clinical and X-ray follow-up before leaving the hospital or at 30 days and at 12 months.

The **endovascular** graft group did not have more complications or deaths as compared to the **open surgical** control group. There were no **ruptures** of the **aneurysms** that were treated in either study group. Patients with **endovascular repair** spent less time in intensive care, were walking sooner, resumed eating and drinking sooner, and had shorter hospital stays as compared to the patients who had **open surgical repair**. No patients had to have an **open surgical repair** after they had an **endovascular repair**. The percent of patients who needed another procedure after their **aneurysm** was treated was low and similar in the two groups. **Aneurysm/ulcer** size did not change or got smaller in most **endovascular** patients at 12 months, and the rates of **endoleak** and movement of the stent graft were low at 12 months. For more details, please see your doctor or the Instructions for Use at www.zenithstentgraft.com.

Talk to Your Doctor

Remember, your doctor can help to answer any questions you may have regarding treatment of a thoracic aneurysm and can discuss potential adverse effects and potential benefits of this treatment based upon your medical history and condition.

Where Can I Find More information?

Cook Medical Incorporated **www.cookmedical.com**

Customer Service Representatives may be reached Monday-Friday between the hours of 8:00 a.m. to 7:00 p.m. EST. - **Phone 800-468-1379.**

Vascular Web Patient Information **www.vascularweb.org**

VascularWeb is a global source of information and services for improving **vascular** health. VascularWeb is owned by the Society for **Vascular** Surgery (SVS), a nonprofit organization.

Society of Interventional Radiology **www.sirweb.org**

The Society of Interventional Radiology (SIR) is a professional group for doctors who specialize in interventional or minimally invasive procedures. SIR is a nonprofit, national scientific organization committed to improving health and quality of life through the practice of cardiovascular and interventional radiology.

U.S. National Library of Medicine **www.medlineplus.gov**

The National Library of Medicine (NLM) on the campus of the National Institutes of Health in Bethesda, Maryland is the world's largest medical library. The library collects materials in all areas of biomedicine and health care.

U.S. Department of Health and Human Services
Food and Drug Administration **www.fda.gov**

This is a U.S. government agency intended to promote and protect public health by helping safe and effective products reach the market in a timely way, and monitoring products for continued safety after they are in use.

Background Information on the Disease

What is a thoracic aortic aneurysm (TAA)?

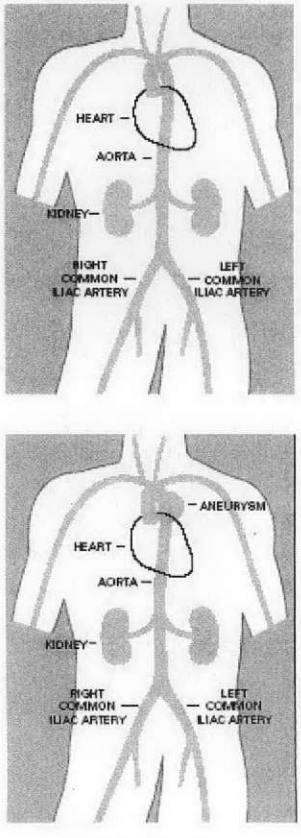
The **aorta** is the main blood vessel that carries blood from the heart to the rest of the body. It starts in the chest and runs down into the abdomen, where it branches into the **iliac arteries**. The **iliac arteries** carry blood to lower parts of the body and to the legs. Sometimes, with aging or other changes, a section of the **aorta** may weaken and begin to bulge.

This bulge can get larger over time as the walls of the **aorta** get thinner and stretch (like a balloon). This bulge in the **aorta** is called an **aneurysm**.

Sometimes an **aneurysm** occurs in the part of the **aorta** that runs through the chest. This is called a **thoracic aortic aneurysm (TAA)**.

Is this a serious condition?

When a **TAA** is small, it may not be an immediate health risk. However, your doctor will want to check its condition regularly. If the **TAA** continues to grow,



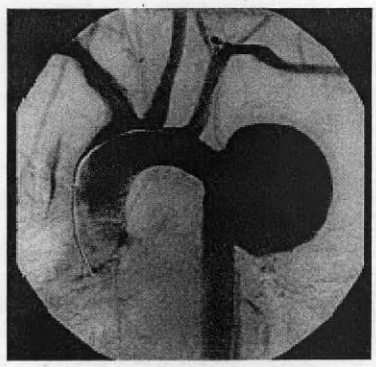
Aortic anatomy

the **aorta's** walls can become thin and less able to stretch. Eventually, the stretched sections may become too weak to support the force of blood flow. This type of **aneurysm** could burst, causing serious internal bleeding.

What are some of the symptoms of a TAA?

Unfortunately, most patients with a **TAA** have no symptoms. For people who do have symptoms, the symptoms include, but are not limited to back and chest pain, trouble breathing or swallowing and hoarse coughing. Many patients feel none of these symptoms, yet may still have a **TAA**. A **TAA** is often found during an examination done for other medical reasons. Most often, **aneurysms** are found during a medical test such as a **CT scan**, **ultrasound** or **angiogram**.

If you know you have a **TAA** and you develop back pain, chest pain or dizziness, call your doctor right away.



X-ray of an aorta with a TAA

What causes a TAA?

Over time, **vascular** disease, injury, or an inherited defect of tissue within the arterial wall can cause the **aorta** to weaken. Blood pressure against the weakened area can cause it to stretch and grow thinner, like a balloon.

Risk factors for developing an **aneurysm** include, but may not be limited to family history, smoking, heart disease, trauma and high blood pressure. If you are at risk for developing an **aneurysm**, your doctor may suggest periodic checks. The checks could include a physical exam and possibly a **CT scan**, **MRI**, or **ultrasound**.

Notes

If you have questions about your **TAA** or treatment, talk to your doctor. He or she should always be your main source of information about this procedure and its impact on your health.

Use the space below to record your doctor's name and phone number. You may also want to write down questions, take notes, or keep a record of talks with your doctor.

Patient Name: _____

Date of graft placement: _____

Doctor's name: _____

Hospital: _____

Doctor's phone #: _____

_____

_____

_____

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AORTIC INTERVENTION CARDIOLOGY CRITICAL CARE ENDOSCOPY PERIPHERAL INTERVENTION SURGERY UROLOGY WOMEN'S HEALTH

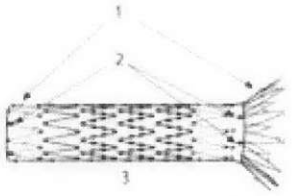
Print Date: May 21, 2008

Zenith TX2® TAA Endovascular Graft with the H&L-B One-Shot™ Introduction System

One-Piece System

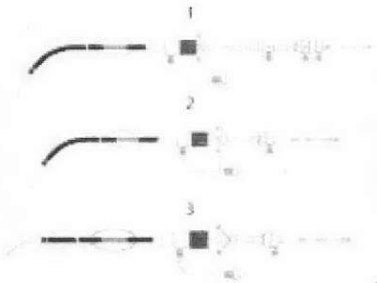
68

Illustrations



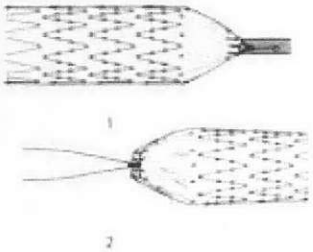
1. Barbed Stents
2. Radiopaque Markers
3. Main Body Graft

Fig. 1



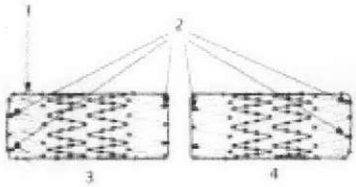
1. Main Body Delivery System
2. Proximal Extension Delivery System
3. Distal Extension Delivery System

Fig. 2



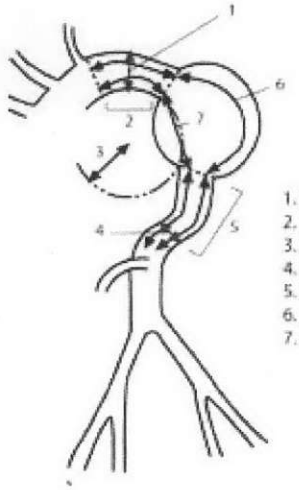
1. Distal Trigger-wire
2. Proximal Trigger-wire

Fig. 3

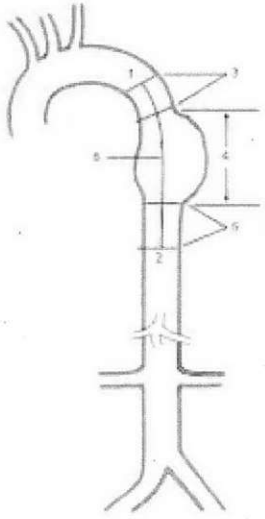


1. Barbed Stents
2. Radiopaque Markers
3. Proximal Extension (TBE)
4. Distal Extension (ESBE-T)

Fig. 4



1. Proximal neck diameter 24-38 mm
2. Proximal neck length ≥ 25 mm
3. Aortic radius > 35 mm
4. Distal neck diameter 24-38 mm
5. Distal neck length ≥ 25 mm
6. Greater
7. Lesser



1. Proximal neck diameter
2. Distal neck diameter
3. Proximal neck length (at least 25 mm and may cross one subclavian)
4. Aneurysm length
5. Distal neck length (at least 25 mm proximal to celiac artery)
6. Total coverage length

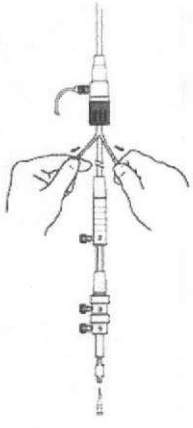


Fig. 7

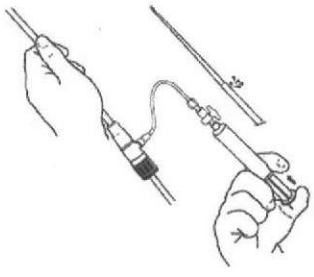


Fig. 8

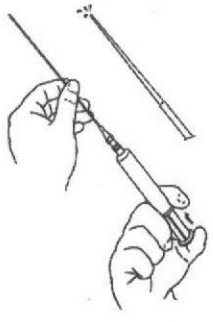


Fig. 9

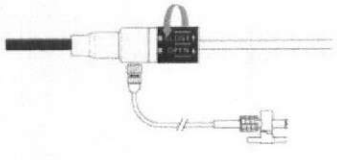


Fig. 10

Fig. 11

Fig. 12

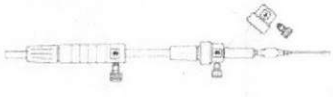


Fig. 13

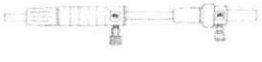


Fig. 14

Fig. 15

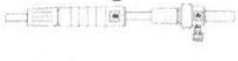


Fig. 16

Fig. 17

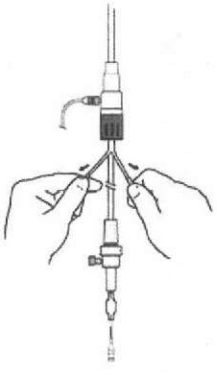


Fig. 18

71

Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System

Read all instructions carefully. Failure to properly follow the instructions, warnings, and precautions may lead to serious consequences or injury to the patient.

CAUTION: Federal (U.S.A.) law restricts this device to sale by or on the order of a physician.

CAUTION: All contents of the outer pouch (including the introduction system and the endovascular grafts) are supplied sterile, for single use only.

1. DEVICE DESCRIPTION

1.1 Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System

The Zenith TX2 TAA Endovascular Graft is a one-piece cylindrical endovascular graft. The stent grafts are constructed of full-thickness woven polyester fabric sewn to self-expanding stainless steel Cook-Z® stents with braided polyester and monofilament polypropylene suture (**Fig. 1**). The Zenith TX2 TAA Endovascular Graft is fully stented to provide stability and the expansile force to open the lumen of the graft during deployment. Additionally, the Cook-Z stents provide the attachment and seal of the graft to the vessel wall.

For added fixation, the device contains barbs placed at a 2 mm stagger, which protrude through the graft material at the proximal end. The bare stent at the distal end also contains barbs. To facilitate fluoroscopic visualization of the stent graft, four radiopaque gold markers are positioned on each end of the device. These markers are placed in a circumferential orientation within 1 mm of the most proximal aspect of the graft material and within 1 mm of the most distal aspect of the graft material.

The Zenith TX2 TAA Endovascular Graft is shipped preloaded onto either a 20 French or 22 French H&L-B One-Shot Introduction System (**Fig. 2**). It has a sequential deployment method with built-in features to provide continuous control of the endovascular graft throughout the deployment procedure. The H&L-B One-Shot Introduction System is designed for precise positioning before deployment of the device.

This system uses a dual trigger-wire release mechanism. The trigger-wires secure the endovascular graft onto the delivery system until released by the physician (**Fig. 3**). All delivery systems feature Flexor® introducer sheaths, which are designed to resist kinking and are hydrophilically coated. Both features are intended to enhance trackability in the iliac arteries and thoracic aorta.

1.2 Zenith TX2 TAA Endovascular Graft Ancillary Components

Ancillary endovascular components (proximal and distal body extensions) are available (**Fig. 4**). The Zenith TX2 TAA Endovascular Graft Ancillary Components are cylindrical components constructed from the same polyester fabric, self-expanding stainless steel Cook-Z stents, and polypropylene suture used in constructing the principal graft component. At the distal and proximal graft margins, the z-stents are attached to the inner surface. Elsewhere the z-stents are sutured on the external surface. The proximal extension contains proximal attachment barbs and the distal extension does not have barbs. Both the proximal and distal main body extensions can be used to provide additional length to their respective portions of the endovascular graft. Additionally, the distal main body extension can be used to increase the overlap length between components.

1.2.1 Zenith TX2 TAA Endovascular Graft Proximal Extensions

The Zenith TX2 TAA Endovascular Graft Proximal Extension is deployed from either a 20 Fr or 22 Fr H&L-B One-Shot Introduction System (**Fig. 2**). A single trigger-wire release mechanism locks the endovascular graft onto the delivery system until released by the physician. All systems are compatible with a .035 inch wire guide.

The covered stent at the proximal end of the proximal extension contains barbs placed at a 2 mm stagger, which protrude through the graft material. To facilitate fluoroscopic visualization of

the proximal extension, four radiopaque markers are positioned on the ends of the graft in a circumferential orientation within 1 mm of the most proximal and distal aspects of the graft material.

1.2.2 Zenith TX2 TAA Endovascular Graft Distal Extensions

The Zenith TX2 TAA Endovascular Graft Distal Extension is deployed from either a 20 French or 22 French H&L-B One-Shot Introduction System (**Fig. 2**). A single trigger-wire release mechanism locks the endovascular graft onto the delivery system until released by the physician. All systems are compatible with a .035 inch wire guide.

To facilitate fluoroscopic visualization of the distal extension, four radiopaque markers are positioned on the ends of the graft in a circumferential orientation within 1 mm of the most proximal and distal aspects of the graft material.

2. INDICATIONS FOR USE

The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is indicated for the endovascular treatment of patients with aneurysms or ulcers of the descending thoracic aorta having vascular morphology suitable for endovascular repair (**Fig. 5**), including:

- Adequate iliac/femoral access compatible with the required introduction systems,
- Non-aneurysmal aortic segments (fixation sites) proximal and distal to the aneurysm or ulcer:
  - with a length of at least 25 mm, and
  - with a diameter measured outer wall to outer wall of no greater than 38 mm and no less than 24 mm.

3. CONTRAINDICATIONS

The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is contraindicated in:

- Patients with known sensitivities or allergies to stainless steel, polyester, solder (tin, silver), polypropylene, nitinol, or gold.
- Patients with a systemic infection which may be at increased risk of endovascular graft infection.

4. WARNINGS AND PRECAUTIONS

4.1 General

- Read all instructions carefully. Failure to properly follow the instructions, warnings, and precautions may lead to serious consequences or injury to the patient.
- Always have a qualified surgery team available during implantation or reintervention procedures in the event that conversion to open surgical repair is necessary.
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System should only be used by physicians and teams trained in vascular interventional techniques (catheter-based and surgical) and in the use of this device. Specific training expectations are described in **Section 10.1, Physician Training**.
- Additional endovascular interventions or conversion to standard open surgical repair following initial endovascular repair should be considered for patients experiencing enlarging aneurysms or ulcers, unacceptable decrease in fixation length (vessel and component overlap) and/or endoleak. An increase in aneurysm or ulcer size and/or persistent endoleak or migration may lead to aneurysm/ulcer rupture.

- Patients experiencing reduced blood flow through the graft and/or leaks may be required to undergo secondary endovascular interventions or surgical procedures.

4.2 Patient Selection, Treatment and Follow-Up

- The Zenith TX2 TAA Endovascular Graft is designed to treat aortic neck diameters no smaller than 24 mm and no larger than 38 mm. The Zenith TX2 TAA Endovascular Graft is designed to treat proximal aortic necks (distal to either the left subclavian or left common carotid artery) of at least 25 mm in length. Additional proximal aortic neck length may be gained by covering the left subclavian artery (with or without discretionary transposition) when necessary to optimize device fixation and maximize aortic neck length. Distal aortic neck length of at least 25 mm proximal to the celiac axis is required. These sizing measurements are critical to the performance of the endovascular repair.
- Key anatomic elements that may affect successful exclusion of the aneurysm or ulcer include a radius of curvature <35 mm; localized aortic neck angulation >45 degrees; short proximal or distal fixation sites (<25 mm); an inverted funnel shape at the proximal fixation site or a funnel shape at the distal fixation site (greater than 10% change in diameter over 25 mm of fixation site length); and circumferential thrombus and/or calcification at the arterial fixation sites. In the presence of anatomical limitations, a longer neck length may be required to obtain adequate sealing and fixation. Irregular calcification and/or plaque may compromise the attachment and sealing at the fixation sites. Necks exhibiting these key anatomic elements may be more conducive to graft migration or endoleak.
- Adequate iliac or femoral access is required to introduce the device into the vasculature. Careful evaluation of vessel size, anatomy and disease state is required to assure successful sheath introduction and subsequent withdrawal, as vessels that are significantly calcified, occlusive, tortuous or thrombus-lined may preclude introduction of the endovascular graft and/or may increase the risk of embolization. A vascular conduit technique may be needed to achieve access in some patients.
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is not recommended for patients who cannot tolerate contrast agents necessary for intraoperative and post-operative follow-up imaging. All patients should be monitored closely and checked periodically for a change in the condition of their disease and the integrity of the endoprosthesis
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is not recommended for patients whose weight or size would compromise or prevent the necessary imaging requirements.
- Graft implantation may increase the risk of paraplegia or paraparesis where graft exclusion covers the origins of dominant spinal cord or intercostal arteries.
- The safety and effectiveness of the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System has not been evaluated in the following patient populations:
    - aortobronchial and aortoesophageal fistulas
    - aortitis or inflammatory aneurysms
    - diagnosed or suspected congenital degenerative collagen disease (e.g., Marfan's or Ehlers-Danlos Syndromes)
    - dissections
    - females that are pregnant, breast-feeding, or planning on becoming pregnant within 24 months
    - leaking, pending rupture or ruptured aneurysm
    - less than 18 years of age

- mycotic aneurysms
- pseudoaneurysms resulting from previous graft placement
- systemic infection (e.g., sepsis)
- traumatic aortic injury

- Successful patient selection requires specific imaging and accurate measurements; please see Pre-Procedure Measurement Techniques and Imaging section below.
- If occlusion of the left subclavian artery ostium is required to obtain adequate neck length fixation and sealing, transposition or bypass of the left subclavian artery may be warranted.
- All lengths and diameters of the devices necessary to complete the procedure should be available to the physician, especially when pre-operative case planning measurements (treatment diameters/lengths) are not certain. This approach allows for greater intra-operative flexibility to achieve optimal procedural outcomes.

4.3 Imaging and Pre-Procedure Measurement Techniques

- Lack of non-contrast CT imaging may result in failure to appreciate iliac or aortic calcification, which may preclude access or reliable device fixation and seal.
- Preprocedure imaging reconstruction thicknesses >3 mm may result in sub-optimal device sizing, or in failure to appreciate focal stenoses from CT.
- Clinical experience indicates that contrast-enhanced spiral computed tomographic angiography (CTA) with 3-D reconstruction is the strongly recommended imaging modality to accurately assess patient anatomy prior to treatment of the Zenith TX2 TAA Endovascular Graft. If contrast-enhanced spiral CTA with 3-D reconstruction is not available, the patient should be referred to a facility with these capabilities. Clinicians recommend positioning of the image intensifier (C-arm) so that it is perpendicular to the neck, typically 45-75 degrees left anterior oblique (LAO) for the arch.
- Diameter
  A contrast-enhanced spiral CTA is strongly recommended for aortic diameter measurements. Diameter measurements should be determined from the outer wall to outer wall vessel diameter and not the lumen diameter. The spiral CTA scan must include the great vessels through the femoral heads at an axial slice thickness of 3 mm or less.
- Length
  Clinical experience indicates that 3-D CTA reconstruction is the strongly recommended imaging modality to accurately assess proximal and distal neck lengths for the Zenith TX2 TAA Endovascular Graft. These reconstructions should be performed in sagital, coronal and varying oblique views depending upon individual patient anatomy. If 3-D reconstruction is not available, the patient should be referred to a facility with these capabilities.
- The long-term performance of endovascular grafts has not yet been established. All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and the performance of their endovascular graft. Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the endovascular graft) should receive enhanced follow-up. Specific follow-up guidelines are described in **Section 12, IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP**.
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is not recommended in patients unable to undergo, or who will not be compliant with, the necessary pre-operative and post-operative imaging and implantation studies as described in **Section 12, IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP**.
- After endovascular graft placement, patients should be regularly monitored for endoleak flow, aneurysm or ulcer growth, or changes in the structure or position of the endovascu-

lar graft. At a minimum, annual imaging is required, including: 1) chest radiographs to examine device integrity (separation between components, stent fracture, or barb separation); and 2) contrast and non-contrast CT to examine aneurysm changes, endoleak flow, patency, tortuosity, device position and progressive disease. If renal complications or other factors preclude the use of image contrast media, chest radiographs and non-contrast CT may be used in combination with transesophogeal echocardiography (for endoleak assessment) to provide similar information.

4.4 Device Selection

- The recommended amount of overlap between devices is 3-4 stents. However, the proximal and distal sealing stent of the component should not be overlapped, as doing so may cause malapposition to the vessel wall. The minimum required amount of overlap between devices is 2 stents (~50 mm) – less than 2 stents may result in endoleak (with or without component separation). Device lengths should be selected accordingly.
- Strict adherence to the Zenith TX2 TAA Endovascular Graft IFU sizing guide is strongly recommended when selecting the appropriate device size **(Tables 10.1 and 10.2)**. Appropriate device oversizing has been incorporated into the IFU sizing guide. Sizing outside of this range can result in endoleak, fracture, migration, device infolding, or compression.

4.5 Implant Procedure

(Refer to **Section 11, DIRECTIONS FOR USE**)

- Appropriate procedural imaging is required to successfully position the Zenith TX2 TAA Endovascular Graft in the neck and to assure appropriate apposition to the aortic wall.
- Do not bend or kink the delivery system. Doing so may cause damage to the delivery system and the Zenith TX2 TAA Endovascular Graft.
- To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.
- Do not continue advancing the wire guide or any portion of the delivery system if resistance is felt. Stop and assess the cause of resistance; vessel, catheter, or graft damage may occur. Exercise particular care in areas of stenosis, intravascular thrombosis, or calcified or tortuous vessels.
- Inadvertent partial deployment or migration of the endoprosthesis may require surgical removal.
- Unless medically indicated, do not deploy the Zenith TX2 TAA Endovascular Graft in a location that will occlude arteries necessary to supply blood flow to organs or extremities. Do not cover significant arch or mesenteric arteries (exception may be the left subclavian artery) with the endoprosthesis. Vessel occlusion may occur. If a left subclavian artery is to be covered with the device, the clinician should be aware of the possibility of compromise to cerebral and upper limb circulation as well as collateral circulation to the spinal cord.
- Do not attempt to re-sheath the graft after partial or complete deployment.
- Repositioning the stent graft distally after partial deployment of the covered proximal stent may result in damage to the stent graft and/or vessel injury.
- During sheath withdrawal, the proximal barbs are exposed and are in contact with the vessel wall. At this stage it may be possible to advance the device, but retraction may cause aortic wall damage.
- Landing the proximal and distal ends of the device in parallel aortic neck segments without acute angulation (>45°) or circumferential thrombus/calcification is important to ensuring fixation and seal.
- Landing the proximal or distal ends of the device in an aortic neck segment with a di-

ameter that differs from that to which the graft was sized initially may potentially result in inadequate sizing (<10% or 25%) and therefore migration, endoleak, aneurysm or ulcer growth or increased risk of thrombosis.

- Inaccurate placement and/or incomplete sealing of the Zenith TX2 TAA Endovascular Graft within the vessel may result in increased risk of endoleak, migration, or inadvertent occlusion of the left subclavian, left common carotid, and/or celiac arteries.
- Inadequate fixation of the Zenith TX2 TAA Endovascular Graft may result in increased risk of migration of the stent graft. Incorrect deployment or migration of the endoprosthesis may require surgical intervention.
- Systemic anticoagulation should be used during the implantation procedure based on hospital and physician preferred protocol. If heparin is contraindicated, an alternative anticoagulant should be used.
- To activate the hydrophilic coating on the outside of the sheath, the surface must be wiped with 4X4 gauze pads soaked in saline solution. Always keep the sheath hydrated for optimal performance.
- Minimize handling of the constrained endoprosthesis during preparation and insertion to decrease the risk of endoprosthesis contamination and infection.
- Maintain wire guide position during delivery system insertion.
- Always use fluoroscopy for guidance, delivery, and observation of the Zenith TX2 TAA Endovascular Graft within the vasculature.
- The use of the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System requires administration of intravascular contrast. Patients with pre-existing renal insufficiency may have an increased risk of renal failure post-operatively. Care should be taken to limit the amount of contrast medium used during the procedure and to observe preventative methods of treatment to decrease renal compromise (e.g., adequate hydration).
- As the sheath and/or wire guide is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.
- The Zenith TX2 TAA Endovascular Graft incorporates a covered proximal stent and an uncovered distal stent, both with fixation barbs. Exercise extreme caution when manipulating interventional and angiographic devices in the region of the covered proximal stent and uncovered distal stent.
- Use caution during manipulation of catheters, wires and sheaths within an aneurysm or the region of an ulcer. Significant disturbances may dislodge fragments of thrombus or plaque, which can cause distal or cerebral embolization, or cause rupture of the aneurysm.
- Avoid damaging the graft or disturbing graft positioning after placement in the event re-instrumentation (secondary intervention) of the graft is necessary.
- Care should be taken not to advance the sheath while the stent graft is still within it. Advancing the sheath at this stage may cause the barbs to perforate the introducer sheath.
- To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

4.6 Molding Balloon Use – Optional

- Do not inflate the balloon in aorta outside of the graft, as doing so may cause damage to the aorta. Use the balloon in accordance with its labeling.
- Use care in inflating the balloon within the graft in the presence of calcification, as excessive inflation may cause damage to the aorta.
- Confirm complete deflation of balloon prior to repositioning.
- For added hemostasis, the Captor® Hemostatic Valve can be loosened or tightened to accommodate the insertion and subsequent withdrawal of a molding balloon.

4.7 MRI Safety and Compatibility

Non-clinical testing has demonstrated that the Zenith TX2® TAA Endovascular Graft is MR Conditional. It can be scanned safely under the following conditions:

1.5 Tesla Systems:

- Static magnetic field of 1.5Tesla
- Spatial gradient field of 450 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning.

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.4 °C at a maximum whole body averaged specific absorption rate (SAR) of 2.8 W/kg for 15 minutes of MR scanning in a 1.5 Tesla Magnetom, Siemens Medical Magnetom MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 2.8 W/kg, which corresponds to a calorimetry measured value of 1.5 W/kg.

3.0 Tesla Systems:

- Static magnetic field of 3.0 Tesla
- Spatial gradient field of 720 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.9 °C at a maximum whole body averaged specific absorption rate (SAR) of 3.0 W/kg for 15 minutes of MR scanning in a 3.0 Tesla, Excite, GE Electric Healthcare MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 3.0 W/kg, which corresponds to a calorimetry measured value of 2.8 W/kg.

The image artifact extends throughout the anatomical region containing the device, obscuring the view of immediately adjacent anatomical structures within approximately 20 cm or mm of the device, as well as the entire device and its lumen, when scanned in nonclinical testing using the sequence: Fast spin echo in a 3.0 Tesla, Excite, GE Electric Healthcare, with G3.0-052B software, MR system with body radiofrequency coil.

For all scanners, the image artifact dissipates as the distance from the device to the area of interest increases. MR scans of the lower extremities may be obtained without image artifact. Image artifact may be present in scans of the abdominal, upper extremity, and head and neck region, depending on distance from the device to the area of interest.

Clinical information is available on six patients who received MRI scans during the course of the clinical trial. There have been no reported adverse events or device problems in any of these patients as a result of having received an MRI. Additionally, there have been approximately 3,000 patients implanted with Zenith TAA Endovascular Grafts world wide, in which there have been no reported adverse events or device problems as a result of MRI.

Cook recommends that the patient register the MR conditions disclosed in this IFU with the MedicAlert Foundation. The MedicAlert Foundation can be contacted in the following manners:

Mail: MedicAlert Foundation International
2323 Colorado Avenue

Turlock, CA 95382

Phone: 888-633-4298 (toll free)
209-668-333 from outside the US

Fax: 209-669-2450

Web: www.medicalert.org

5. POTENTIAL ADVERSE EVENTS

Adverse events that may occur and/or require intervention include, but are not limited to:

- Amputation
- Anesthetic complications and subsequent attendant problems (e.g., aspiration)
- Aneurysm enlargement
- Aneurysm rupture and death
- Aortic damage, including perforation, dissection, bleeding, rupture and death
- Aorto-bronchial fistula
- Aorto-esophageal fistula
- Arterial or venous thrombosis and/or pseudoaneurysm
- Arteriovenous fistula
- Bleeding, hematoma, or coagulopathy
- Bowel complications (e.g., ileus, transient ischemia, infarction, necrosis)
- Cardiac complications and subsequent attendant problems (e.g., arrhythmia, tamponade myocardial infarction, congestive heart failure, hypotension, hypertension)
- Claudication (e.g., buttock, lower limb)
- Compartment Syndrome
- Death
- Edema
- Embolization (micro and macro) with transient or permanent ischemia or infarction
- Endoleak
- Endoprosthesis: improper component placement; incomplete component deployment; component migration and/or separation; suture break; occlusion; infection; stent fracture; graft material wear; dilatation; erosion; puncture; perigraft flow; barb separation and corrosion
- Femoral neuropathy
- Fever and localized inflammation
- Genitourinary complications and subsequent attendant problems (e.g., ischemia, erosion, fistula, urinary incontinence, hematuria, infection)
- Hepatic failure
- Impotence
- Infection of the aneurysm, device or access site, including abscess formation, transient fever and pain
- Lymphatic complications and subsequent attendant problems (e.g., lymph fistula, lymphocele)
- Local or systemic neurologic complications and subsequent attendant problems (e.g., stroke, transient ischemic attack, paraplegia, paraparesis/spinal cord shock, paralysis)
- Occlusion of device or native vessel
- Pulmonary embolism
- Pulmonary/respiratory complications and subsequent attendant problems (e.g., pneumonia, respiratory failure, prolonged intubation)
- Renal complications and subsequent attendant problems (e.g., artery occlusion, contrast toxicity, insufficiency, failure)

- Surgical conversion to open repair
- Vascular access site complications, including infection, pain, hematoma, pseudoaneurysm, arteriovenous fistula
- Vascular spasm or vascular trauma (e.g., ilio-femoral vessel dissection, bleeding, rupture, death)
- Wound complications and subsequent attendant problems (e.g., dehiscence, infection)

Device-Related Adverse Event Reporting

Any adverse event (clinical incident) involving the Zenith TX2 TAA Endovascular Graft should be reported to COOK immediately. To report an incident, call the Customer Relations Department at 1-800-457-4500 (24 hour) or 1-812-339-2235.

6. SUMMARY OF CLINICAL DATA

The STARZ-TX2 Clinical Trial is a non-randomized, controlled, multi-center, study that was conducted to evaluate safety and effectiveness of the Zenith TX2® TAA Endovascular Graft in the elective treatment of patients with descending thoracic aortic aneurysms or ulcers, as compared to open surgical repair. The study consisted of an endovascular treatment group and an open surgical control group. The open surgical control group was comprised of both prospectively enrolled and retrospectively enrolled patients. The same inclusion/exclusion criteria applied to both the endovascular treatment group and open surgical control group, except that patients in the open surgical control group were not required to have anatomy amenable to endovascular repair with the Zenith TX2® TAA Endovascular Graft.

The study was designed to assess two primary and two secondary hypotheses regarding the endovascular treatment group compared to the open surgical control group. The primary hypothesis for safety was non-inferior 30-day survival, and the primary hypothesis for effectiveness was non-inferior 30-day rupture-free survival (i.e., freedom from rupture). The secondary hypotheses were superior clinical utility in the endovascular treatment group and non-inferior 30-day morbidity, expressed as a composite morbidity score including 57 pre-specified events. In addition, the study assessed survival, morbidity, and device performance through 12 months, and will continue these assessments at yearly intervals through 5 years.

In addition to covariate analysis, propensity score analysis was used to assess comparability of the groups. The control group was analyzed to justify the use of both retrospectively and prospectively enrolled patients.

FDA requested additional analyses, including the analysis of a composite effectiveness endpoint (freedom from a device event) and separate analyses of patients with aneurysms and patients with ulcers. The separate analyses for aneurysm patients and ulcer patients did not show any findings unique to the specific indications. Data for aneurysm and ulcer patients are presented separately where appropriate.

Patient imaging underwent independent core laboratory analysis. Adverse events, including all patient deaths, were adjudicated by an independent clinical events committee. A data safety monitoring board, comprised of independent physicians and a biostatistician, monitored the safety of the study.

Forty-two (42) institutions enrolled a total of 160 endovascular treatment patients and 70 (19 prospective and 51 retrospective) open surgical control patients, including 20 institutions that enrolled both endovascular treatment and open surgical control patients, 16 institutions that enrolled only endovascular treatment patients, and 6 institutions that enrolled only open surgical control patients. Although nearly 75% of the open surgical control patients were enrolled retrospectively, the endovascular treatment group and open surgical control groups proved to be

largely contemporaneous; the earliest open surgical control patient was treated less than one year prior to IDE initiation, and 81% of the open surgical control patients were treated on or after the date on which the first endovascular patient was treated.

The study follow-up schedule for patients enrolled in the endovascular treatment group consisted of radiographic (CT scan and X-ray) and clinical assessments at pre-discharge, 30 days, 6 months, 12 months, and yearly thereafter through 5 years. The study follow-up schedule for patients enrolled in the open surgical control group consisted of radiographic (CT scan) and clinical assessments at pre-discharge (or 30 days) and 12 months, with an interim telephone contact at 6 months. Patient availability for study follow-up through 12 months as of September 12, 2007 is summarized in Table 6.1. Available data from on-going 24-month follow-up are also provided.

Table 6.1 Follow-up Availability

Time point	Eligible for follow-up (n)	Subjects with submitted data: Clinical % (n)	CT % (n)	X-ray % (n)	Adequate imaging to assess parameter per core lab: Size increase % (n)	Endoleak % (n)	Migration % (n)	Fracture % (n)	Events occurring before next visit: Death (n)	Conversion (n)	LTF (n)	Not due for next visit (n)
Endovascular												
Pre-discharge	158[a]	100% (158)	94% (149)	98% (154)	n/a	85% (135)	n/a	96% (152)	3	0	0	0
30-day	155	94% (146)	92% (142)	87% (134)	78% (121)	81% (126)	72% (111)	88% (136)	5	0	5	0
6-month	145	90% (130)	89% (129)	85% (123)	81% (117)	79% (114)	77% (112)	88% (127)	5	0	5	0
12-month	135	94% (127)	92% (124)	85% (115)	83% (112)	76% (103)	79% (107)	91% (123)	10	0	4	25
24-month	96	70% (67)	61% (59)	63% (60)	58% (56)	59% (57)	57% (55)	66% (63)	n/a	n/a	n/a	n/a
Open Surgical												
Pre-discharge / 30-day	70	100% (70)	n/a	n/a	n/a	n/a	n/a	n/a	8	n/a	0	0
6-month	62	60% (37)	n/a	n/a	n/a	n/a	n/a	n/a	2	n/a	0	0
12-month	60	65% (39)	n/a	n/a	n/a	n/a	n/a	n/a	0	n/a	1	29[b]
24-month	30	27% (8)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

n/a – not applicable

[a] Device insertion was not achieved in two patients.

[b] IRB/EC-approved follow-up was limited to 12 months at 11 sites that enrolled open surgical control patients (n=24); 5 patients not due for next visit.

The following tables (Tables 6.2 through 6.5) present characteristics of the two study groups. Covariate and propensity score analysis supported the appropriateness of comparisons between study groups. Table 6.2 compares the demographics and patient characteristics between the endovascular treatment group and open surgical control group.

Table 6.2 Demographics and Patient Characteristics

Demographic/characteristic	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
Age (years)	72.4 ± 9.6 (160)	67.6 ± 11.6 (70)	4.8 (1.9, 7.7)	<0.01
Gender				0.09
Male	72% (115/160)	60% (42/70)	12 (-1.6, 25)	
Female	28% (45/160)	40% (28/70)	-12 (-25, 1.6)	
Ethnicity[3]				0.82
Asian	2.5% (4/159)	1.4% (1/70)	1.1 (-2.6, 4.8)	
Black/African American	12% (19/159)	8.6% (6/70)	3.4 (-4.9, 12)	
Hispanic/Latino	3.8% (6/159)	4.3% (3/70)	-0.5 (-6.1, 5.1)	
White/Caucasian	80% (127/159)	86% (60/70)	-5.8 (-16, 4.5)	
Other	1.9% (3/159)	0.0% (0/70)	1.9 (n/a)	
Height (in)	67.5 ± 4.0 (154)	66.9 ± 3.6 (69)	0.6 (-0.5, 1.8)	0.26
Weight (lbs)	177 ± 35 (158)	167 ± 32 (70)	11 (1.1, 20)	0.02
Body mass index	27.2 ± 4.9 (153)	25.9 ± 3.7 (69)	1.3 (0.1, 2.5)	0.03

n/a – not applicable
[1] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.
[2] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.
[3] Ethnicity reported as unknown in one patient.

Table 6.3 compares the medical history between the endovascular treatment group and open surgical control group.

Table 6.3 Medical History

Medical history	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value[2]
Cardiovascular				
Myocardial infarction	22.2% (35/158)	25% (17/68)	-2.9 (-15, 9.3)	0.73
Congestive heart failure	12.5% (20/160)	11.6% (8/69)	0.9 (-8.2, 10)	>0.99
Coronary artery disease	43.7% (69/158)	42% (29/69)	1.6 (-12, 16)	0.88
Arrhythmia	30.2% (48/159)	18.8% (13/69)	11 (-0.3, 23)	0.10
Vascular				
Thromboembolic event	10.1% (16/159)	8.7% (6/69)	1.4 (-6.8, 9.5)	>0.99
Peripheral vascular disease	24.4% (39/160)	26.1% (18/69)	-1.7 (-14, 11)	0.86
Family history of aneurysm	17.1% (24/140)	20.4% (11/54)	-3.2 (-16, 9.2)	0.67
Hypertension	89.4% (143/160)	82.9% (58/70)	6.5 (-3.5, 17)	0.19
Thoracic surgery/trauma	10% (16/160)	25.7% (18/70)	-16 (-27, -4.5)	<0.01
Diagnosed AAA	31.3% (50/160)	22.9% (16/70)	8.4 (-3.8, 21)	0.20
Repaired AAA	19.4% (31/160)	14.3% (10/70)	5.1 (-5.1, 15)	0.47
Chronic obstructive pulmonary disease	44.7% (71/159)	42.9% (30/70)	1.8 (-12, 16)	0.88
Renal failure requiring dialysis	3.1% (5/160)	2.9% (2/70)	0.3 (-4.5, 5.0)	>0.99
Diabetes	18.8% (30/160)	14.3% (10/70)	4.5 (-5.7, 15)	0.45
Sepsis	1.9% (3/156)	1.5% (1/68)	0.5 (-3.1, 4.0)	>0.99

Neurologic Cerebrovascular accident Carotid endarterectomy	 15.0% (24/160) 5.7% (9/159)	 14.7% (10/68) 2.9% (2/70)	 0.3 (-9.8, 10) 2.8 (-2.5, 8.1)	 >0.99 0.51
Gastrointestinal disease	40.5% (64/158)	30% (21/70)	11 (-2.7, 24)	0.14
Liver disease	6.3% (10/160)	4.3% (3/70)	2.0 (-4.1, 8.0)	0.75
Cancer	25.2% (40/159)	15.7% (11/70)	9.4 (-1.4, 20)	0.12
Excessive alcohol use	3.2% (5/157)	0.0% (0/67)	3.2 (n/a)	0.32
Tobacco use Current smoker Quit smoking Never smoked	 22.4% (35/156) 66% (103/156) 11.5% (18/156)	 17.6% (12/68) 61.8% (42/68) 20.6% (14/68)	 4.8 (-6.4, 16) 4.3 (-9.5, 18) -9.1 (-20, 1.8)	0.19
Access site Previous surgery Previous radiation	 10.1% (16/159) 0.0% (0/159)	 1.4% (1/69) 0.0% (0/69)	 8.6 (3.2, 14) 0 (n/a)	 0.02 n/a
Allergies	43.8% (70/160)	40% (28/70)	3.8 (-10, 18)	0.66

n/a – not applicable
[1] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.
[2] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.

Table 6.4 compares the results from patient risk assessment between the endovascular treatment group and open surgical control group.

Table 6.4 Patient Risk Assessment

Item[1]	Endovascular	Open Surgical	Diff (95% CI)[2]	*p* value [3]
ASA classification Healthy patient (1) Mild systemic disease (2) Severe systemic disease (3) Incapacitating systemic disease (4) Moribund patient (5)	 8.8% (14/160) 50% (80/160) 36.9% (59/160) 4.4% (7/160) 0% (0/160)	 7.1% (5/70) 41.4% (29/70) 28.6% (20/70) 22.9% (16/70) 0% (0/70)	 1.6 (-5.9, 9.1) 8.6 (-5.3, 22) 8.3 (-4.7, 21) -18 (-29, -8.2) 0 (n/a)	< 0.01
Total SVS-ISCVS risk score	6.4 ± 3.0 (159)	5.4 ± 3.5 (68)	1.0 (0.1, 1.9)	0.03

n/a – not applicable
[1] The SVS-ISCVS scoring system may be considered more objective than the ASA classification; however, direct comparisons of key patient characteristics are provided in Tables 6.2 and 6.3.
[2] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.
[3] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.

Table 6.5 compares the morphology type, location, and size between the endovascular treatment group and open surgical control group based on the results from core lab analysis.

Table 6.5 Morphology Type, Location and Size

Item	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
Morphology type Aneurysm Ulcer[3]	 85.6% (137/160) 14.4% (23/160)	 90.0% (63/70)[4] 10.0% (7/70)	 -4.4 (-13,4.5) 4.4 (-4.5, 13)	0.40
Morphology location[5]				0.02

Proximal Middle Distal	22.5% (36/160) 55.0% (88/160) 22.5% (36/160)	36.9% (24/65) 52.3% (34/65) 10.8% (7/65)	-14 (-28, -1.0) 2.7 (-12, 17) 12 (1.8, 22)	
Aneurysm size				
Major axis diameter (mm)	60.8 ± 10.7 (137)	63.0 ± 10.8 (53)	-2.2 (-5.6, 1.2)	0.20
Minor axis diameter (mm)	50.8 ± 10.5 (137)	57.5 ± 9.3 (49)	-6.7 (-10, -3.3)	<0.01
Length (mm)	151 ± 71.3 (132)	158.6 ± 81.0 (46)	-7.9 (-33, 17)	0.53
Ulcer size				
Major axis diameter (mm)	28.7 ± 9.7 (22)	29.0 ± 7.3 (7)	-0.2 (-8.4, 8.0)	0.95
Minor axis diameter (mm)	20.9 ± 7.7 (23)	21.1 ± 9.8 (7)	-0.1 (-7.4, 7.1)	0.96
Depth (mm)	14.4 ± 4.7 (22)	20.7 ± 7.8 (7)	-6.3 (-11, -1.4)	0.01

n/a – not applicable

[1] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.

[2] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.

[3] Ulcers ≥10 mm in depth and 20 mm in diameter were eligible for study inclusion.

[4] As determined by site assessment for 7 open surgical patients without available imaging for core lab analysis.

[5] Primary location described as proximal one-third (i.e., arch to T6), middle one-third (i.e., T6-T8), or distal one-third (i.e., T9-L2).

Devices Implanted

Endovascular patients were treated using either a two-piece main body (proximal main body component in combination with a distal main body component – note: the proximal main body component and distal main body component are described in a separate IFU specific to the two-piece main body system) or a one-piece main body (either a proximal main body component only or a one-piece main body component). Table 6.6 reports the percent of endovascular patients treated with a two-piece main body and the percent of patients treated with a one-piece main body. Also reported are the total number of components deployed during the initial implant procedure for patients treated with a two-piece main body and for patients treated with a one-piece main body in order to account for ancillary component use.

Table 6.6 Main Body System Type and Total Number of Components

Type	% (n)	Total number of components (main body and ancillary)			
		1	2	3	4
Two-piece	59.5% (94/158)	n/a	88.3% (83/94)	11.7% (11/94)	0% (0/94)
One-piece	40.5% (64/158)	90.6% (58/64)[1]	7.8% (5/64)	1.6% (1/64)	0% (0/64)

[1] One patient received a proximal extension as the principal endograft.

Table 6.7 reports the number of components (main body components and main body extensions) used during the initial implant procedure, by diameter.

Table 6.7 Graft Diameters Implanted during Initial Procedure

Diameter (mm)	Non-tapered proximal main body component[1] (n)	Tapered proximal main body component[1] (n)	Distal main body compo-nent[1] (n)	One-piece main body component (n)	Proximal extension (n)	Distal extension (n)
28	4	n/a	2	0	0	1
30	8	n/a	2	2	1	0
32	13	2	7	0	1	1
34	22	1	14	1	2	2
36	19	3	17	0	3	1
38	22	7	22	0	0	0
40	29	5	20	0	0	4
42	12	7	10	0	2	1

[1]Multiple length increments available for each diameter.

Results

Safety

The primary safety hypothesis was based on 30-day survival, which was non-inferior ($p<0.01$) in the endovascular treatment group compared to the open surgical control group (98.1% vs. 94.3%). As illustrated by Figure 6.1 and presented in Table 6.8, 365-day survival from all-cause mortality was 91.6% in the endovascular treatment group and 85.5% in the open surgical control group. Survival from all-cause mortality at 730 days is 79.8% in the endovascular treatment group and 85.5% in the open surgical control group, with follow-up on-going. Survival from aneurysm-related mortality (i.e., death occurring within 30 days of the initial implant procedure or a secondary intervention, or any death adjudicated to be aneurysm-related by the independent clinical events committee) through 365 days was 94.2% in the endovascular treatment group and 88.2% in the open surgical control group, as illustrated by Figure 6.2 and presented in Table 6.9. Survival from aneurysm-related mortality at 730 days is 92.9% in the endovascular treatment group and 88.2% in the open surgical control group, with follow-up on-going.

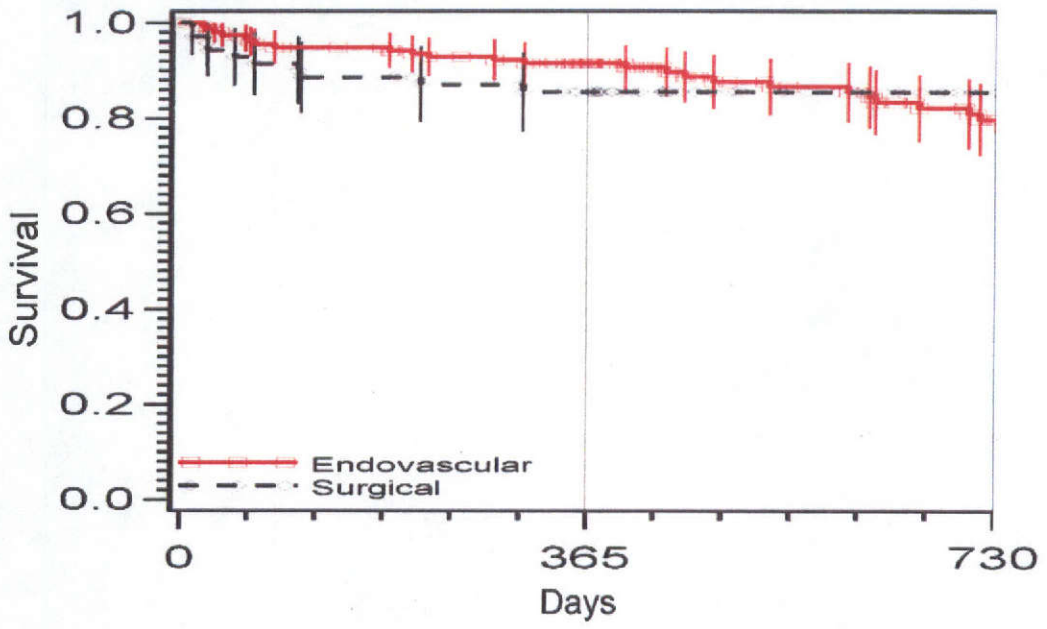


Figure 6.1 Survival from All-Cause Mortality through 730 Days

Table 6.8 Kaplan-Meier All-cause Mortality Survival Estimates

Arm	Days	Kaplan-Meier Estimate	Standard Error	Cumulative Events	Cumulative Censored	Patients Remaining
Endovascular	0	1.000	0.0000	0	0	160
	30	0.981	0.0107	3	1	156
	365	0.916	0.0223	13	28	119
	730	0.798	0.0387	24	78	58
Open Surgical	0	1.000	0.0000	0	0	70
	30	0.943	0.0277	4	0	66
	365	0.855	0.0423	10	7	53
	730	0.855	0.0423	10	45	15

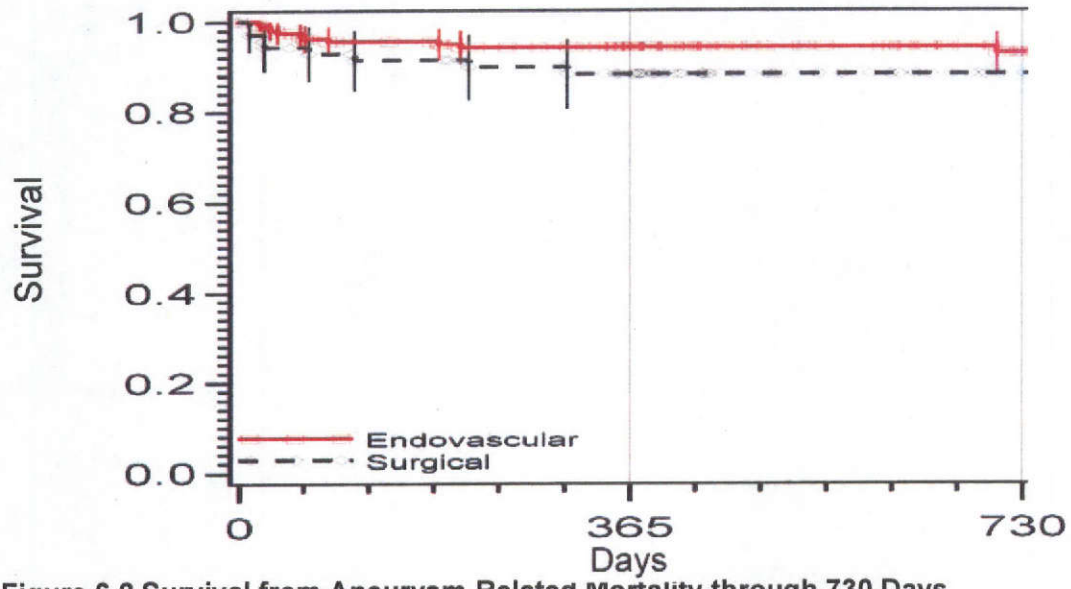


Figure 6.2 Survival from Aneurysm-Related Mortality through 730 Days

Table 6.9 Kaplan-Meier TAA-related Mortality Survival Estimates

Arm	Days	Kaplan-Meier Estimate	Standard Error	Cumulative Events	Cumulative Censored	Patients Remaining
Endovascular	0	1.000	0.0000	0	0	160
	30	0.981	0.0107	3	1	156
	365	0.942	0.0187	9	32	119
	730	0.929	0.0229	10	92	58
Open Surgical	0	1.000	0.0000	0	0	70
	30	0.943	0.0277	4	0	66
	365	0.882	0.0391	8	9	53
	730	0.882	0.0391	8	47	15

A secondary hypothesis was based on 30-day morbidity with endovascular treatment, expressed as a composite morbidity score (mean number of events per patient), which, as shown in Table 6.10, was non-inferior in the endovascular treatment group compared to the open surgical control group ($p<0.01$).

Table 6.10 Total Morbidity Score within 0-30 Days

Item	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
30-day morbidity score (events[3] per patient)	1.3 ± 3.0 (160)	2.9 ± 3.6 (70)	-1.6 (-2.5, -0.7)	<0.01

[1] Confidence interval on the difference in means utilized the T-distribution and is unadjusted for multiplicity.
[2] *p* value is based on test for non-inferiority and is unadjusted for multiplicity.
[3] Pre-specified events that were considered for the morbidity score included: cardiovascular events (Q-wave myocardial infarction; non-Q-wave myocardial infarction; congestive heart failure; arrhythmia requiring intervention or new treatment; cardiac ischemia requiring intervention; inotropic support; refractory hypertension [systolic BP of >160 despite receiving medication]; cardiac event involving arrest, resuscitation, or balloon pump); pulmonary events (ventilation >24 hours; re-intubation; pneumonia requiring antibiotics; supplemental oxygen at time of discharge; chronic obstructive pulmonary disease; pleural effusion requiring treatment; pulmonary edema requiring treatment; pneumothorax; hemothorax; pulmonary event requiring tracheostomy or chest tube); renal events (urinary tract infection requiring antibiotic treatment; renal failure requiring dialysis; renal insufficiency [serum creatinine rise >30% from baseline resulting in a persistent value >2.0 mg/dL]; permanent dialysis, hemofiltration, or kidney transplant in patient with normal pre-procedure creatinine); gastrointestinal events (bowel/mesenteric ischemia; gastrointestinal infection requiring treatment; gastrointestinal bleeding requiring treatment; paralytic ileus >4 days; bowel resection); neurological events (stroke; TIA/RIND; carotid artery embolization/occlusion; paraparesis/spinal cord shock; paraplegia); vascular events (pulmonary embolism; pulmonary embolism involving hemodynamic instability or surgery; vascular injury; aneurysm leak/rupture; aneurysm or vessel leak requiring re-operation; pseudoaneurysm requiring surgical repair; increase in aneurysm size >0.5 cm relative to first post-procedure measurement; aorto-esophageal fistula; aorto-bronchial fistula; aorto-enteric fistula; arterial thrombosis; embolization resulting in tissue loss or requiring intervention; amputation involving more than the toes; deep vein thrombosis; deep vein thrombosis requiring surgical or lytic therapy; hematoma requiring surgical repair; hematoma requiring receipt of blood products; coagulopathy requiring surgery; post-procedure transfusion); wound events (wound infection requiring antibiotic treatment; incisional hernia; lymph fistula; wound breakdown requiring debridement; seroma requiring treatment; wound complication requiring return to the operating room).

The 30-day and 365-day Kaplan-Meier estimates for freedom from any one of the following pre-specified events (representing a subset of the events listed in Table 6.10) are illustrated in Figure 6.3 and reported in Table 6.11, along with the estimates for each individual event: Q-wave MI; cardiac event involving arrest, resuscitation, or balloon pump; ventilation >72 hours; re-intubation; pulmonary event requiring a tracheostomy or chest tube; permanent dialysis, hemofiltration, or transplant [in a patient with normal pre-procedure creatinine]; bowel resection; stroke; paraplegia; pulmonary embolism involving hemodynamic instability or requiring surgery; aneurysm or vessel leak requiring re-operation; amputation involving more than the toes; deep vein thrombosis requiring surgery or lytic therapy; coagulopathy requiring surgery; and wound complication requiring return to OR. The 30-day estimate for freedom from any of the events from this pre-specified subset was 90.6% in the endovascular treatment group and 67.1% in the open surgical control group. The 365-day estimate for freedom from these events was 87.3% in the endovascular treatment group and 64.3% in the open surgical control group. The 730 day estimate for freedom from any of the events from the pre-specified subset is 83.6% in the endovascular treatment group and 64.3% in the open surgical control group, with follow-up ongoing.

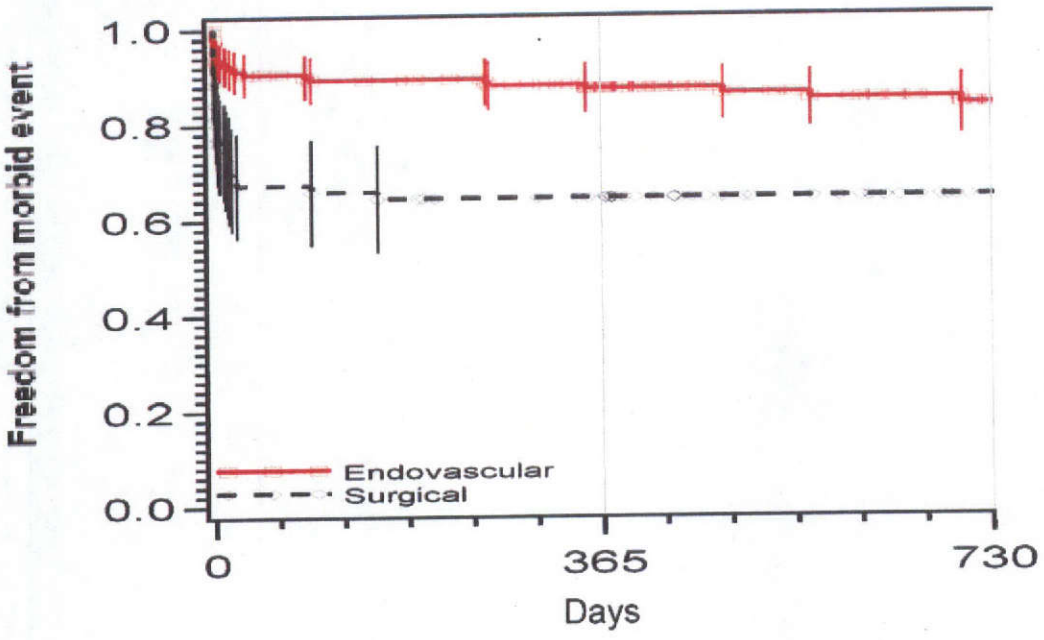


Figure 6.3 Freedom from Pre-specified Subset of Morbid Events through 730 Days

Table 6.11 Summary of Kaplan-Meier Estimates for Freedom from Pre-specified Subset of Morbid Events*

Event	Parameter	30 days		365 days		730 days	
		Endo	Open	Endo	Open	Endo	Open
Any event	Number at risk[1]	160	70	144	47	109	39
	Cumulative events	15	23	20	25	23	25
	Cumulative censored[2]	1	0	31	6	84	35
	Kaplan-Meier est.[3]	0.91	0.67	0.87	0.64	0.84	0.64
	Standard error	0.02	0.06	0.03	0.06	0.3	0.06
Q-wave MI	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	0	0	0
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	1.00	1.00	1.00	1.00	1.00
	Standard error	0.00	0.00	0.00	0.00	0.00	0.00
Cardiac event involving arrest, resuscitation or balloon pump	Number at risk[1]	160	70	153	66	118	53
	Cumulative events	4	1	4	2	5	2
	Cumulative censored[2]	3	3	38	15	98	53
	Kaplan-Meier est.[3]	0.98	0.99	0.98	0.97	0.96	0.97
	Standard error	0.01	0.01	0.01	0.02	0.02	0.02
Vent. >72 hours	Number at risk[1]	160	70	155	57	119	46
	Cumulative events	1	11	1	11	1	11
	Cumulative censored[2]	4	2	40	13	101	47
	Kaplan-Meier est.[3]	0.99	0.84	0.99	0.84	0.99	0.84
	Standard error	0.01	0.04	0.01	0.04	0.01	0.04
Re-intubation	Number at risk[1]	160	70	150	57	117	47
	Cumulative events	8	10	8	11	9	11
	Cumulative censored[2]	2	3	35	12	94	47
	Kaplan-Meier est.[3]	0.95	0.86	0.95	0.84	0.94	0.84
	Standard error	0.02	0.04	0.02	0.04	0.02	0.04

Pulmonary event requiring tracheostomy or chest tube	Number at risk[1]	160	70	154	59	118	49
	Cumulative events	2	9	4	12	5	12
	Cumulative censored[2]	4	2	38	9	97	45
	Kaplan-Meier est.[3]	0.99	0.87	0.97	0.82	0.96	0.82
	Standard error	0.01	0.04	0.01	0.05	0.02	0.05
Permanent dialysis or transplant	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	0	0	0
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	1.00	1.00	1.00	1.00	1.00
	Standard error	0.00	0.00	0.00	0.00	0.00	0.00
Bowel resection	Number at risk[1]	160	70	153	65	117	52
	Cumulative events	3	1	5	1	5	1
	Cumulative censored[2]	4	4	38	17	98	54
	Kaplan-Meier est.[3]	0.98	0.99	0.97	0.99	0.97	0.99
	Standard error	0.01	0.01	0.01	0.01	0.01	0.01
Stroke	Number at risk[1]	160	70	153	63	117	50
	Cumulative events	4	6	5	7	6	7
	Cumulative censored[2]	3	1	38	13	98	48
	Kaplan-Meier est.[3]	0.98	0.91	0.97	0.90	0.95	0.90
	Standard error	0.01	0.03	0.01	0.04	0.02	0.04
Paraplegia	Number at risk[1]	160	70	155	63	119	53
	Cumulative events	2	4	2	4	2	4
	Cumulative censored[2]	3	3	39	13	100	51
	Kaplan-Meier est.[3]	0.99	0.94	0.99	0.94	0.99	0.94
	Standard error	0.01	0.03	0.01	0.03	0.01	0.03
PE involving hemodynamic instability or surgery	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	0	0	0
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	1.00	1.00	1.00	1.00	1.00
	Standard error	0.00	0.00	0.00	0.00	0.00	0.00
Aneurysm or vessel leak requiring re-operation	Number at risk[1]	160	70	156	65	119	52
	Cumulative events	0	1	0	1	0	1
	Cumulative censored[2]	4	4	41	17	102	54
	Kaplan-Meier est.[3]	1.00	0.99	1.00	0.99	1.00	0.99
	Standard error	0.00	0.01	0.00	0.01	0.00	0.01
Amputation involving more than toes	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	1	0	1
	Cumulative censored[2]	4	4	41	16	102	54
	Kaplan-Meier est.[3]	1.00	1.00	1.00	0.98	1.00	0.98
	Standard error	0.00	0.00	0.00	0.02	0.00	0.02
Deep vein thrombosis requiring surgery or lytic therapy	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	1	0	1	0
	Cumulative censored[2]	4	4	40	17	101	55
	Kaplan-Meier est.[3]	1.00	1.00	0.99	1.00	0.99	1.00
	Standard error	0.00	0.00	0.01	0.00	0.01	0.00
Coagulopathy requiring surgery	Number at risk[1]	160	70	156	65	119	52
	Cumulative events	0	1	0	1	0	1
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	0.99	1.00	0.99	1.00	0.99
	Standard error	0.00	0.01	0.00	0.01	0.00	0.01
Wound complication requiring return to OR	Number at risk[1]	160	70	156	66	117	53
	Cumulative events	0	0	2	0	2	0
	Cumulative censored[2]	4	4	41	17	100	55
	Kaplan-Meier est.[3]	1.00	1.00	0.99	1.00	0.99	1.00
	Standard error	0.00	0.00	0.01	0.00	0.01	0.00

*Subset of events pre-selected from list in Table 6-10 prior to start of the study by the physician steering committee.

[1] Number of patients at risk at the beginning of the interval

[2] Total censored patients up to and including the specific interval

[3] Made at end of interval

Effectiveness

The primary effectiveness hypothesis was based on 30-day rupture-free survival (i.e., freedom from rupture), which was non-inferior ($p<0.01$) in the endovascular treatment group compared to the open surgical control group (100% vs. 100%). Because there were no ruptures in either group, the planned analysis (Blackwelder) could not be performed, and an alternate analysis (exact non-inferiority test) was necessary to generate the p value. Freedom from rupture was 100% in both groups through 365 days post-procedure. Freedom from rupture is 100% in both groups through 730 days post-procedure, with follow-up on-going.

The results from Kaplan-Meier analysis for freedom from any of the following device events are illustrated in Figure 6.4 and presented in Table 6.12: technical failure; loss of patency; rupture; secondary intervention; conversion; stent fracture; Type I or III endoleak; or migration. Freedom from any device event was 94.9% at 30 days and 90.1% at 365 days. Freedom from any device event at 730 days is 89.1%, with follow-up on-going.

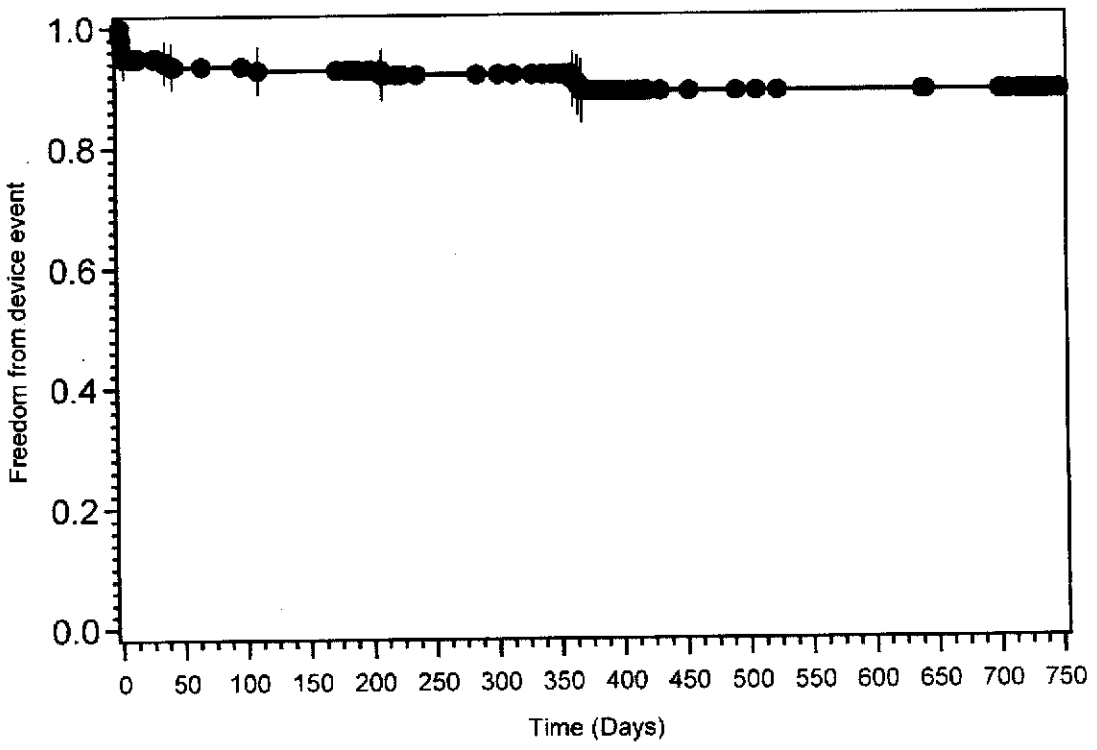


Figure 6.4 Freedom from Device Events

Table 6.12. Kaplan-Meier Estimate for Freedom from Device Events

Days	Kaplan-Meier Estimate	Standard Error	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Cumulative Events	Cumulative Censored	Patients Remaining
30	0.949	0.0176	0.914	0.983	8	14	138
365	0.901	0.0254	0.851	0.951	14	55	91
730	0.891	0.0271	n/a	n/a	15	105	40

Table 6.13 reports the percent of patients with an increase (>5 mm), decrease (>5 mm), or no change (≤5 mm) in aneurysm diameter or ulcer depth at each follow-up time point subsequent to pre-discharge (baseline) based on the results from core lab analysis. In total, 9 patients (7 aneurysm, 2 ulcer) experienced an increase in size within 12 months, with no new cases of growth identified at the 24-month follow-up, which remains on-going.

Table 6.13 Percent of Endovascular Treatment Patients with an Increase, Decrease, or No Change in Aneurysm/Ulcer Size Based on Core Lab Analysis

Time point	Combined % (n)	Aneurysm % (n)	Ulcer % (n)
30-day			
Increase (>5 mm)	0.8% (1/121)[1]	1.0% (1/105)	0% (0/16)
Decrease (>5 mm)	6.6% (8/121)	5.7% (6/105)	12.5% (2/16)
No change (≤5 mm)	92.6% (112/121)	93.3% (98/105)	87.5% (14/16)
6-month			
Increase (>5 mm)	3.4% (4/117)[2]	3.1% (3/98)	5.3% (1/19)
Decrease (>5 mm)	33.3% (39/117)	33.7% (33/98)	31.6% (6/19)
No change (≤5 mm)	63.2% (74/117)	63.3% (62/98)	63.2% (12/19)
12-month			
Increase (>5 mm)	7.1% (8/112)[3]	7.2% (7/97)	6.7% (1/15)
Decrease (>5 mm)	48.2% (54/112)	50.5% (49/97)	33.3% (5/15)
No change (≤5 mm)	44.6% (50/112)	42.3% (41/97)	60% (9/15)
24-month			
Increase (>5 mm)	1.8% (1/56)[4]	0% (0/49)	14.3% (1/7)
Decrease (>5 mm)	53.6% (30/56)	57.1% (28/49)	28.6% (2/7)
No change (≤5 mm)	44.6% (25/56)	42.9% (21/49)	57.1% (4/7)

[1] This aneurysm patient is also counted as an increase at 6 and 12 months, was without detectable endoleak or evidence of graft infection, and was found to have a decrease in size at the 24-month follow-up (without secondary intervention).

[2] Includes three new patients (2 aneurysm, 1 ulcer). Both aneurysm patients are also counted as an increase at 12 months. One aneurysm patient had no detectable endoleak or evidence of graft infection and was found to have no change in size at 24 months (without secondary intervention). The other aneurysm patient also had no detectable endoleak or evidence of graft infection, but had an aortic neck diameter at the location of actual graft placement that does not meet the recommended oversizing of at least 10% as well as an inverted funnel-shaped proximal neck and a funnel-shaped distal neck. This same patient also underwent two secondary interventions for aneurysm growth and expired within 30 days of the later secondary intervention (after removal of ventilator support following a stroke). The ulcer patient, who was noted to have a Type II endoleak at pre-discharge, was found to have no change in size at 12 months and 24 months (without secondary intervention).

[3] Includes five new patients (4 aneurysm, 1 ulcer). In three of the aneurysm patients, each of which are awaiting further follow-up, there was no detectable endoleak or evidence of graft infection, but the aortic neck diameter at the location of actual graft placement does not meet the recommended oversizing of at least 10%, and there was also an inverted funnel-shaped proximal aortic neck and a funnel-shaped distal aortic neck. The other new aneurysm patient was noted to have a distal Type I endoleak, underwent two secondary interventions, and is awaiting further follow-up. In the new ulcer patient, who also exhibited growth at 24 months, there was no detectable endoleak or evidence of graft infection, but the aortic neck diameter at the location of actual graft placement does not meet the recommended oversizing of at least 10%.

[4] This ulcer patient was first noted to have growth at 12 months, as discussed in note '3'.

Table 6.14 reports the percent of patients with endoleak (by type) at each follow-up time point based on the results from core lab analysis.

Table 6.14 Percent of Endovascular Treatment Patients with Endoleak (New and Persistent) Based on Core Lab Analysis

Type	Time point				
	Pre-discharge	30-day	6-month	12-month	24-month
Any (new only)	12.6% (17/135)	1.6% (2/126)[a,b]	0% (0/114)	1.0% (1/103)[c]	0% (0/57)
Any (new and persistent)	12.6% (17/135)	4.8% (6/126)	2.6% (3/114)	3.9% (4/103)	1.8% (1/57)
Multiple	0% (0/135)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)
Proximal Type I	0% (0/135)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)
Distal Type I	0.7% (1/135)	0.8% (1/126)	0.9% (1/114)	0% (0/103)	0% (0/57)
Type IIa	1.5% (2/135)	0.8% (1/126)[a]	0% (0/114)	0% (0/103)	0% (0/57)
Type IIb	5.9% (8/135)	2.4% (3/126)	1.8% (2/114)	1.9% (2/103)	1.8% (1/57)
Type III	1.5% (2/135)	0.8% (1/126)[b]	0% (0/114)	1.0% (1/103)[b]	0% (0/57)
Type IV	1.5% (2/135)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)
Unknown	1.5% (2/135)	0% (0/126)	0% (0/114)	1.0% (1/103)[c]	0% (0/57)

[a]Type IIa in one patient who did not undergo endoleak assessment at pre-discharge.

[b]Non-junctional Type III endoleak in one patient that was not evident at pre-discharge or 6-months, is not associated with aneurysm growth, has not required reintervention, and is awaiting further follow-up.

[c]Unknown Type endoleak, but in a patient who previously had a Type IIb endoleak at pre-discharge and no endoleak at 30 days or 6 months.

Table 6.15 reports the percent of patients with core lab-identified and CEC-confirmed migration (>10 mm) at each follow-up time point (date of first occurrence). There have been no patients with clinically significant migration (i.e., migration resulting in endoleak, growth, or requiring secondary intervention).

Table 6.15 Percent of Patients with CEC-Confirmed Migration (Date of First Occurrence)

Item	30-day	6-month	12-month	24-month
Migration (>10 mm)	0% (0/111)	0.9% (1/112)*	1.9% (2/106)*	1.8% (1/55)*

*Includes two cases of caudal migration of the proximal graft and two cases of cranial migration of the distal graft. All patients have an aortic neck diameter at the location of actual graft placement that does not meet the recommended oversizing of at least 10%. Additionally, three also have placement of the pertinent barbed stent in a neck that is either an acutely angled segment or in an area of thrombus.

Table 6.16 reports the percent of patients with device integrity findings at each follow-up time point based on the results from core lab analysis. One patient was noted to have a device integrity finding: entanglement of neighboring struts of the distal bare stent, which has not been associated with migration, endoleak, or the need for secondary intervention.

Table 6.16 Percent of Endovascular Treatment Patients with Device Integrity Findings by Core Lab

Finding	Time point				
	Pre-discharge	30-day	6-month	12-month	24-month
Stent fracture	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)
Barb separation	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)
Stent-to-graft separation	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)
Component	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)

separation					
Other	0.7% (1/152)[†]	0% (0/136)	0% (0/127)	0.8% (1/123)[†]	0% (0/63)

[†]Entanglement of neighboring struts of distal bare stent; same patient at pre-discharge and 12 months; finding not associated with migration, endoleak, or the need for secondary intervention.

Table 6.17 reports the results from core lab assessment for endovascular graft kink (evidence of reduced graft diameter or narrowing of lumen in the presence of acute aortic angulation), compression (evidence of reduced graft diameter or narrowing of the lumen in the absence of aortic angulation), and loss of patency. Three patients were noted to have a kink at one or more time points and two patients were noted to have compression at one or more time points. None required a secondary intervention.

Table 6.17 Endovascular Graft Kink, Compression, and Loss of Patency by Core Lab Analysis

	Time point				
Finding	**Pre-discharge**	**30-day**	**6-month**	**12-month**	**24-month**
Kink	1.9% (3/155)	0.7% (1/139)	0.8% (1/127)	1.6% (2/123)	0% (0/63)
Compression	1.4% (2/142)[a]	0.8% (1/124)[a]	0.9% (1/117)[a]	0.9% (1/108)[a]	2.1% (1/47)[a]
Loss of patency	0% (0/138)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)

[a] Concentric constriction of one mid-body stent of the device not associated with tortuosity or flow limitation with expansion of the stents above and below the compressed segment – this should be distinguished from the phenomena of endovascular graft collapse described in literature for other (non-Zenith) grafts.

Seven (4.4%) endovascular treatment patients (6 aneurysm, 1 ulcer) and four (5.7%) open surgical control patients (2 aneurysm, 2 ulcer) underwent at least one re-intervention within 365 days subsequent to the initial aneurysm/ulcer repair procedure. The reasons for re-intervention are reported in Table 6.18. There have been no conversions to open surgical repair in the endovascular treatment group.

Table 6.18 Reasons for Secondary Intervention

Reason	**Endovascular**			**Open Surgical**		
	0-30 days	**31-365 days**	**366-730 days**	**0-30 days**	**31-365 days**	**366-730 days**
Aneurysm rupture	0	0	0	0	0	0
Component separation	0	0	0	n/a	n/a	0
Symptoms	0	0	0	1[f]	0	0
Occlusion	0	0	0	0	0	0
Device stenosis	0	0	0	n/a	n/a	n/a
Device kink	0	0	0	n/a	n/a	n/a
Device migration	0	0	0	n/a	n/a	n/a
Infection	0	0	0	0	0	0
Endoleak	3	2[a]	0	n/a	n/a	n/a
Proximal Type I	1[b]	0	0			
Distal Type I	1[c]	2[a]	0			
Type IIa	0	0	0			
Type IIb	0	0	0			
Type III	1[d]	0	0			
Type IV	0	0	0			
Unknown	0	0	0			
Other	0	3[e]	1[f]	3[f,g]	1[h]	0

n/a – not applicable

[a] One aneurysm patient with two interventions for a distal Type I endoleak – bare stent placement and stent placement/coil embolization/distal extension placement.

[b] Aneurysm patient treated with proximal main body extension placement.
[c] Aneurysm patient treated with molding balloon angioplasty and distal extension placement
[d] Aneurysm patient underwent angiogram to rule out endoleak.
[e] Includes one ulcer patient with iliac artery occlusion, treated with femoral-femoral bypass; one aneurysm patient with growth, treated with distal extension placement in overlap and distal end of graft; and one aneurysm patient who developed a pseudoaneurysm at follow-up, treated with proximal extension placement.
[f] One ulcer patient with multiple reasons of symptoms and other (continued bleeding), treated with re-exploration and hemostatic sealing agents.
[g] Includes one aneurysm patient with intrapleural hematoma, treated with exploratory thoracotomy and evacuation; one ulcer patient with bleeding and tamponade, treated with intercostal vessel ligation.
[h] One aneurysm patient who developed an aorto-esophageal fistula at follow-up, treated with custom endograft placement.
[i] One aneurysm patient with growth, treated with placement of additional endovascular graft components, who also underwent secondary intervention for growth at 31-365 days, as discussed in note 'e'.

Clinical Utility

Another secondary hypothesis was superior clinical utility in the endovascular treatment group compared to the open surgical control group. All clinical utility measures were superior in the endovascular treatment group compared to the open surgical control group ($p<0.01$), as reported in Table 6.19.

Table 6.19 Clinical Utility Measures

Measure	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
Number of blood transfusions	0.3 ± 1.0 (160)	1.7 ± 1.9 (70)	-1.4 (-1.9, -0.9)	<0.01
Duration of intubation (hrs)	2.8 ± 4.6 (147)	53.1 ± 85.4 (66)	-50 (-71, -29)	<0.01
Duration of ICU stay (days)	2.2 ± 6.2 (153)	9.4 ± 16.9 (70)	-7.2 (-11, -3.1)	<0.01
Days to ambulation	1.6 ± 2.5 (148)	5.5 ± 5.6 (63)	-3.9 (-5.4, -2.5)	<0.01
Days to resumption of oral fluid intake	0.7 ± 1.9 (155)	4.0 ± 5.6 (60)	-3.3 (-4.8, -1.8)	<0.01
Days to resumption of regular diet	1.9 ± 2.7 (156)	5.2 ± 3.7 (58)	-3.3 (-4.4, -2.3)	<0.01
Days to resumption of bowel function	2.9 ± 2.3 (94)	5.5 ± 3.3 (61)	-2.6 (-3.6, -1.7)	<0.01
Days to hospital discharge	5.0 ± 8.6 (159)	16.1 ± 18.7 (70)	-11 (-16, -6.4)	<0.01

[1] Confidence interval on difference in means utilized the T-distribution and is unadjusted for multiplicity.
[2] *p* values are unadjusted for multiplicity.

Summary

All primary and secondary hypotheses were met. Specifically, 30-day mortality was non-inferior in the endovascular treatment group compared to the open surgical control group; 30-day morbidity was non-inferior in the endovascular treatment group compared to the open surgical control group; there were no ruptures in either the endovascular treatment group or open surgical control group; and all clinical utility measures were superior in the endovascular treatment group compared to the open surgical control group. There were no conversions to the open surgical repair in the endovascular treatment group, and the percent of patients requiring secondary interventions were similarly low between the endovascular treatment group and open surgical control group. Aneurysm/ulcer size stabilized or decreased in most endovascular patients at 12 months, and the rates of endoleak, migration, and device integrity findings were low at 12 months. Follow-up beyond 12 months remains on-going.

7. PATIENT SELECTION AND TREATMENT
(See **Section 4, WARNINGS AND PRECAUTIONS**)

7.1 Individualization of Treatment

Cook recommends that the Zenith TX2 TAA Endovascular Graft component diameters be selected as described in **Tables 10.1 and 10.2** . All lengths and diameters of the devices necessary to complete the procedure should be available to the physician, especially when pre-operative case planning measurements (treatment diameters/lengths) are not certain. This approach allows for greater intra-operative flexibility to achieve optimal procedural outcomes. The risks and benefits should be carefully considered for each patient before use of the Zenith TX2 TAA Endovascular Graft. Additional considerations for patient selection include but are not limited to:

- Patient's age and life expectancy.
- Co-morbidities (e.g., cardiac, pulmonary or renal insufficiency prior to surgery, morbid obesity).
- Patient's suitability for open surgical repair.
- The risk of aneurysm rupture compared to the risk of treatment with the Zenith TX2 TAA Endovascular Graft.
- Ability to tolerate general, regional, or local anesthesia.
- Ilio-femoral access vessel size and morphology (thrombus, calcification and/or tortuosity) should be compatible with vascular access techniques and accessories of the delivery profile of a 20 French to 22 French vascular introducer sheath.
- Vascular morphology suitable for endovascular repair, including:
  - Adequate iliac/femoral access compatible with the required introduction systems,
  - Radius of curvature greater than 35 mm along the entire length of aorta intended to be treated.
- Non-aneurysmal aortic segments (fixation sites) proximal and distal to the aneurysm or ulcer:
  - with a length of at least 25 mm
  - with a diameter measured outer wall to outer wall of no greater than 38 mm and no less than 24 mm, and
  - with an angle less than 45 degrees.

The final treatment decision is at the discretion of the physician and patient.

8. PATIENT COUNSELING INFORMATION

The physician and patient (and/or family members) should review the risks and benefits when discussing this endovascular device and procedure including:

- Risks and differences between endovascular repair and open surgical repair.
- Potential advantages of traditional open surgical repair.
- Potential advantages of endovascular repair.
- The possibility that subsequent interventional or open surgical repair of the aneurysm or ulcer may be required after initial endovascular repair.

In addition to the risks and benefits of an endovascular repair, the physician should assess the patient's commitment to and compliance with post-operative follow-up as necessary to ensure continuing safe and effective results. Listed below are additional topics to discuss with the patient as to expectations after an endovascular repair:

- The long-term performance of endovascular grafts has not yet been established. All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and the performance of their endovascular graft. Patients with spe-

cific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the endovascular graft) should receive enhanced follow-up. Specific follow-up guidelines are described in **Section 12, IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP.**

- Patients should be counseled on the importance of adhering to the follow-up schedule, both during the first year and at yearly intervals thereafter. Patients should be told that regular and consistent follow-up is a critical part of ensuring the ongoing safety and effectiveness of endovascular treatment of thoracic aortic aneurysms/ulcers. At a minimum, annual imaging and adherence to routine post-operative follow-up requirements is required and should be considered a life-long commitment to the patient's health and well-being.
- The patient should be told that successful aneurysm or ulcer repair does not arrest the disease process. It is still possible to have associated degeneration of vessels.
- Physicians must advise every patient that it is important to seek prompt medical attention if he/she experiences signs of graft occlusion, aneurysm or ulcer enlargement or rupture. Symptoms of graft occlusion include, but may not be limited to, pulse less legs, pain, ischemia of intestines, and cold extremities. Aneurysm or ulcer rupture may be asymptomatic, but usually presents as back or chest pain, persistent cough, dizziness, fainting, rapid heartbeat, or sudden weakness.
- Due to the imaging required for successful placement of endovascular devices, the risks of radiation exposure to developing tissue should be discussed with women who are or suspect they are pregnant. Men who undergo endovascular or open surgical repair may experience impotence.

The physician should complete the Patient Card and give it to the patient so that he/she can carry it with him/her at all times. The patient should refer to the card anytime he/she visits additional health practitioners, particularly for any additional diagnostic procedures (e.g., MRI). For additional information, please refer to the Zenith TX2 TAA Endovascular Graft Patient Guide.

9. HOW SUPPLIED

- The Zenith TX2 TAA Endovascular Graft is supplied sterile and pre-loaded in peel-open packages.
- The device is intended for single use only. Do not re-sterilize the device.
- Inspect the device and packaging to verify that no damage has occurred as a result of shipping. Do not use this device if damage has occurred or if the sterilization barrier has been damaged or broken. If damage has occurred, do not use the product and return to COOK.
- Prior to use, verify correct devices (quantity and size) have been supplied for the patient by matching the device to the order prescribed by the physician for that particular patient.
- The device is loaded into a 20 French or 22 French Flexor® Introducer Sheath. Its surface is treated with a hydrophilic coating that, when hydrated, enhances trackability. To activate the hydrophilic coating, the surface must be wiped with a 4X4 gauze pad soaked in saline solution.
- Do not use after the expiration date printed on the label.
- Store in a dark, cool, dry place.

10. CLINICAL USE INFORMATION

10.1 Physician Training

CAUTION: Always have a qualified surgery team available during implantation or reinter-

vention procedures in the event that conversion to open surgical repair is necessary.

CAUTION: The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System should only be used by physicians and teams trained in vascular interventional techniques (endovascular and surgical) and in the use of this device. The recommended skill/knowledge requirements for physicians using the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System are outlined below:

Patient selection:

- Knowledge of the natural history of thoracic aortic aneurysms (TAA) or ulcers, and co-morbidities associated with TAA repair.
- Knowledge of radiographic image interpretation, patient selection, device selection, planning and sizing.

A multidisciplinary team that has combined procedural experience with:

- Femoral and brachial cutdown, arteriotomy, and repair or conduit technique
- Percutaneous access and closure techniques
- Non-selective and selective wire guide and catheter techniques
- Fluoroscopic and angiographic image interpretation
- Embolization
- Angioplasty
- Endovascular stent placement
- Snare techniques
- Appropriate use of radiographic contrast material
- Techniques to minimize radiation exposure
- Expertise in necessary patient follow-up modalities

10.2 Inspection Prior to Use

Inspect the device and packaging to verify that no damage has occurred as a result of shipping. Do not use this device if damage has occurred or if the sterilization barrier has been damaged or broken. If damage has occurred, do not use the product and return to COOK.

Prior to use, verify correct devices (quantity and size) have been supplied for the patient by matching the device to the order prescribed by the physician for that particular patient.

10.3 Materials Required

(Not included in one-piece system)

- A selection of Zenith TX2 TAA Endovascular Graft Proximal and Distal ancillary components in diameters compatible with the one-piece system are available.
- Fluoroscope with digital angiography capabilities (C-arm or fixed unit)
- Contrast media
- Power injector
- Syringe
- Heparinized saline solution
- Sterile 4X4 gauze pads

10.4 Materials Recommended

(Not included in one-piece system)

The following products are recommended for implantation of any component in the Zenith product line. For information on these products, refer to the individual product's Suggested Instructions For Use.

- .035 inch (0.89 mm) extra stiff wire guide, 260 cm; for example:
  - Cook Amplatz Ultra Stiff Wire Guides (AUS)
  - Cook Lunderquist Extra Stiff Wire Guides (LESDC)

- .035 inch (0.89 mm) standard wire guide; for example:
  - Cook .035 inch wire guides
  - Cook .035 inch Bentson Wire Guide
  - Cook Nimble® Wire Guides
- Molding Balloons; for example:
  - Cook CODA® Balloon Catheter
- Introducer sets; for example:
  - Cook Check-Flo® Introducer Sets
- Sizing catheter; for example:
  - Cook Aurous® Centimeter Sizing Catheters
- Angiographic radiopaque marker catheters; for example:
  - Cook Beacon® Tip Angiographic Catheters
  - Cook Beacon® Tip Royal Flush Catheters
- Entry needles; for example:
  - Cook single wall entry needles

10.5 Device Diameter Sizing Guidelines

The choice of diameter should be determined from the outer wall to outer wall vessel diameter and **not** the lumen diameter. Undersizing or oversizing may result in incomplete sealing or compromised flow. In order to ensure accurate diameter measurements for the purpose of graft sizing, particularly when in curved segments of the aorta, measuring the aortic diameter using 3D reconstructed views perpendicular to the aortic centerline of flow may be important

Table 10.1 - Main Body Graft Diameter Sizing Guide*

Intended Aortic Vessel Diameter[1,2] (mm)	Graft Diameter[3] (mm)	Overall length of Main Body Graft	Introducer Sheath (Fr)	Introducer Sheath Outer Diameter (OD) (mm)
24	28	84	20	7.7
25	30	84	20	7.7
26	30	84	20	7.7
27	30	84	20	7.7
28	32	84	20	7.7

29	32	84	20	7.7
30	34	81	20	7.7
31	36	81	22	8.6
32	36	81	22	8.6
33	38	81	22	8.6
34	38	81	22	8.6
35	40	85	22	8.6
36	40	85	22	8.6
37	42	85	22	8.6
38	42	85	22	8.6

*All dimensions are nominal.
[1]Maximum diameter along the fixation site, measured outer wall to outer wall.
[2]Round measured aortic diameter to nearest mm.
[3]Additional considerations may affect choice of diameter.

Table 11.2 - Proximal and Distal Extension Graft Diameter Sizing Guide*

Intended Aortic Vessel Diameter[1,2] (mm)	Graft Diameter[3] (mm)	Overall Length of Component (mm)	Introducer Sheath (Fr)	Introducer Sheath Outer Diameter (OD) (mm)
24	28	80	20	7.7
25	30	80	20	7.7
26	30	80	20	7.7
27	30	80	20	7.7
28	32	80	20	7.7
29	32	80	20	7.7
30	34	77	20	7.7
31	36	77	22	8.6
32	36	77	22	8.6
33	38	77	22	8.6
34	38	77	22	8.6
35	40	81	22	8.6
36	40	81	22	8.6
37	42	81	22	8.6
38	42	81	22	8.6

*All dimensions are nominal.
[1]Maximum diameter along the fixation site, measured outer wall to outer wall.
[2]Round measured aortic diameter to nearest mm.
[3]Additional considerations may affect choice of diameter.

11. DIRECTIONS FOR USE

Anatomical Requirements

- Iliofemoral access vessel size and morphology (minimal thrombus, calcium and/or tortuosity) should be compatible with vascular access techniques and accessories. Arterial conduit technique may be required
- Proximal and distal aortic neck lengths should be a minimum of 25 mm.
- Aortic neck diameters measured outer wall to outer wall between 24-38 mm.
- Measurements to be taken during the pre-treatment assessment are described in **Fig. 5 and 6**.

The following instructions embody a basic guideline for device placement. Variations in the following procedures may be necessary. These instructions are intended to help guide the physician and do not take the place of physician judgment.

General Use Information

Standard techniques for placement of arterial access sheaths, guiding catheters, angiographic catheters and wire guides should be employed during use of the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System. The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is compatible with .035 inch diameter wire guides.

Pre-Implant Determinants

Verify from pre-implant planning that the correct device has been selected. Determinants include:

1. Femoral artery selection for introduction of the delivery system(s).
2. Angulation of aorta, aneurysm and iliac arteries.
3. Quality of the proximal and distal fixation sites.
4. Diameters of proximal and distal fixation sites and distal iliac arteries.
5. Length of proximal and distal fixation sites.

Patient Preparation

1. Refer to institutional protocols relating to anesthesia, anticoagulation, and monitoring of vital signs.
2. Position patient on imaging table allowing fluoroscopic visualization from the aortic arch to the femoral bifurcations.
3. Expose femoral artery using standard surgical technique.
4. Establish adequate proximal and distal vascular control of femoral artery.

11.1 The Zenith TX2 TAA Endovascular Graft System Component Preparation/Flush/Placement

1. Remove yellow-hubbed shipping stylet. Remove cannula protector tube. Remove Peel-Away® sheath from back of valve assembly (**Fig. 7**).
2. Elevate distal tip of system and flush through the hemostatic valve until fluid emerges from the sideport near the tip of the introduction sheath (**Fig. 8**). Continue to inject a full 20 cc of flushing solution through the device. Discontinue injection and close stopcock on connecting tube.

NOTE: Ensure that the side-arm adapter is securely connected to the side of the valve body.

NOTE: Graft flushing solution of heparinized saline is often used.

3. Attach syringe with heparinized saline to the hub on the inner cannula. Flush until fluid exits the distal sideports and dilator tip (**Fig. 9**).

4. Ensure that the black pin vise on the control handle is tight.
5. Soak 4X4 gauze pads in saline solution and use to wipe the Flexor® Introducer Sheath to activate the hydrophilic coating. Hydrate both sheath and dilator liberally.

11.1.1 Placement of Main Body Graft

1. Puncture the selected artery using standard technique with an 18 gage access needle. Upon vessel entry, insert:
   - Wire guide - standard .035 inch, 260 cm, 15 mm J tip or Bentson wire guide
   - Appropriate size sheath (e.g., 5.0 French)
   - Pigtail flush catheter (often radiopaque banded sizing catheters; i.e., Cook Centimeter Sizing CSC-20 catheter)
2. Perform angiography at the appropriate level. Using radiopaque markers, adjust position as necessary and repeat angiography.
3. Ensure graft system has been flushed and primed with heparinized saline (appropriate flush solution), and all air has been removed.
4. Give systemic heparin. Flush all catheters and wet all wire guides with heparinized saline. This should be repeated following each exchange.
5. Replace the standard wire guide with a stiff .035 inch, 260 cm –LESDC wire guide and advance through the catheter and up to the aortic arch.
6. Remove pigtail flush catheter and sheath.

NOTE: At this stage, the second femoral artery can be accessed for angiographic catheter placement. Alternatively, a brachial approach may be considered.

7. Introduce the freshly hydrated delivery system over the wire and advance until the desired graft position is reached.

CAUTION: To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.

NOTE: The dilator tip will soften at body temperature.

NOTE: To facilitate introduction of the wire guide into the delivery system, it may be necessary to slightly straighten the delivery system dilator tip.

8. Verify wire guide position and ensure correct graft position.

CAUTION: Care should be taken not to advance the sheath while the stent graft is still within it. Advancing the sheath at this stage may cause the barbs to perforate the introducer sheath.

9. Ensure that the Captor Hemostatic Valve on the Flexor Introducer Sheath is turned counter-clockwise to the open position (**Fig. 10**).
10. Stabilize the grey positioner (delivery system shaft) and begin withdrawing the sheath.

CAUTION: As the sheath is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.

CAUTION: During sheath withdrawal, the proximal barbs are exposed and are in contact with the vessel wall. At this stage it may be possible to advance the device, but retraction may cause aortic wall damage.

NOTE: If extreme difficulty is encountered when attempting to withdraw the sheath, place the device in a less tortuous position which enables the sheath to be retracted. Very carefully withdraw the sheath until it begins to retract, and stop. Move device back to original position and

continue deployment.

11. Withdraw the sheath until the graft is fully expanded. Continue sheath withdrawal until the valve assembly docks with the control handle.
12. Release the distal attachment by first unscrewing the trigger-wire safety lock, and then withdrawing and removing the white trigger-wire release mechanism (labeled number "1") (**Figs. 12** and **13**).
13. Unscrew and remove the safety lock on the telescoping handle (labeled number "2") (**Figs. 14** and **15**).
14. Stabilize the delivery system and slide the telescoping handle together with the grey tube and the outer sheath in a distal direction until the distal attachment stent is released. The telescoping handle should be retracted as far as it will travel distally until it locks automatically into position (**Figs. 16** and **17**).
15. Loosen the safety lock from the green trigger-wire release mechanism. Withdraw the trigger-wire slowly until the proximal end of the graft opens, then withdraw and remove the trigger-wire release mechanism (labeled number "3").

NOTE: Check to make sure that all trigger-wires are removed prior to withdrawal of the delivery system.

16. Remove the inner introduction system entirely, leaving the sheath and wire guide in the graft.
17. Close the Captor Hemostatic Valve on the Flexor Introducer Sheath by turning it in a clockwise direction until it stops.

CAUTION: To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

11.1.2 Main Body Molding Balloon Insertion - Optional

1. Prepare molding balloon as follows and/or per the manufacturer's instructions.
   - Flush wire lumen with heparinized saline.
   - Remove all air from balloon.
2. In preparation for the insertion of the molding balloon, open the Captor Hemostatic Valve by turning it counter-clockwise.
3. Advance the molding balloon over the wire guide and through the hemostatic valve of the main body introduction system to the level of the proximal fixation/seal site. Maintain proper sheath positioning.
4. Tighten the Captor Hemostatic Valve around the molding balloon with gentle pressure by turning it clockwise.

CAUTION: Do not inflate balloon in aorta outside of graft.

5. Expand the molding balloon with diluted contrast media (as directed by the manufacturer) in the area of the proximal covered stent, starting proximally and working in the distal direction.

CAUTION: Confirm complete deflation of balloon prior to repositioning.

6. Withdraw the molding balloon to the distal covered stent and expand.
7. Open the Captor Hemostatic Valve, remove the molding balloon and replace it with an angiographic catheter to perform completion angiograms.
8. Tighten the Captor Hemostatic Valve around the angiographic catheter with gentle pressure by turning it clockwise.
9. Remove or replace all stiff wire guides to allow aorta to resume its natural position.

Final Angiogram

1. Position angiographic catheter just above the level of the endovascular graft. Perform angiography to verify correct positioning. Verify patency of arch vessels and celiac plexus.
2. Confirm that there are no endoleaks or kinks, and verify position of proximal and distal gold radiopaque markers. Remove the sheaths, wires and catheters.

NOTE: If endoleaks or other problems are observed, refer to **Section 11.2, Ancillary Devices**.

3. Repair vessels and close in standard surgical fashion.

11.2 Ancillary Devices

General Use Information

Inaccuracies in device size selection or placement, changes or anomalies in patient anatomy, or procedural complications can require placement of additional endovascular grafts and extensions. Regardless of the device placed, the basic procedure(s) will be similar to the maneuvers required and described previously in this document. It is vital to maintain wire guide access.

Standard techniques for placement of arterial access sheaths, guiding catheters, angiographic catheters and wire guides should be employed during use of the Zenith TX2 TAA Endovascular Graft ancillary devices.

The Zenith TX2 TAA Endovascular Graft ancillary devices with the H&L-B One-Shot Introduction Systems are compatible with .035 inch diameter wire guides.

11.2.1 Proximal Extensions

Proximal extensions are used for extending the proximal body of an *in situ* endovascular graft.

Proximal Extension Preparation/Flush

1. Remove yellow-hubbed shipping stylet. Remove cannula protector tube. Remove Peel-Away sheath from back of valve assembly (**Fig. 18**).
2. Elevate distal tip of system and flush through the hemostatic valve until fluid emerges from the sideport near the tip of the introduction sheath (**Fig. 8**). Continue to inject a full 20 cc of flushing solution through the device. Discontinue injection and close stopcock on connecting tube.

NOTE: Ensure that the side-arm adapter is securely connected to the side of the valve body.

NOTE: Graft flushing solution of heparinized saline is often used.

3. Attach syringe with heparinized saline to the hub on the inner cannula. Flush until fluid exits the distal sideports and dilator tip (**Fig. 9**).
4. Ensure that the black pin vise on the control handle is tight.
5. Soak 4X4 gauze pads with saline and use to wipe the Flexor introducer sheath to activate the hydrophilic coating. Hydrate both sheath and dilator liberally.

Placement of the Proximal Extension

1. Puncture the selected artery using standard technique with an 18 gage access needle. Upon vessel entry, insert:
   - Wire guide – standard .035 inch, 260 cm, 15 mm J tip or Bentson wire guide
   - Appropriate size sheath (e.g., 5.0 French)
   - Pigtail flush catheter (often radiopaque-banded sizing catheters; i.e., Cook Centimeter Sizing CSC-20 catheter)
2. Perform angiography at the appropriate level. Using radiopaque markers, adjust position as necessary and repeat angiography.
3. Ensure delivery system has been primed with heparinized saline, and all air has been

removed.

4. Give systemic heparin. Flush all catheters and wire guides with heparinized saline. This should be repeated following each exchange.
5. Replace the standard wire guide with a stiff .035 inch, 260 cm –LESDC wire guide and advance through the catheter and up to the aortic arch.
6. Remove pigtail flush catheter and sheath.

NOTE: At this stage, the second femoral artery can be accessed for flush catheter placement. Alternatively, a brachial approach may be considered.

7. Introduce the freshly hydrated delivery system over the wire guide and advance until the desired graft position is reached. Ensure there is a minimum overlap of 2 stents.

CAUTION: To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.

NOTE: The dilator tip softens at body temperature.

NOTE: To facilitate introduction of the wire guide into the delivery system, it may be necessary to slightly straighten the delivery system dilator tip.

NOTE: The proximal extension contains barbs which should not be placed within other graft components.

8. Verify wire guide position in the aortic arch. Ensure correct graft position.

CAUTION: Care should be taken not to advance the sheath while the stent graft is still within it. Advancing the sheath at this stage may cause the barbs to perforate the introducer sheath.

9. Ensure that the Captor Hemostatic Valve on the Flexor Introducer Sheath is turned counter-clockwise to the open position.
10. Stabilize the grey positioner (delivery system shaft) and withdraw the sheath until the graft is fully expanded and the valve assembly docks with the control handle.

CAUTION: As the sheath is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.

CAUTION: During sheath withdrawal, the proximal barbs are exposed and are in contact with the vessel wall. At this stage it may be possible to advance the device, but retraction may cause aortic wall damage.

NOTE: If extreme difficulty is encountered when attempting to withdraw the sheath, place the device in a less tortuous position which enables the sheath to be retracted. Very carefully withdraw the sheath until it just begins to retract, and stop instantly. Move back to original position and continue deployment.

11. Verify graft position and adjust it forward, if necessary. Recheck graft position with angiography.

NOTE: If an angiographic catheter is placed parallel to the stent graft, use this to perform position angiography.

12. Loosen the safety lock from the green trigger-wire release mechanism. Withdraw the trigger-wire slowly until the proximal end of the graft opens (**Fig. 11**). Withdrawing the trigger-wire completely will also release the distal attachment to the introducer.

NOTE: Check to make sure that all trigger-wires are removed prior to withdrawal of the delivery system.

13. Remove the inner introduction system entirely, leaving the sheath and wire guide in the graft.

CAUTION: To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

14. Close the Captor Hemostatic Valve on the Flexor Introducer Sheath by turning it in a clockwise direction until it stops.

Proximal Extension Molding Balloon Insertion - Optional

1. Prepare molding balloon as follows and/or per the manufacturer's instructions.
   - Flush wire lumen with heparinized saline.
   - Remove all air from balloon.
2. In preparation for the insertion of the molding balloon, open the Captor Hemostatic Valve by turning it counter-clockwise.
3. Advance the molding balloon over the wire guide and through the Captor Hemostatic Valve of the introduction system to the level of the proximal fixation/seal site. Maintain proper sheath positioning.
4. Tighten the Captor Hemostatic Valve around the molding balloon with gentle pressure by turning it clockwise.

CAUTION: Do not inflate balloon in aorta outside of graft.

5. Expand the molding balloon with diluted contrast media (as directed by the manufacturer) in the area of the proximal covered stent, starting proximally and working in the distal direction.

CAUTION: Confirm complete deflation of balloon prior to repositioning.

6. Withdraw the molding balloon to the proximal extension/main body overlap and expand.
7. Open the Captor Hemostatic Valve, remove the molding balloon and replace it with an angiographic catheter to perform completion angiograms.
8. Tighten the Captor Hemostatic Valve around the angiographic catheter with gentle pressure by turning it clockwise.
9. Remove or replace all stiff wire guides to allow aorta to resume its natural position.

Final Angiogram

1. Position angiographic catheter just above the level of the endovascular graft. Perform angiography to verify correct positioning. Verify patency of arch vessels.
2. Confirm there are no endoleaks or kinks, and verify position of proximal gold radiopaque markers. Remove the sheaths, wires and catheters.
3. Repair vessels and close in standard surgical fashion.

11.2.2 Distal Extensions

Distal extensions are used for extending the distal end of an *in situ* endovascular graft or increasing the length of overlap between graft components.

Distal Extension Preparation/Flush

1. Remove yellow-hubbed shipping stylet. Remove cannula protector tube. Remove Peel-Away sheath from back of valve assembly (**Fig. 18**).
2. Elevate distal tip of system and flush through the hemostatic valve until fluid emerges from the sideport near the tip of the introduction sheath (**Fig. 10**). Continue to inject a full 20 cc of flushing solution through the device. Discontinue injection and close stopcock on connecting tube.

NOTE: Ensure that the side-arm adapter is securely connected to the side of the valve body.

NOTE: Graft flushing solution of heparinized saline is often used.

3. Attach syringe with heparinized saline to the hub on the inner cannula. Flush until fluid exits the distal sideports and dilator tip (**Fig. 9**).
4. Ensure that the black pin vise on the control handle is tight.
5. Soak 4X4 gauze pads with saline and use to wipe the Flexor introducer sheath to activate the hydrophilic coating. Hydrate both sheath and dilator liberally.

Placement of the Distal Extension

1. Puncture the selected artery using standard technique with an 18 gage access needle. Upon vessel entry, insert:
   - Wire guide – standard .035 inch, 260 cm, 15 mm J tip or Bentson wire guide
   - Appropriate size sheath (e.g., 5.0 French)
   - Pigtail flush catheter (often radiopaque-banded sizing catheters; i.e., Cook Centimeter Sizing CSC-20 catheter)
2. Perform angiography at the appropriate level. Using radiopaque markers, adjust position as necessary and repeat angiography.
3. Ensure graft system has been primed with heparinized saline, and all air has been removed.
4. Give systemic heparin. Flush all catheters and wire guides with heparinized saline. This should be repeated following each exchange.
5. Replace the standard wire guide with a stiff .035 inch, 260 cm –LESDC wire guide and advance through the catheter and up to the aortic arch.
6. Remove pigtail flush catheter and sheath.

NOTE: At this stage, the second femoral artery can be accessed for flush catheter placement. Alternatively, a brachial approach may be considered.

7. Introduce the freshly hydrated delivery system over the wire guide and advance until the desired graft position is reached. Ensure there is a minimum overlap of 2 stents (plus the distal uncovered stent).

CAUTION: To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.

NOTE: The dilator tip softens at body temperature.

NOTE: To facilitate introduction of the wire guide into the delivery system, it may be necessary to slightly straighten the delivery system dilator tip.

8. Verify wire guide position in the aortic arch. Ensure correct graft position.
9. Ensure that the Captor Hemostatic Valve on the Flexor Introducer Sheath is turned counter-clockwise to the open position.
10. Stabilize the grey positioner (delivery system shaft) and withdraw the sheath until the graft is fully expanded and the valve assembly docks with the control handle.

CAUTION: As the sheath or wire guide is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.

NOTE: If extreme difficulty is encountered when attempting to withdraw the sheath, place the device in a less tortuous position which enables the sheath to be retracted. Very carefully withdraw the sheath until it just begins to retract, and stop instantly. Move back to original position and continue deployment.

11. Verify graft position and adjust it forward, if necessary. Recheck graft position with angiography.

NOTE: If an angiographic catheter is placed parallel to the stent graft, use this to perform position angiography.

12. Loosen the safety lock from the green trigger-wire release mechanism. Withdraw the trigger-wire slowly until the proximal end of the graft opens (**Fig. 11**). Withdraw the trigger-wire completely to release the distal attachment to the introducer.

NOTE: Check to make sure that all trigger-wires are removed prior to withdrawal of the delivery system.

13. Remove the inner introduction system entirely, leaving the sheath and wire guide in the graft.

CAUTION: To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

14. Close the Captor® Hemostatic Valve on the Flexor® Introducer Sheath by turning it in a clockwise direction until it stops.

Distal Extension Molding Balloon Insertion

1. Prepare molding balloon as follows and/or per the manufacturer's instructions.
   - Flush wire lumen with heparinized saline.
   - Remove all air from balloon.
2. In preparation for the insertion of the molding balloon, open the Captor Hemostatic Valve by turning it counter-clockwise.
3. Advance the molding balloon over the wire guide and through the Captor Hemostatic Valve of the introduction system to the level of the main body/distal extension overlap. Maintain proper sheath positioning.
4. Tighten the Captor Hemostatic Valve around the molding balloon with gentle pressure by turning it clockwise.

CAUTION: Do not inflate balloon in aorta outside of graft.

5. Expand the molding balloon with diluted contrast media (as directed by the manufacturer) in the area of the overlap, starting proximally and working in the distal direction.

CAUTION: Confirm complete deflation of balloon prior to repositioning.

6. Withdraw the molding balloon to the distal covered stent and expand.
7. Loosen the Captor Hemostatic Valve, remove the molding balloon and replace it with an angiographic catheter to perform completion angiograms.
8. Tighten the Captor Hemostatic Valve around the angiographic catheter with gentle pressure by turning it clockwise.
9. Remove or replace all stiff wire guides to allow aorta to resume its natural position.

Final Angiogram

1. Position angiographic catheter just above the level of the endovascular graft. Perform angiography to verify correct positioning. Verify patency of arch vessels.
2. Confirm there are no endoleaks or kinks, and verify position of proximal and distal gold radiopaque markers. Remove the sheaths, wires and catheters.
3. Repair vessels and close in standard surgical fashion.

12. IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP

12.1 General

The long-term performance of endovascular grafts has not yet been established. All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and performance of their endovascular graft. Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the endovascular graft) should receive additional follow-up. Patients should be counseled on the importance of adhering to the follow-up schedule, both during the first year and at yearly intervals thereafter. Patients should be told that regular and consistent follow-up is a critical part of ensuring the ongoing safety and effectiveness of endovascular treatment of thoracic aortic aneurysms and ulcers.

Physicians should evaluate patients on an individual basis and prescribe their follow-up relative to the needs and circumstances of each individual patient. The recommended imaging schedule is presented in **Table 12.1**. This schedule continues to be the minimum recommendation for patient follow-up and should be maintained even in the absence of clinical symptoms (e.g., pain, numbness, weakness). Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the stent graft) should receive follow-up at more frequent intervals.

Annual imaging follow-up should include chest radiographs and both contrast and non-contrast CT examinations. If renal complications or other factors preclude the use of image contrast media, chest radiographs and non-contrast CT may be used in combination with a transesophageal echocardiography for assessment of endoleak.

- The combination of contrast and non-contrast CT imaging provides information on device migration, aneurysm diameter or ulcer depth change, endoleak, patency, tortuosity, progressive disease, fixation length, and other morphological changes.
- The chest radiographs provide information on device integrity (separation between components, stent fracture, and barb separation) and device migration.

Table 12.1 lists the minimum requirements for imaging follow-up for patients with the Zenith TX2 TAA Endovascular Graft. Patients requiring enhanced follow-up should have interim evaluations.

Table 12.1 - Recommended Imaging Schedule for Endograft Patients

	Angiogram	CT (contrast and non-contrast)	Chest Radiographs
Pre-procedure		X[1]	
Procedural	X		
1 month		X[2]	X
6 month		X[2]	X
12 month (annually thereafter)		X[2]	X

[1]Imaging should be performed within 6 months before the procedure.
[2]If Type I or III endoleak, prompt intervention and additional follow-up post-intervention recommended, **See Section 12.5, Additional Surveillance and Treatment.**

12.2 Contrast and Non-Contrast CT Recommendations

- Film sets should include all sequential images at lowest possible slice thickness (≤3 mm).

DO NOT perform large slice thickness (>3 mm) and/or omit consecutive CT images/film sets, as it prevents precise anatomical and device comparisons over time.

- All images should include a scale for each film/image. Images should be arranged no smaller than 20:1 images on 14" x 17" sheets if film is used.
- Both non-contrast and contrast runs are required, with matching or corresponding table positions.
- Pre-contrast and contrast run slice thickness and interval must match.
- DO NOT change patient orientation or re-landmark patient between non-contrast and contrast runs.

Non-contrast and contrast enhanced baseline and follow-up imaging are important for optimal patient surveillance. It is important to follow acceptable imaging protocols during the CT exam. **Table 12.2** lists examples of acceptable imaging protocols.

Table 12.2 - Acceptable Imaging Protocols

	Non-contrast	Contrast
IV contrast	No	Yes
Acceptable machines	Spiral CT or high-performance MDCT capable of >40 seconds	Spiral CT or high-performance MDCT capable of >40 seconds
Injection volume	n/a	Per Institutional Protocol
Injection rate	n/a	>2.5 cc/sec
Injection mode	n/a	Power
Bolus timing	n/a	Test bolus: Smart Prep, C.A.R.E. or equivalent
Coverage - start	Neck	Subclavian aorta
Coverage - finish	Diaphragm	Profunda femoris origin
Collimation	<3 mm	<3 mm
Reconstruction	2.5 mm throughout - soft algorithm	2.5 mm throughout - soft algorithm
Axial DFOV	32 cm	32 cm
Post-injection runs	None	None

12.3 Chest Radiographs

The following views are required:

- Two films: supine-frontal (AP) and cross-table lateral.
- Record the table-to-film distance and use the same distance at each subsequent examination.
- Ensure entire device is captured on each single image format lengthwise.
- The middle photocell should be used for all views to ensure adequate penetration of the mediastinum.

If there is any concern about the device integrity (e.g., kinking, stent breaks, barb separation, relative component migration), it is recommended to use magnified views. The attending physician should evaluate films for device integrity (entire device length, including components) using 2-4X magnification visual aid.

12.4 MRI Safety and Compatibility

Non-clinical testing has demonstrated that the Zenith TX2® TAA Endovascular Graft is MR Conditional. It can be scanned safely under the following conditions:

1.5 Tesla Systems:

- Static magnetic field of 1.5Tesla
- Spatial gradient field of 450 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning.

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.4 °C at a maximum whole body averaged specific absorption rate (SAR) of 2.8 W/kg for 15 minutes of MR scanning in a 1.5 Tesla Magnetom, Siemens Medical Magnetom MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 2.8 W/kg, which corresponds to a calorimetry measured value of 1.5 W/kg.

3.0 Tesla Systems:

- Static magnetic field of 3.0 Tesla
- Spatial gradient field of 720 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.9 °C at a maximum whole body averaged specific absorption rate (SAR) of 3.0 W/kg for 15 minutes of MR scanning in a 3.0 Tesla, Excite, GE Electric Healthcare MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 3.0 W/kg, which corresponds to a calorimetry measured value of 2.8 W/kg.

The image artifact extends throughout the anatomical region containing the device, obscuring the view of immediately adjacent anatomical structures within approximately 20 cm or mm of the device, as well as the entire device and its lumen, when scanned in nonclinical testing using the sequence: Fast spin echo in a 3.0 Tesla, Excite, GE Electric Healthcare, with G3.0-052B software, MR system with body radiofrequency coil.

For all scanners, the image artifact dissipates as the distance from the device to the area of interest increases. MR scans of the lower extremities may be obtained without image artifact. Image artifact may be present in scans of the abdominal, upper extremity, and head and neck region, depending on distance from the device to the area of interest.

Clinical information is available on six patients who received MRI scans during the course of the clinical trial. There have been no reported adverse events or device problems in any of these patients as a result of having received an MRI. Additionally, there have been approximately 3,000 patients implanted with Zenith TAA Endovascular Grafts world wide, in which there have been no reported adverse events or device problems as a result of MRI.

Cook recommends that the patient register the MR conditions disclosed in this IFU with the MedicAlert Foundation. The MedicAlert Foundation can be contacted in the following manners:

Mail: MedicAlert Foundation International
2323 Colorado Avenue
Turlock, CA 95382

Phone: 888-633-4298 (toll free)
209-668-333 from outside the US

Fax: 209-669-2450

Web: www.medicalert.org

12.5 Additional Surveillance and Treatment

(Refer to **Section 4, WARNINGS AND PRECAUTIONS)**

Additional surveillance and possible treatment is recommended for:

- Aneurysms or ulcers with Type I endoleak
- Aneurysms or ulcers with Type III endoleak
- Aneurysm or ulcer enlargement, >5 mm of maximum aneurysm diameter or ulcer depth (regardless of endoleak status)
- Migration
- Inadequate seal length

Consideration for reintervention or conversion to open repair should include the attending physician's assessment of an individual patient's co-morbidities, life expectancy, and the patient's personal choices. Patients should be counseled that subsequent reinterventions, including catheter-based and open surgical conversion, are possible following endograft placement.

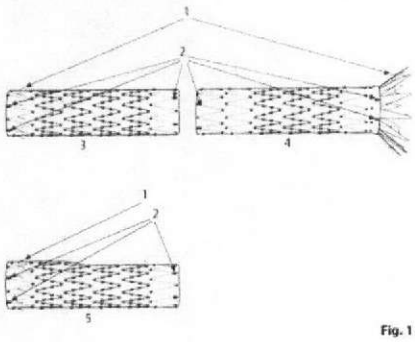
13 PATIENT TRACKING INFORMATION

In addition to these Instructions for Use, the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is packaged with a **Device Tracking Form** which the hospital staff is required to complete and forward to COOK INCORPORATED for the purposes of tracking all patients who receive the Zenith TX2 TAA Endovascular Graft (as required by U. S. Federal Regulation).

Zenith TX2® TAA Endovascular Graft with the H&L-B One-Shot™ Introduction System
Two-Piece System

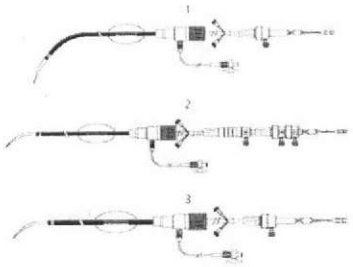
115

Illustrations



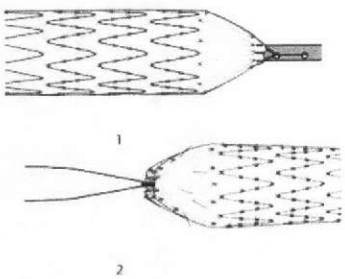
1. Barbed Stents
2. Radiopaque Markers
3. Proximal Component
4. Distal Component
5. Proximal Tapered Component

Fig. 1

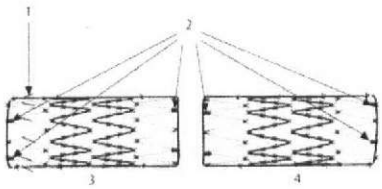


1. Proximal Component/Proximal Extension Delivery System
2. Distal Component Delivery System
3. Distal Extension Delivery System

Fig. 2

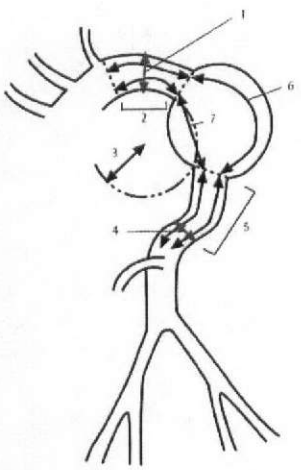


1. Distal Trigger-wire
2. Proximal Trigger-wire



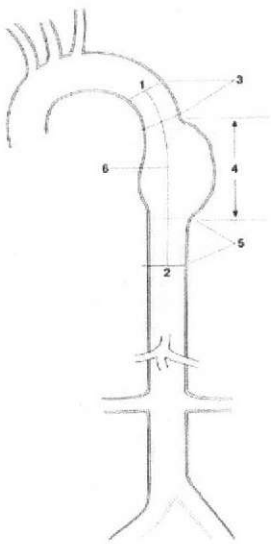
1. Barbed Stent
2. Radiopaque Markers
3. Proximal Extension (TBE)
4. Distal Extension (ESBE-T)

Fig. 4



1. Proximal neck diameter 24-38 mm
2. Proximal neck length ≥25 mm
3. Aortic radius >35 mm
4. Distal neck diameter 24-38 mm
5. Distal neck length ≥25 mm
6. Greater
7. Lesser

Fig. 5



1. Proximal neck diameter
2. Distal neck diameter
3. Proximal neck length (at least 25 mm and may cross one subclavian)
4. Aneurysm length
5. Distal neck length (at least 25 mm proximal to celiac artery)
6. Total coverage length

FIG.6

117

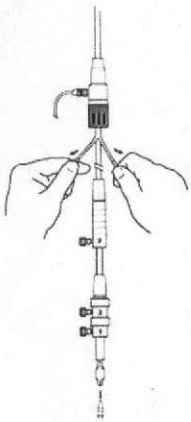


Fig. 7

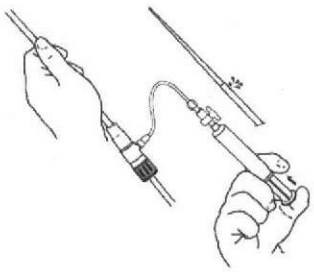


Fig. 8

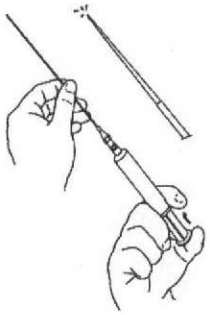


Fig. 9

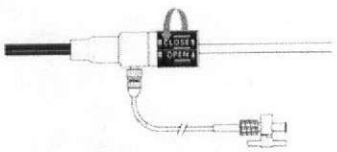


Fig. 10

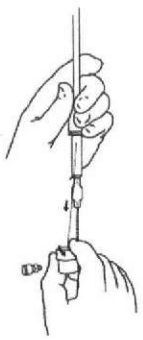


Fig. 11

Fig. 12

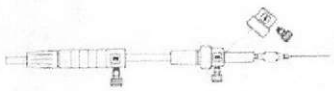


Fig. 13

Fig. 14

Fig. 15

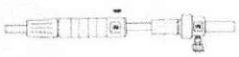


Fig. 16

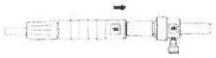


Fig. 17

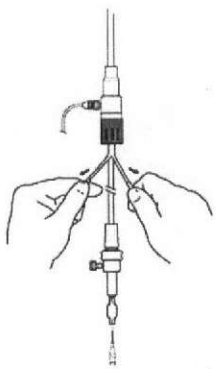


Fig. 18

ZENITH TX2® TAA ENDOVASCULAR GRAFT with the H&L-B One-Shot™ Introduction System

Read all instructions carefully. Failure to properly follow the instructions, warnings, and precautions may lead to serious consequences or injury to the patient.

CAUTION: Federal (U.S.A.) law restricts this device to sale by or on the order of a physician.

CAUTION: All contents of the outer pouch (including the introduction system and the endovascular grafts) are supplied sterile, for single use only.

1. DEVICE DESCRIPTION

1.1 Zenith TX2 TAA Endovascular Graft with the H&L-B One Shot Introduction System

The Zenith TX2 TAA Endovascular Graft is a two-piece cylindrical endovascular graft consisting of proximal and distal components. The proximal components can be either non-tapered or tapered. The stent grafts are constructed of full-thickness woven polyester fabric sewn to self-expanding stainless steel Cook-Z stents with braided polyester and monofilament polypropylene suture. (**Fig. 1**) The Zenith TX2 TAA Endovascular Graft is fully stented to provide stability and the expansile force to open the lumen of the graft during deployment. Additionally, the Cook-Z stents provide the attachment and seal of the graft to the vessel wall.

For added fixation, the covered stent at the proximal end of the proximal component contains barbs placed at a 2 mm stagger, which protrude through the graft material. In addition, the bare stent at the distal end of the distal component also contains barbs. To facilitate fluoroscopic visualization of the stent graft, four radiopaque gold markers are positioned on each end of the proximal and distal components. These markers are placed in a circumferential orientation within 1 mm of the most proximal aspect of the graft material and within 1 mm of the most distal aspect of the graft material.

The Zenith TX2 TAA Endovascular Graft is shipped preloaded onto either a 20 French or 22 French H&L-B One-Shot™ Introduction System. (**Fig. 2**) It has a sequential deployment method with built-in features to provide continuous control of the endovascular graft throughout the deployment procedure. The H&L-B One-Shot™ Introduction System is designed for precise positioning before deployment of the proximal and/or distal components. The proximal component uses a single trigger-wire release mechanism. The distal component uses a dual trigger-wire release mechanism. The trigger-wires secure the endovascular graft onto the delivery system until released by the physician. (**Fig. 3**) All delivery systems feature Flexor® introducer sheaths, which are designed to resist kinking and are hydrophilically coated. Both features are intended to enhance trackability in the iliac arteries and thoracic aorta.

1.2 Zenith TX2 TAA Endovascular Graft Ancillary Components

Ancillary endovascular components (proximal and distal body extensions) are available. (**Fig. 4**) The Zenith TX2 TAA Endovascular Graft Ancillary Components are cylindrical components constructed from the same polyester fabric, self-expanding stainless steel Cook-Z stents, and polypropylene suture used in constructing the principal graft components. At the distal and proximal graft margins, the stents are attached to the inner surface. Elsewhere the stents are sutured on the external surface. The proximal extension contains proximal attachment barbs and the distal extension does not have barbs. Both the proximal and distal main body extensions can be used to provide additional length to their respective portions of the endovascular graft. Additionally, the distal main body extension can be used to increase the overlap length between components.

1.2.1 Zenith TX2 TAA Endovascular Graft Proximal Extensions

The Zenith TX2 TAA Endovascular Graft Proximal Extension is deployed from either a 20 French or 22 French H&L-B One-Shot Introduction System. (**Fig. 2**) A single trigger-wire release

mechanism locks the endovascular graft onto the delivery system until released by the physician. All systems are compatible with a .035 inch wire guide.

The covered stent at the proximal end of the proximal extension contains barbs placed at a 2 mm stagger, which protrude through the graft material. To facilitate fluoroscopic visualization of the proximal extension, four radiopaque markers are positioned on the ends of the graft in a circumferential orientation within 1 mm of the most proximal and distal aspects of the graft material.

1.2.2 Zenith TX2 TAA Endovascular Graft Distal Extensions

The Zenith TX2 TAA Endovascular Graft Distal Extension is deployed from either a 20 French or 22 French H&L-B One-Shot Introduction System. (**Fig. 2**) A single trigger-wire release mechanism locks the endovascular graft onto the delivery system until released by the physician. All systems are compatible with a .035 inch wire guide.

To facilitate fluoroscopic visualization of the distal extension, four radiopaque markers are positioned on the ends of the graft in a circumferential orientation within 1 mm of the most proximal and distal aspects of the graft material.

2. INDICATIONS FOR USE

The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is indicated for the endovascular treatment of patients with aneurysms or ulcers of the descending thoracic aorta having vascular morphology suitable for endovascular repair (**Fig. 5**), including:

- Adequate iliac/femoral access compatible with the required introduction systems,
- Non-aneurysmal aortic segments (fixation sites) proximal and distal to the aneurysm or ulcer:
  - with a length of at least 25 mm, and
  - with a diameter measured outer wall to outer wall of no greater than 38 mm and no less than 24 mm.

3. CONTRAINDICATIONS

The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is contraindicated in:

- Patients with known sensitivities or allergies to stainless steel, polyester, solder (tin, silver), polypropylene, nitinol, or gold.
- Patients with a systemic infection which may be at increased risk of endovascular graft infection.

4. WARNINGS AND PRECAUTIONS

4.1 General

- Read all instructions carefully. Failure to properly follow the instructions, warnings, and precautions may lead to serious consequences or injury to the patient.
- Always have a qualified surgery team available during implantation or reintervention procedures in the event that conversion to open surgical repair is necessary.
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System should only be used by physicians and teams trained in vascular interventional techniques (catheter-based and surgical) and in the use of this device. Specific training expectations are described in **Section 10.1, Physician Training**.
- Additional endovascular interventions or conversion to standard open surgical repair following initial endovascular repair should be considered for patients experiencing enlarging aneurysms or ulcers, unacceptable decrease in fixation length (vessel and

component overlap) and/or endoleak. An increase in aneurysm or ulcer size and/or persistent endoleak or migration may lead to aneurysm/ulcer rupture.

- Patients experiencing reduced blood flow through the graft and/or leaks may be required to undergo secondary endovascular interventions or surgical procedures.

4.2 Patient Selection, Treatment and Follow-Up

- The Zenith TX2 TAA Endovascular Graft is designed to treat aortic neck diameters no smaller than 24 mm and no larger than 38 mm. The Zenith TX2 TAA Endovascular Graft is designed to treat proximal aortic necks (distal to either the left subclavian or left common carotid artery) of at least 25 mm in length. Additional proximal aortic neck length may be gained by covering the left subclavian artery (with or without discretionary transposition) when necessary to optimize device fixation and maximize aortic neck length. Distal aortic neck length of at least 25 mm proximal to the celiac axis is required. These sizing measurements are critical to the performance of the endovascular repair.
- Key anatomic elements that may affect successful exclusion of the aneurysm or ulcer include a radius of curvature <35 mm; localized aortic neck angulation >45 degrees; short proximal or distal fixation sites (<25 mm); an inverted funnel shape at the proximal fixation site or a funnel shape at the distal fixation site (greater than 10% change in diameter over 25 mm of fixation site length); and circumferential thrombus and/or calcification at the arterial fixation sites. In the presence of anatomical limitations, a longer neck length may be required to obtain adequate sealing and fixation. Irregular calcification and/or plaque may compromise the attachment and sealing at the fixation sites. Necks exhibiting these key anatomic elements may be more conducive to graft migration or endoleak.
- Adequate iliac or femoral access is required to introduce the device into the vasculature. Careful evaluation of vessel size, anatomy and disease state is required to assure successful sheath introduction and subsequent withdrawal, as vessels that are significantly calcified, occlusive, tortuous or thrombus-lined may preclude introduction of the endovascular graft and/or may increase the risk of embolization. A vascular conduit technique may be needed to achieve access in some patients.
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is not recommended for patients who cannot tolerate contrast agents necessary for intraoperative and post-operative follow-up imaging. All patients should be monitored closely and checked periodically for a change in the condition of their disease and the integrity of the endoprosthesis.
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is not recommended for patients whose weight or size would compromise or prevent the necessary imaging requirements.
- Graft implantation may increase the risk of paraplegia or paraparesis where graft exclusion covers the origins of dominant spinal cord or intercostal arteries.
- The safety and effectiveness of the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System has not been evaluated in the following patient populations:
    - aortobronchial and aortoesophageal fistulas
    - aortitis or inflammatory aneurysms
    - diagnosed or suspected congenital degenerative collagen disease (e.g., Marfan's or Ehlers-Danlos Syndromes)
    - dissections
    - females that are pregnant, breast-feeding, or planning on becoming pregnant within 24 months
    - leaking, pending rupture or ruptured aneurysm

- less than 18 years of age
- mycotic aneurysms
- pseudoaneurysms resulting from previous graft placement
- systemic infection (e.g., sepsis)
- traumatic aortic injury

- Successful patient selection requires specific imaging and accurate measurements; please see Pre-Procedure Measurement Techniques and Imaging section below.
- If occlusion of the left subclavian artery ostium is required to obtain adequate neck length for fixation and sealing, transposition or bypass of the left subclavian artery may be warranted.
- All lengths and diameters of the devices necessary to complete the procedure should be available to the physician, especially when pre-operative case planning measurements (treatment diameters/lengths) are not certain. This approach allows for greater intra-operative flexibility to achieve optimal procedural outcomes.

4.3 Imaging and Pre-Procedure Measurement Techniques

- Lack of non-contrast CT imaging may result in failure to appreciate iliac or aortic calcification, which may preclude access or reliable device fixation and seal.
- Preprocedure imaging reconstruction thicknesses >3 mm may result in sub-optimal device sizing, or in failure to appreciate focal stenoses from CT.
- Clinical experience indicates that contrast-enhanced spiral computed tomographic angiography (CTA) with 3-D reconstruction is the strongly recommended imaging modality to accurately assess patient anatomy prior to treatment for the Zenith TX2 TAA Endovascular Graft. If contrast-enhanced spiral CTA with 3-D reconstruction is not available, the patient should be referred to a facility with these capabilities. Clinicians recommend positioning of the image intensifier (C-arm) so that it is perpendicular to the neck, typically 45-75 degrees left anterior oblique (LAO) for the arch.
- Diameter
  A contrast-enhanced spiral CTA is strongly recommended for aortic diameter measurements. Diameter measurements should be determined from the outer wall to outer wall vessel diameter and not the lumen diameter.The spiral CTA scan must include the great vessels through the femoral heads at an axial slice thickness of 3 mm or less.
- Length
  Clinical experience indicates that 3-D CTA reconstruction is the strongly recommended imaging modality to accurately assess proximal and distal neck lengths for the Zenith TX2 TAA Endovascular Graft. These reconstructions should be performed in sagittal, coronal and varying oblique views depending upon individual patient anatomy. If 3-D reconstruction is not available, the patient should be referred to a facility with these capabilities.
- The long-term performance of endovascular grafts has not yet been established. All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and the performance of their endovascular graft. Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the endovascular graft) should receive enhanced follow-up. Specific follow-up guidelines are described in **Section 12, IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP.**
- The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is not recommended in patients unable to undergo, or who will not be compliant with, the necessary pre-operative and post-operative imaging and implantation studies as described in **Section 12, IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP.**

- After endovascular graft placement, patients should be regularly monitored for endoleak flow, aneurysm or ulcer growth, or changes in the structure or position of the endovascular graft. At a minimum, annual imaging is required, including: 1) chest radiographs to examine device integrity (separation between components, stent fracture, or barb separation); and 2) contrast and non-contrast CT to examine aneurysm changes, endoleak flow, patency, tortuosity, device position and progressive disease. If renal complications or other factors preclude the use of image contrast media, chest radiographs and non-contrast CT may be used in combination with transesophogeal echocardiography (for endoleak assessment) to provide similar, although suboptimal, information.

4.4 Device Selection

- The recommended amount of overlap between devices is 3-4 stents. However, the proximal sealing stent of the proximal component or distal sealing stent of the distal component should not be overlapped, as doing so may cause malapposition to the vessel wall. The minimum required amount of overlap between devices is 2 stents (~50 mm) – less than 2 stents may result in endoleak (with or without component separation). Device lengths should be selected accordingly.
- Strict adherence to the Zenith TX2 TAA Endovascular Graft IFU sizing guide is strongly recommended when selecting the appropriate device size **(Tables 10.1 and 10.2)**. Appropriate device oversizing has been incorporated into the IFU sizing guide. Sizing outside of this range can result in endoleak, fracture, migration, device infolding, or compression.

4.5 Implant Procedure

(Refer to **Section 11, DIRECTIONS FOR USE**)

- Appropriate procedural imaging is required to successfully position the Zenith TX2 TAA Endovascular Graft in the neck and to assure appropriate apposition to the aortic wall.
- Do not bend or kink the delivery system. Doing so may cause damage to the delivery system and the Zenith TX2 TAA Endovascular Graft.
- To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.
- Do not continue advancing the wire guide or any portion of the delivery system if resistance is felt. Stop and assess the cause of resistance; vessel, catheter, or graft damage may occur. Exercise particular care in areas of stenosis, intravascular thrombosis, or calcified or tortuous vessels.
- Inadvertent partial deployment or migration of the endoprosthesis may require surgical removal.
- Unless medically indicated, do not deploy the Zenith TX2 TAA Endovascular Graft in a location that will occlude arteries necessary to supply blood flow to organs or extremities. Do not cover significant arch or mesenteric arteries (exception may be the left subclavian artery) with the endoprosthesis. Vessel occlusion may occur. If a left subclavian artery is to be covered with the device, the clinician should be aware of the possibility of compromise to cerebral and upper limb circulation and as collateral circulation to the spinal cord.
- Do not attempt to re-sheath the graft after partial or complete deployment.
- Repositioning the stent graft distally after partial deployment of the covered proximal stent may result in damage to the stent graft and/or vessel injury.
- During sheath withdrawal, the proximal barbs are exposed and are in contact with the vessel wall. At this stage it may be possible to advance the device, but retraction may cause aortic wall damage.

- Landing the proximal and distal ends of the device in parallel aortic neck segments without acute angulation (>45°) or circumferential thrombus/calcification is important to ensuring fixation and seal.
- Landing the proximal or distal ends of the device in an aortic neck segment with a diameter that differs from that to which the graft was sized initially may potentially result in inadequate sizing (<10% or >25%) and therefore migration, endoleak, aneurysm or ulcer growth, or increased risk of thrombosis.
- Inaccurate placement and/or incomplete sealing of the Zenith TX2 TAA Endovascular Graft within the vessel may result in increased risk of endoleak, migration, or inadvertent occlusion of the left subclavian, left common carotid, and/or celiac arteries.
- Inadequate fixation of the Zenith TX2 TAA Endovascular Graft may result in increased risk of migration of the stent graft. Incorrect deployment or migration of the endoprosthesis may require surgical intervention.
- Systemic anticoagulation should be used during the implantation procedure based on hospital and physician preferred protocol. If heparin is contraindicated, an alternative anticoagulant should be used.
- To activate the hydrophilic coating on the outside of the sheath, the surface must be wiped with 4X4 gauze pads soaked in saline solution. Always keep the sheath hydrated for optimal performance.
- Minimize handling of the constrained endoprosthesis during preparation and insertion to decrease the risk of endoprosthesis contamination and infection.
- Maintain wire guide position during delivery system insertion.
- Always use fluoroscopy for guidance, delivery, and observation of the Zenith TX2 TAA Endovascular Graft within the vasculature.
- The use of the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System requires administration of intravascular contrast. Patients with pre-existing renal insufficiency may have an increased risk of renal failure post-operatively. Care should be taken to limit the amount of contrast medium used during the procedure and to observe preventative methods of treatment to decrease renal compromise (e.g., adequate hydration).
- As the sheath and/or wire guide is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.
- The Zenith TX2 TAA Endovascular Graft incorporates a covered proximal stent (on the proximal component) with fixation barbs and an uncovered distal stent (on the distal component) with fixation barbs. Exercise extreme caution when manipulating interventional and angiographic devices in the region of the covered proximal stent and uncovered distal stent.
- Use caution during manipulation of catheters, wires and sheaths within an aneurysm or the region of an ulcer. Significant disturbances may dislodge fragments of thrombus or plaque, which can cause distal or cerebral embolization, or cause rupture of the aneurysm.
- Avoid damaging the graft or disturbing graft positioning after placement in the event reinstrumentation (secondary intervention) of the graft is necessary.
- Care should be taken not to advance the sheath while the stent graft is still within it. Advancing the sheath at this stage may cause the barbs to perforate the introducer sheath.
- To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

4.6 Molding Balloon Use-Optional

- Do not inflate the balloon in aorta outside of the graft, as doing so may cause damage to the aorta. Use the balloon in accordance with its labeling.

- Use care in inflating the balloon within the graft in the presence of calcification, as excessive inflation may cause damage to the aorta.
- Confirm complete deflation of balloon prior to repositioning.
- For added hemostasis, the Captor® Hemostatic Valve can be loosened or tightened to accommodate the insertion and subsequent withdrawal of a molding balloon.

4.7 MRI Safety and Compatibility

Non-clinical testing has demonstrated that the Zenith TX2® TAA Endovascular Graft is MR Conditional. It can be scanned safely under the following conditions:

1.5 Tesla Systems:

- Static magnetic field of 1.5Tesla
- Spatial gradient field of 450 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning.

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.4 °C at a maximum whole body averaged specific absorption rate (SAR) of 2.8 W/kg for 15 minutes of MR scanning in a 1.5 Tesla Magnetom, Siemens Medical Magnetom MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 2.8 W/kg, which corresponds to a calorimetry measured value of 1.5 W/kg.

3.0 Tesla Systems:

- Static magnetic field of 3.0 Tesla
- Spatial gradient field of 720 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.9 °C at a maximum whole body averaged specific absorption rate (SAR) of 3.0 W/kg for 15 minutes of MR scanning in a 3.0 Tesla, Excite, GE Electric Healthcare MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 3.0 W/kg, which corresponds to a calorimetry measured value of 2.8 W/kg.

The image artifact extends throughout the anatomical region containing the device, obscuring the view of immediately adjacent anatomical structures within approximately 20 cm of the device, as well as the entire device and its lumen, when scanned in nonclinical testing using the sequence: Fast spin echo in a 3.0 Tesla, Excite, GE Electric Healthcare, with G3.0-052B software, MR system with body radiofrequency coil.

For all scanners, the image artifact dissipates as the distance from the device to the area of interest increases. MR scans of the lower extremities may be obtained without image artifact. Image artifact may be present in scans of the abdominal, upper extremity, and head and neck region, depending on distance from the device to the area of interest.

Clinical information is available on six patients who received MRI scans during the course of the clinical trial. There have been no reported adverse events or device problems in any of these patients as a result of having received an MRI. Additionally, there have been approximately 3,000 patients implanted with Zenith TAA Endovascular Grafts world wide, in which there have been no reported adverse events or device problems as a result of MRI.

Cook recommends that the patient register the MR conditions disclosed in this IFU with the MedicAlert Foundation. The MedicAlert Foundation can be contacted in the following manners:

Mail: MedicAlert Foundation International
2323 Colorado Avenue
Turlock, CA 95382

Phone: 888-633-4298 (toll free)
209-668-333 from outside the US

Fax: 209-669-2450

Web: www.medicalert.org

5. POTENTIAL ADVERSE EVENTS

Adverse events that may occur and/or require intervention include, but are not limited to:

- Amputation
- Anesthetic complications and subsequent attendant problems (e.g., aspiration)
- Aneurysm enlargement
- Aneurysm rupture and death
- Aortic damage, including perforation, dissection, bleeding, rupture and death
- Aorto-bronchial fistula
- Aorto-esophageal fistula
- Arterial or venous thrombosis and/or pseudoaneurysm
- Arteriovenous fistula
- Bleeding, hematoma, or coagulopathy
- Bowel complications (e.g., ileus, transient ischemia, infarction, necrosis)
- Cardiac complications and subsequent attendant problems (e.g., arrhythmia, tamponade, myocardial infarction, congestive heart failure, hypotension, hypertension)
- Claudication (e.g., buttock, lower limb)
- Compartment Syndrome
- Death
- Edema
- Embolization (micro and macro) with transient or permanent ischemia or infarction
- Endoleak
- Endoprosthesis: improper component placement; incomplete component deployment; component migration and/or separation; suture break; occlusion; infection; stent fracture; graft material wear; dilatation; erosion; puncture; perigraft flow; barb separation and corrosion
- Femoral neuropathy
- Fever and localized inflammation
- Genitourinary complications and subsequent attendant problems (e.g., ischemia, erosion, fistula, urinary incontinence, hematuria, infection)
- Hepatic failure
- Impotence
- Infection of the aneurysm, device or access site, including abscess formation, transient fever and pain
- Lymphatic complications and subsequent attendant problems (e.g., lymph fistula, lymphocele)
- Local or systemic neurologic complications and subsequent attendant problems (e.g., stroke, transient ischemic attack, paraplegia, paraparesis/spinal cord shock, paralysis)
- Occlusion of device or native vessel

- Pulmonary Embolism
- Pulmonary/respiratory complications and subsequent attendant problems (e.g., pneumonia, respiratory failure, prolonged intubation)
- Renal complications and subsequent attendant problems (e.g., artery occlusion, contrast toxicity, insufficiency, failure)
- Surgical conversion to open repair
- Vascular access site complications, including infection, pain, hematoma, pseudoaneurysm, arteriovenous fistula
- Vascular spasm or vascular trauma (e.g., ilio-femoral vessel dissection, bleeding, rupture, death)
- Wound complications and subsequent attendant problems (e.g., dehiscence, infection)

Device Related Adverse Event Reporting

Any adverse event (clinical incident) involving the Zenith TX2 TAA Endovascular Graft should be reported to COOK immediately. To report an incident, call the Customer Relations Department at 1-800-457-4500 (24 hour) or 1-812-339-2235.

6. SUMMARY OF CLINICAL DATA

The STARZ-TX2 Clinical Trial is a non-randomized, controlled, multi-center, study that was conducted to evaluate safety and effectiveness of the Zenith TX2® TAA Endovascular Graft in the elective treatment of patients with descending thoracic aortic aneurysms or ulcers, as compared to open surgical repair. The study consisted of an endovascular treatment group and an open surgical control group. The open surgical control group was comprised of both prospectively enrolled and retrospectively enrolled patients. The same inclusion/exclusion criteria applied to both the endovascular treatment group and open surgical control group, except that patients in the open surgical control group were not required to have anatomy amenable to endovascular repair with the Zenith TX2® TAA Endovascular Graft.

The study was designed to assess two primary and two secondary hypotheses regarding the endovascular treatment group compared to the open surgical control group. The primary hypothesis for safety was non-inferior 30-day survival, and the primary hypothesis for effectiveness was non-inferior 30-day rupture-free survival (i.e., freedom from rupture). The secondary hypotheses were superior clinical utility in the endovascular treatment group and non-inferior 30-day morbidity, expressed as a composite morbidity score including 57 pre-specified events. In addition, the study assessed survival, morbidity, and device performance through 12 months, and will continue these assessments at yearly intervals through 5 years.

In addition to covariate analysis, propensity score analysis was used to assess comparability of the groups. The control group was analyzed to justify the use of both retrospectively and prospectively enrolled patients.

FDA requested additional analyses, including the analysis of a composite effectiveness endpoint (freedom from a device event) and separate analyses of patients with aneurysms and patients with ulcers. The separate analyses for aneurysm patients and ulcer patients did not show any findings unique to the specific indications. Data for aneurysm and ulcer patients are presented separately where appropriate.

Patient imaging underwent independent core laboratory analysis. Adverse events, including all patient deaths, were adjudicated by an independent clinical events committee. A data safety

monitoring board, comprised of independent physicians and a biostatistician, monitored the safety of the study.

Forty-two (42) institutions enrolled a total of 160 endovascular treatment patients and 70 (19 prospective and 51 retrospective) open surgical control patients, including 20 institutions that enrolled both endovascular treatment and open surgical control patients, 16 institutions that enrolled only endovascular treatment patients, and 6 institutions that enrolled only open surgical control patients. Although nearly 75% of the open surgical control patients were enrolled retrospectively, the endovascular treatment group and open surgical control groups proved to be largely contemporaneous; the earliest open surgical control patient was treated less than one year prior to IDE initiation, and 81% of the open surgical control patients were treated on or after the date on which the first endovascular patient was treated.

The study follow-up schedule for patients enrolled in the endovascular treatment group consisted of radiographic (CT scan and X-ray) and clinical assessments at pre-discharge, 30 days, 6 months, 12 months, and yearly thereafter through 5 years. The study follow-up schedule for patients enrolled in the open surgical control group consisted of radiographic (CT scan) and clinical assessments at pre-discharge (or 30 days) and 12 months, with an interim telephone contact at 6 months. Patient availability for study follow-up through 12 months as of September 12, 2007 is summarized in Table 6.1. Available data from on-going 24-month follow-up are also provided.

Table 6.1 Follow-up Availability

Time point	Eligible for follow-up (n)	Subjects with submitted data			Adequate imaging to assess parameter per core lab				Events occurring before next visit			
		Clinical % (n)	CT % (n)	X-ray % (n)	Size in-crease % (n)	Endoleak % (n)	Migration % (n)	Fracture % (n)	Death (n)	Conversion (n)	LTF (n)	Not due for next visit (n)
Endovascular												
Pre-discharge	158[a]	100% (158)	94% (149)	98% (154)	n/a	85% (135)	n/a	96% (152)	3	0	0	0
30-day	155	94% (146)	92% (142)	87% (134)	78% (121)	81% (126)	72% (111)	88% (136)	5	0	5	0
6-month	145	90% (130)	89% (129)	85% (123)	81% (117)	79% (114)	77% (112)	88% (127)	5	0	5	0
12-month	135	94% (127)	92% (124)	85% (115)	83% (112)	76% (103)	79% (107)	91% (123)	10	0	4	25
24-month	96	70% (67)	61% (59)	63% (60)	58% (56)	59% (57)	57% (55)	66% (63)	n/a	n/a	n/a	n/a
Open Surgical												
Pre-discharge / 30-day	70	100% (70)	n/a	n/a	n/a	n/a	n/a	n/a	8	n/a	0	0
6-month	62	60% (37)	n/a	n/a	n/a	n/a	n/a	n/a	2	n/a	0	0
12-month	60	65% (39)	n/a	n/a	n/a	n/a	n/a	n/a	0	n/a	1	29[b]
24-month	30	27% (8)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

n/a – not applicable

[a] Device insertion was not achieved in two patients.

[b] IRB/EC-approved follow-up was limited to 12 months at 11 sites that enrolled open surgical control patients (n=24); 5 patients not due for next visit.

The following tables (Tables 6.2 through 6.5) present characteristics of the two study groups. Covariate and propensity score analysis supported the appropriateness of comparisons between study groups. Table 6.2 compares the demographics and patient characteristics between the endovascular treatment group and open surgical control group.

Table 6.2 Demographics and Patient Characteristics

Demographic/characteristic	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
Age (years)	72.4 ± 9.6 (160)	67.6 ± 11.6 (70)	4.8 (1.9, 7.7)	<0.01
Gender				0.09
Male	72% (115/160)	60% (42/70)	12 (-1.6, 25)	
Female	28% (45/160)	40% (28/70)	-12 (-25, 1.6)	
Ethnicity[3]				0.82
Asian	2.5% (4/159)	1.4% (1/70)	1.1 (-2.6, 4.8)	
Black/African American	12% (19/159)	8.6% (6/70)	3.4 (-4.9, 12)	
Hispanic/Latino	3.8% (6/159)	4.3% (3/70)	-0.5 (-6.1, 5.1)	
White/Caucasian	80% (127/159)	86% (60/70)	-5.8 (-16, 4.5)	
Other	1.9% (3/159)	0.0% (0/70)	1.9 (n/a)	
Height (in)	67.5 ± 4.0 (154)	66.9 ± 3.6 (69)	0.6 (-0.5, 1.8)	0.26
Weight (lbs)	177 ± 35 (158)	167 ± 32 (70)	11 (1.1, 20)	0.02
Body mass index	27.2 ± 4.9 (153)	25.9 ± 3.7 (69)	1.3 (0.1, 2.5)	0.03

n/a – not applicable
[1] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.
[2] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.
[3] Ethnicity reported as unknown in one patient.

Table 6.3 compares the medical history between the endovascular treatment group and open surgical control group.

Table 6.3 Medical History

Medical history	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value[2]
Cardiovascular				
Myocardial infarction	22.2% (35/158)	25% (17/68)	-2.9 (-15, 9.3)	0.73
Congestive heart failure	12.5% (20/160)	11.6% (8/69)	0.9 (-8.2, 10)	>0.99
Coronary artery disease	43.7% (69/158)	42% (29/69)	1.6 (-12, 16)	0.88
Arrhythmia	30.2% (48/159)	18.8% (13/69)	11 (-0.3, 23)	0.10
Vascular				
Thromboembolic event	10.1% (16/159)	8.7% (6/69)	1.4 (-6.8, 9.5)	>0.99
Peripheral vascular disease	24.4% (39/160)	26.1% (18/69)	-1.7 (-14, 11)	0.86
Family history of aneurysm	17.1% (24/140)	20.4% (11/54)	-3.2 (-16, 9.2)	0.67
Hypertension	89.4% (143/160)	82.9% (58/70)	6.5 (-3.5, 17)	0.19
Thoracic surgery/trauma	10% (16/160)	25.7% (18/70)	-16 (-27, -4.5)	<0.01
Diagnosed AAA	31.3% (50/160)	22.9% (16/70)	8.4 (-3.8, 21)	0.20
Repaired AAA	19.4% (31/160)	14.3% (10/70)	5.1 (-5.1, 15)	0.47
Chronic obstructive pulmonary disease	44.7% (71/159)	42.9% (30/70)	1.8 (-12, 16)	0.88
Renal failure requiring dialysis	3.1% (5/160)	2.9% (2/70)	0.3 (-4.5, 5.0)	>0.99
Diabetes	18.8% (30/160)	14.3% (10/70)	4.5 (-5.7, 15)	0.45
Sepsis	1.9% (3/156)	1.5% (1/68)	0.5 (-3.1, 4.0)	>0.99

Neurologic Cerebrovascular accident Carotid endarterectomy	 15.0% (24/160) 5.7% (9/159)	 14.7% (10/68) 2.9% (2/70)	 0.3 (-9.8, 10) 2.8 (-2.5, 8.1)	 >0.99 0.51
Gastrointestinal disease	40.5% (64/158)	30% (21/70)	11 (-2.7, 24)	0.14
Liver disease	6.3% (10/160)	4.3% (3/70)	2.0 (-4.1, 8.0)	0.75
Cancer	25.2% (40/159)	15.7% (11/70)	9.4 (-1.4, 20)	0.12
Excessive alcohol use	3.2% (5/157)	0.0% (0/67)	3.2 (n/a)	0.32
Tobacco use Current smoker Quit smoking Never smoked	 22.4% (35/156) 66% (103/156) 11.5% (18/156)	 17.6% (12/68) 61.8% (42/68) 20.6% (14/68)	 4.8 (-6.4, 16) 4.3 (-9.5, 18) -9.1 (-20, 1.8)	0.19
Access site Previous surgery Previous radiation	 10.1% (16/159) 0.0% (0/159)	 1.4% (1/69) 0.0% (0/69)	 8.6 (3.2, 14) 0 (n/a)	 0.02 n/a
Allergies	43.8% (70/160)	40% (28/70)	3.8 (-10, 18)	0.66

n/a – not applicable
[1] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.
[2] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.

Table 6.4 compares the results from patient risk assessment between the endovascular treatment group and open surgical control group.

Table 6.4 Patient Risk Assessment

Item[1]	Endovascular	Open Surgical	Diff (95% CI)[2]	*p* value [3]
ASA classification Healthy patient (1) Mild systemic disease (2) Severe systemic disease (3) Incapacitating systemic disease (4) Moribund patient (5)	 8.8% (14/160) 50% (80/160) 36.9% (59/160) 4.4% (7/160) 0% (0/160)	 7.1% (5/70) 41.4% (29/70) 28.6% (20/70) 22.9% (16/70) 0% (0/70)	 1.6 (-5.9, 9.1) 8.6 (-5.3, 22) 8.3 (-4.7, 21) -18 (-29, -8.2) 0 (n/a)	< 0.01
Total SVS-ISCVS risk score	6.4 ± 3.0 (159)	5.4 ± 3.5 (68)	1.0 (0.1, 1.9)	0.03

n/a – not applicable
[1] The SVS-ISCVS scoring system may be considered more objective than the ASA classification; however, direct comparisons of key patient characteristics are provided in Tables 6.2 and 6.3.
[2] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.
[3] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.

Table 6.5 compares the morphology type, location, and size between the endovascular treatment group and open surgical control group based on the results from core lab analysis.

Table 6.5 Morphology Type, Location and Size

Item	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
Morphology type Aneurysm Ulcer[3]	 85.6% (137/160) 14.4% (23/160)	 90.0% (63/70)[4] 10.0% (7/70)	 -4.4 (-13,4.5) 4.4 (-4.5, 13)	0.40
Morphology location[5]				0.02

Proximal	22.5% (36/160)	36.9% (24/65)	-14 (-28, -1.0)	
Middle	55.0% (88/160)	52.3% (34/65)	2.7 (-12, 17)	
Distal	22.5% (36/160)	10.8% (7/65)	12 (1.8, 22)	
Aneurysm size				
Major axis diameter (mm)	60.8 ± 10.7 (137)	63.0 ± 10.8 (53)	-2.2 (-5.6, 1.2)	0.20
Minor axis diameter (mm)	50.8 ± 10.5 (137)	57.5 ± 9.3 (49)	-6.7 (-10, -3.3)	<0.01
Length (mm)	151 ± 71.3 (132)	158.6 ± 81.0 (46)	-7.9 (-33, 17)	0.53
Ulcer size				
Major axis diameter (mm)	28.7 ± 9.7 (22)	29.0 ± 7.3 (7)	-0.2 (-8.4, 8.0)	0.95
Minor axis diameter (mm)	20.9 ± 7.7 (23)	21.1 ± 9.8 (7)	-0.1 (-7.4, 7.1)	0.96
Depth (mm)	14.4 ± 4.7 (22)	20.7 ± 7.8 (7)	-6.3 (-11, -1.4)	0.01

n/a – not applicable

[1] Confidence intervals are unadjusted for multiplicity and are based on the difference in means for continuous variables utilizing the T-distribution and the difference in percentages for categorical variables utilizing the Z-distribution.

[2] *p* values are based on Fisher's exact test for categorical variables and t-test for continuous variables and are unadjusted for multiplicity.

[3] Ulcers ≥10 mm in depth and 20 mm in diameter were eligible for study inclusion.

[4] As determined by site assessment for 7 open surgical patients without available imaging for core lab analysis.

[5] Primary location described as proximal one-third (i.e., arch to T6), middle one-third (i.e., T6-T8), or distal one-third (i.e., T9-L2).

Devices Implanted

Endovascular patients were treated using either a two-piece main body (proximal main body component in combination with a distal main body component) or a one-piece main body (either a proximal main body component only or a one-piece main body component – note: the one-piece main body component is described in a separate IFU specific to the one-piece main body component). Table 6.6 reports the percent of endovascular patients treated with a two-piece main body and the percent of patients treated with a one-piece main body. Also reported are the total number of components deployed during the initial implant procedure for patients treated with a two-piece main body and for patients treated with a one-piece main body in order to account for ancillary component use.

Table 6.6 Main Body System Type and Total Number of Components

Type	% (n)	Total number of components (main body and ancillary)			
		1	2	3	4
Two-piece	59.5% (94/158)	n/a	88.3% (83/94)	11.7% (11/94)	0% (0/94)
One-piece	40.5% (64/158)	90.6% (58/64)[1]	7.8% (5/64)	1.6% (1/64)	0% (0/64)

[1] One patient received a proximal extension as the principal endograft.

Table 6.7 reports the number of components (main body components and main body extensions) used during the initial implant procedure, by diameter.

Table 6.7 Graft Diameters Implanted during Initial Procedure

Diameter (mm)	Non-tapered proximal main body component[1] (n)	Tapered proximal main body compo-nent[1] (n)	Distal main body compo-nent[1] (n)	One-piece main body component (n)	Proximal extension (n)	Distal extension (n)
28	4	n/a	2	0	0	1
30	8	n/a	2	2	1	0
32	13	2	7	0	1	1
34	22	1	14	1	2	2
36	19	3	17	0	3	1
38	22	7	22	0	0	0
40	29	5	20	0	0	4
42	12	7	10	0	2	1

[1]Multiple length increments available for each diameter.

Results

Safety

The primary safety hypothesis was based on 30-day survival, which was non-inferior ($p<0.01$) in the endovascular treatment group compared to the open surgical control group (98.1% vs. 94.3%). As illustrated by Figure 6.1 and presented in Table 6.8, 365-day survival from all-cause mortality was 91.6% in the endovascular treatment group and 85.5% in the open surgical control group. Survival from all-cause mortality at 730 days is 79.8% in the endovascular treatment group and 85.5% in the open surgical control group, with follow-up on-going. Survival from aneurysm-related mortality (i.e., death occurring within 30 days of the initial implant procedure or a secondary intervention, or any death adjudicated to be aneurysm-related by the independent clinical events committee) through 365 days was 94.2% in the endovascular treatment group and 88.2% in the open surgical control group, as illustrated by Figure 6.2 and presented in Table 6.9. Survival from aneurysm-related mortality at 730 days is 92.9% in the endovascular treatment group and 88.2% in the open surgical control group, with follow-up on-going.

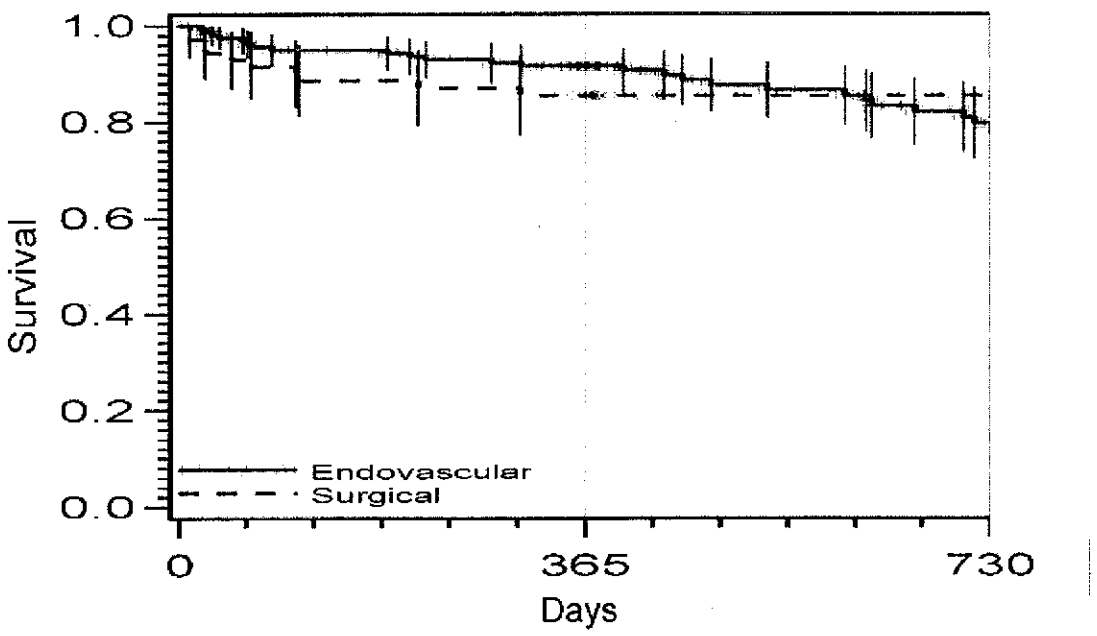


Figure 6.1 Survival from All-Cause Mortality through 730 Days

Table 6.8 Kaplan-Meier All-cause Mortality Survival Estimates

Arm	Days	Kaplan-Meier Estimate	Standard Error	Cumulative Events	Cumulative Censored	Patients Remaining
Endovascular	0	1.000	0.0000	0	0	160
	30	0.981	0.0107	3	1	156
	365	0.916	0.0223	13	28	119
	730	0.798	0.0387	24	78	58
Open Surgical	0	1.000	0.0000	0	0	70
	30	0.943	0.0277	4	0	66
	365	0.855	0.0423	10	7	53
	730	0.855	0.0423	10	45	15

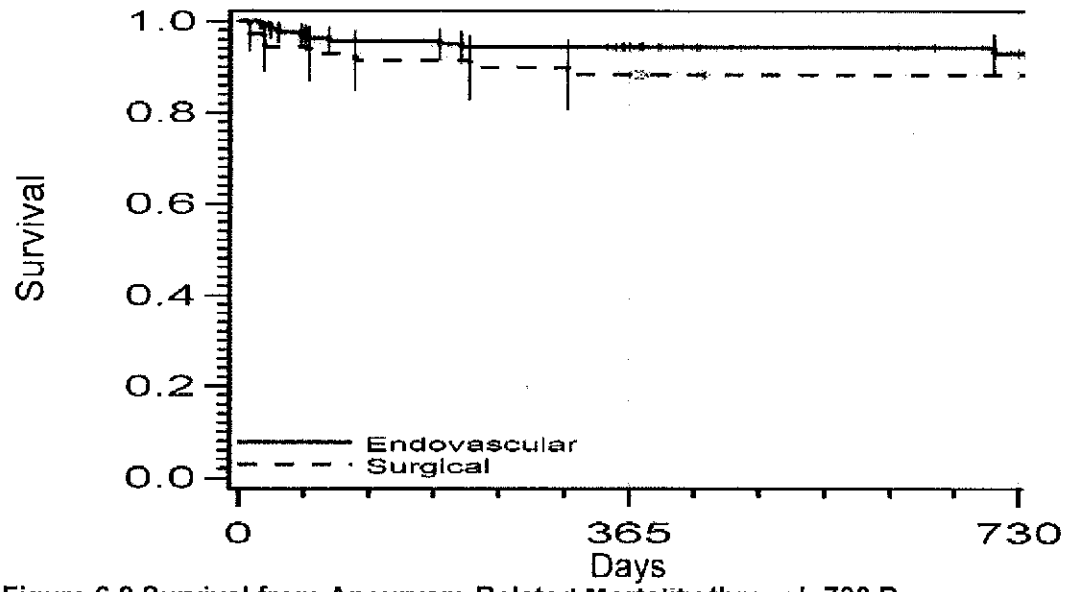


Figure 6.2 Survival from Aneurysm-Related Mortality through 730 Days

Table 6.9 Kaplan-Meier TAA-related Mortality Survival Estimates

Arm	Days	Kaplan-Meier Estimate	Standard Error	Cumulative Events	Cumulative Censored	Patients Remaining
Endovascular	0	1.000	0.0000	0	0	160
	30	0.981	0.0107	3	1	156
	365	0.942	0.0187	9	32	119
	730	0.929	0.0229	10	92	58
Open Surgical	0	1.000	0.0000	0	0	70
	30	0.943	0.0277	4	0	66
	365	0.882	0.0391	8	9	53
	730	0.882	0.0391	8	47	15

A secondary hypothesis was based on 30-day morbidity with endovascular treatment, expressed as a composite morbidity score (mean number of events per patient), which, as shown in Table 6.10, was non-inferior in the endovascular treatment group compared to the open surgical control group ($p<0.01$).

Table 6.10 Total Morbidity Score within 0-30 Days

Item	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
30-day morbidity score (events[3] per patient)	1.3 ± 3.0 (160)	2.9 ± 3.6 (70)	-1.6 (-2.5, -0.7)	<0.01

[1] Confidence interval on the difference in means utilized the T-distribution and is unadjusted for multiplicity.
[2] *p* value is based on test for non-inferiority and is unadjusted for multiplicity.
[3]Pre-specified events that were considered for the morbidity score included: cardiovascular events (Q-wave myocardial infarction; non-Q-wave myocardial infarction; congestive heart failure; arrhythmia requiring intervention or new treatment; cardiac ischemia requiring intervention; inotropic support; refractory hypertension [systolic BP of >160 despite receiving medication]; cardiac event involving arrest, resuscitation, or balloon pump); pulmonary events (ventilation >24 hours; re-intubation; pneumonia requiring antibiotics; supplemental oxygen at time of discharge; chronic obstructive pulmonary disease; pleural effusion requiring treatment; pulmonary edema requiring treatment; pneumothorax; hemothorax; pulmonary event requiring tracheostomy or chest tube); renal events (urinary tract infection requiring antibiotic treatment; renal failure requiring dialysis; renal insufficiency [serum creatinine rise >30% from baseline resulting in a persistent value >2.0 mg/dL]; permanent dialysis, hemofiltration, or kidney transplant in patient with normal pre-procedure creatinine); gastrointestinal events (bowel/mesenteric ischemia; gastrointestinal infection requiring treatment; gastrointestinal bleeding requiring treatment; paralytic ileus >4 days; bowel resection); neurological events (stroke; TIA/RIND; carotid artery embolization/occlusion; paraparesis/spinal cord shock; paraplegia); vascular events (pulmonary embolism; pulmonary embolism involving hemodynamic instability or surgery; vascular injury; aneurysm leak/rupture; aneurysm or vessel leak requiring re-operation; pseudoaneurysm requiring surgical repair; increase in aneurysm size >0.5 cm relative to first post-procedure measurement; aorto-esophageal fistula; aorto-bronchial fistula; aorto-enteric fistula; arterial thrombosis; embolization resulting in tissue loss or requiring intervention; amputation involving more than the toes; deep vein thrombosis; deep vein thrombosis requiring surgical or lytic therapy; hematoma requiring surgical repair; hematoma requiring receipt of blood products; coagulopathy requiring surgery; post-procedure transfusion); wound events (wound infection requiring antibiotic treatment; incisional hernia; lymph fistula; wound breakdown requiring debridement; seroma requiring treatment; wound complication requiring return to the operating room).

The 30-day and 365-day Kaplan-Meier estimates for freedom from any one of the following pre-specified events (representing a subset of the events listed in Table 6.10) are illustrated in Figure 6.3 and reported in Table 6.11, along with the estimates for each individual event: Q-wave MI; cardiac event involving arrest, resuscitation, or balloon pump; ventilation >72 hours; re-intubation; pulmonary event requiring a tracheostomy or chest tube; permanent dialysis, hemofiltration, or transplant [in a patient with normal pre-procedure creatinine]; bowel resection; stroke; paraplegia; pulmonary embolism involving hemodynamic instability or requiring surgery; aneurysm or vessel leak requiring re-operation; amputation involving more than the toes; deep vein thrombosis requiring surgery or lytic therapy; coagulopathy requiring surgery; and wound complication requiring return to OR. The 30-day estimate for freedom from any of the events from this pre-specified subset was 90.6% in the endovascular treatment group and 67.1% in the open surgical control group. The 365-day estimate for freedom from these events was 87.3% in the endovascular treatment group and 64.3% in the open surgical control group. The 730 day estimate for freedom from any of the events from the pre-specified subset is 83.6% in the endovascular treatment group and 64.3% in the open surgical control group, with follow-up ongoing.

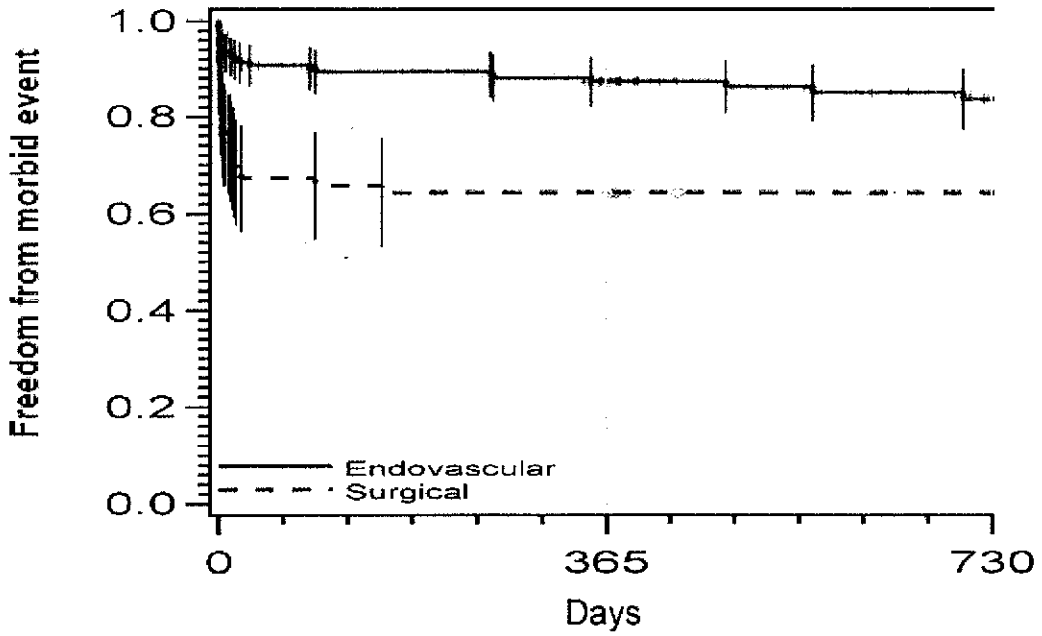


Figure 6.3 Freedom from Pre-specified Subset of Morbid Events through 730 Days

Table 6.11 Summary of Kaplan-Meier Estimates for Freedom from Pre-specified Subset of Morbid Events*

Event	Parameter	30 days		365 days		730 days	
		Endo	Open	Endo	Open	Endo	Open
Any event	Number at risk[1]	160	70	144	47	109	39
	Cumulative events	15	23	20	25	23	25
	Cumulative censored[2]	1	0	31	6	84	35
	Kaplan-Meier est.[3]	0.91	0.67	0.87	0.64	0.84	0.64
	Standard error	0.02	0.06	0.03	0.06	0.3	0.06
Q-wave MI	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	0	0	0
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	1.00	1.00	1.00	1.00	1.00
	Standard error	0.00	0.00	0.00	0.00	0.00	0.00
Cardiac event involving arrest, resuscitation or balloon pump	Number at risk[1]	160	70	153	66	118	53
	Cumulative events	4	1	4	2	5	2
	Cumulative censored[2]	3	3	38	15	98	53
	Kaplan-Meier est.[3]	0.98	0.99	0.98	0.97	0.96	0.97
	Standard error	0.01	0.01	0.01	0.02	0.02	0.02
Vent. >72 hours	Number at risk[1]	160	70	155	57	119	46
	Cumulative events	1	11	1	11	1	11
	Cumulative censored[2]	4	2	40	13	101	47
	Kaplan-Meier est.[3]	0.99	0.84	0.99	0.84	0.99	0.84
	Standard error	0.01	0.04	0.01	0.04	0.01	0.04
Re-intubation	Number at risk[1]	160	70	150	57	117	47
	Cumulative events	8	10	8	11	9	11
	Cumulative censored[2]	2	3	35	12	94	47
	Kaplan-Meier est.[3]	0.95	0.86	0.95	0.84	0.94	0.84
	Standard error	0.02	0.04	0.02	0.04	0.02	0.04

Pulmonary event requiring tracheostomy or chest tube	Number at risk[1]	160	70	154	59	118	49
	Cumulative events	2	9	4	12	5	12
	Cumulative censored[2]	4	2	38	9	97	45
	Kaplan-Meier est.[3]	0.99	0.87	0.97	0.82	0.96	0.82
	Standard error	0.01	0.04	0.01	0.05	0.02	0.05
Permanent dialysis or transplant	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	0	0	0
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	1.00	1.00	1.00	1.00	1.00
	Standard error	0.00	0.00	0.00	0.00	0.00	0.00
Bowel resection	Number at risk[1]	160	70	153	65	117	52
	Cumulative events	3	1	5	1	5	1
	Cumulative censored[2]	4	4	38	17	98	54
	Kaplan-Meier est.[3]	0.98	0.99	0.97	0.99	0.97	0.99
	Standard error	0.01	0.01	0.01	0.01	0.01	0.01
Stroke	Number at risk[1]	160	70	153	63	117	50
	Cumulative events	4	6	5	7	6	7
	Cumulative censored[2]	3	1	38	13	98	48
	Kaplan-Meier est.[3]	0.98	0.91	0.97	0.90	0.95	0.90
	Standard error	0.01	0.03	0.01	0.04	0.02	0.04
Paraplegia	Number at risk[1]	160	70	155	63	119	53
	Cumulative events	2	4	2	4	2	4
	Cumulative censored[2]	3	3	39	13	100	51
	Kaplan-Meier est.[3]	0.99	0.94	0.99	0.94	0.99	0.94
	Standard error	0.01	0.03	0.01	0.03	0.01	0.03
PE involving hemodynamic instability or surgery	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	0	0	0
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	1.00	1.00	1.00	1.00	1.00
	Standard error	0.00	0.00	0.00	0.00	0.00	0.00
Aneurysm or vessel leak requiring re-operation	Number at risk[1]	160	70	156	65	119	52
	Cumulative events	0	1	0	1	0	1
	Cumulative censored[2]	4	4	41	17	102	54
	Kaplan-Meier est.[3]	1.00	0.99	1.00	0.99	1.00	0.99
	Standard error	0.00	0.01	0.00	0.01	0.00	0.01
Amputation involving more than toes	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	0	1	0	1
	Cumulative censored[2]	4	4	41	16	102	54
	Kaplan-Meier est.[3]	1.00	1.00	1.00	0.98	1.00	0.98
	Standard error	0.00	0.00	0.00	0.02	0.00	0.02
Deep vein thrombosis requiring surgery or lytic therapy	Number at risk[1]	160	70	156	66	119	53
	Cumulative events	0	0	1	0	1	0
	Cumulative censored[2]	4	4	40	17	101	55
	Kaplan-Meier est.[3]	1.00	1.00	0.99	1.00	0.99	1.00
	Standard error	0.00	0.00	0.01	0.00	0.01	0.00
Coagulopathy requiring surgery	Number at risk[1]	160	70	156	65	119	52
	Cumulative events	0	1	0	1	0	1
	Cumulative censored[2]	4	4	41	17	102	55
	Kaplan-Meier est.[3]	1.00	0.99	1.00	0.99	1.00	0.99
	Standard error	0.00	0.01	0.00	0.01	0.00	0.01
Wound complication requiring return to OR	Number at risk[1]	160	70	156	66	117	53
	Cumulative events	0	0	2	0	2	0
	Cumulative censored[2]	4	4	41	17	100	55
	Kaplan-Meier est.[3]	1.00	1.00	0.99	1.00	0.99	1.00
	Standard error	0.00	0.00	0.01	0.00	0.01	0.00

*Subset of events pre-selected from list in Table 6-10 prior to start of the study by the physician steering committee.
[1] Number of patients at risk at the beginning of the interval
[2] Total censored patients up to and including the specific interval
[3] Made at end of interval

Effectiveness

The primary effectiveness hypothesis was based on 30-day rupture-free survival (i.e., freedom from rupture), which was non-inferior ($p<0.01$) in the endovascular treatment group compared to the open surgical control group (100% vs. 100%). Because there were no ruptures in either group, the planned analysis (Blackwelder) could not be performed, and an alternate analysis (exact non-inferiority test) was necessary to generate the p value. Freedom from rupture was 100% in both groups through 365 days post-procedure. Freedom from rupture is 100% in both groups through 730 days post-procedure, with follow-up on-going.

The results from Kaplan-Meier analysis for freedom from any of the following device events are illustrated in Figure 6.4 and presented in Table 6.12: technical failure; loss of patency; rupture; secondary intervention; conversion; stent fracture; Type I or III endoleak; or migration. Freedom from any device event was 94.9% at 30 days and 90.1% at 365 days. Freedom from any device event at 730 days is 89.1%, with follow-up on-going.

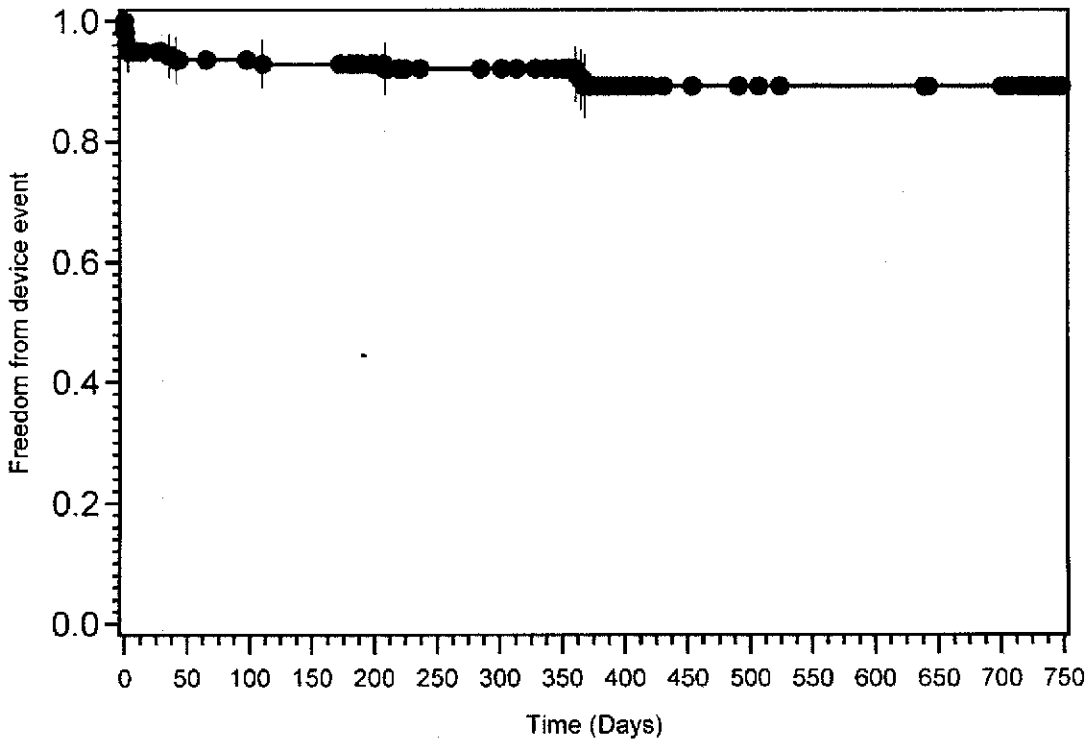


Figure 6.4 Freedom from Device Events

Table 6.12. Kaplan-Meier Estimate for Freedom from Device Events

Days	Kaplan-Meier Estimate	Standard Error	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Cumulative Events	Cumulative Censored	Patients Remaining
30	0.949	0.0176	0.914	0.983	8	14	138
365	0.901	0.0254	0.851	0.951	14	55	91
730	0.891	0.0271	n/a	n/a	15	105	40

Table 6.13 reports the percent of patients with an increase (>5 mm), decrease (>5 mm), or no change (≤5 mm) in aneurysm diameter or ulcer depth at each follow-up time point subsequent to pre-discharge (baseline) based on the results from core lab analysis. In total, 9 patients (7 aneurysm, 2 ulcer) experienced an increase in size within 12 months, with no new cases of growth identified at the 24-month follow-up, which remains on-going.

Table 6.13 Percent of Endovascular Treatment Patients with an Increase, Decrease, or No Change in Aneurysm/Ulcer Size Based on Core Lab Analysis

Time point	Combined % (n)	Aneurysm % (n)	Ulcer % (n)
30-day			
Increase (>5 mm)	0.8% (1/121)[1]	1.0% (1/105)	0% (0/16)
Decrease (>5 mm)	6.6% (8/121)	5.7% (6/105)	12.5% (2/16)
No change (≤5 mm)	92.6% (112/121)	93.3% (98/105)	87.5% (14/16)
6-month			
Increase (>5 mm)	3.4% (4/117)[2]	3.1% (3/98)	5.3% (1/19)
Decrease (>5 mm)	33.3% (39/117)	33.7% (33/98)	31.6% (6/19)
No change (≤5 mm)	63.2% (74/117)	63.3% (62/98)	63.2% (12/19)
12-month			
Increase (>5 mm)	7.1% (8/112)[3]	7.2% (7/97)	6.7% (1/15)
Decrease (>5 mm)	48.2% (54/112)	50.5% (49/97)	33.3% (5/15)
No change (≤5 mm)	44.6% (50/112)	42.3% (41/97)	60% (9/15)
24-month			
Increase (>5 mm)	1.8% (1/56)[4]	0% (0/49)	14.3% (1/7)
Decrease (>5 mm)	53.6% (30/56)	57.1% (28/49)	28.6% (2/7)
No change (≤5 mm)	44.6% (25/56)	42.9% (21/49)	57.1% (4/7)

[1] This aneurysm patient is also counted as an increase at 6 and 12 months, was without detectable endoleak or evidence of graft infection, and was found to have a decrease in size at the 24-month follow-up (without secondary intervention).

[2] Includes three new patients (2 aneurysm, 1 ulcer). Both aneurysm patients are also counted as an increase at 12 months. One aneurysm patient had no detectable endoleak or evidence of graft infection and was found to have no change in size at 24 months (without secondary intervention). The other aneurysm patient also had no detectable endoleak or evidence of graft infection, but had an aortic neck diameter at the location of actual graft placement that does not meet the recommended oversizing of at least 10% as well as an inverted funnel-shaped proximal neck and a funnel-shaped distal neck. This same patient also underwent two secondary interventions for aneurysm growth and expired within 30 days of the later secondary intervention (after removal of ventilator support following a stroke). The ulcer patient, who was noted to have a Type II endoleak at pre-discharge, was found to have no change in size at 12 months and 24 months (without secondary intervention).

[3] Includes five new patients (4 aneurysm, 1 ulcer). In three of the aneurysm patients, each of which are awaiting further follow-up, there was no detectable endoleak or evidence of graft infection, but the aortic neck diameter at the location of actual graft placement does not meet the recommended oversizing of at least 10%, and there was also an inverted funnel-shaped proximal aortic neck and a funnel-shaped distal aortic neck. The other new aneurysm patient was noted to have a distal Type I endoleak, underwent two secondary interventions, and is awaiting further follow-up. In the new ulcer patient, who also exhibited growth at 24 months, there was no detectable endoleak or evidence of graft infection, but the aortic neck diameter at the location of actual graft placement does not meet the recommended oversizing of at least 10%.

[4] This ulcer patient was first noted to have growth at 12 months, as discussed in note '3'.

Table 6.14 reports the percent of patients with endoleak (by type) at each follow-up time point based on the results from core lab analysis.

Table 6.14 Percent of Endovascular Treatment Patients with Endoleak (New and Persistent) Based on Core Lab Analysis

Type	Time point				
	Pre-discharge	30-day	6-month	12-month	24-month
Any (new only)	12.6% (17/135)	1.6% (2/126)[a,b]	0% (0/114)	1.0% (1/103)[c]	0% (0/57)
Any (new and persistent)	12.6% (17/135)	4.8% (6/126)	2.6% (3/114)	3.9% (4/103)	1.8% (1/57)
Multiple	0% (0/135)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)
Proximal Type I	0% (0/135)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)
Distal Type I	0.7% (1/135)	0.8% (1/126)	0.9% (1/114)	0% (0/103)	0% (0/57)
Type IIa	1.5% (2/135)	0.8% (1/126)[a]	0% (0/114)	0% (0/103)	0% (0/57)
Type IIb	5.9% (8/135)	2.4% (3/126)	1.8% (2/114)	1.9% (2/103)	1.8% (1/57)
Type III	1.5% (2/135)	0.8% (1/126)[b]	0% (0/114)	1.0% (1/103)[b]	0% (0/57)
Type IV	1.5% (2/135)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)
Unknown	1.5% (2/135)	0% (0/126)	0% (0/114)	1.0% (1/103)[c]	0% (0/57)

[a]Type IIa in one patient who did not undergo endoleak assessment at pre-discharge.

[b]Non-junctional Type III endoleak in one patient that was not evident at pre-discharge or 6-months, is not associated with aneurysm growth, has not required reintervention, and is awaiting further follow-up.

[c]Unknown Type endoleak, but in a patient who previously had a Type IIb endoleak at pre-discharge and no endoleak at 30 days or 6 months.

Table 6.15 reports the percent of patients with core lab-identified and CEC-confirmed migration (>10 mm) at each follow-up time point (date of first occurrence). There have been no patients with clinically significant migration (i.e., migration resulting in endoleak, growth, or requiring secondary intervention).

Table 6.15 Percent of Patients with CEC-Confirmed Migration (Date of First Occurrence)

Item	30-day	6-month	12-month	24-month
Migration (>10 mm)	0% (0/111)	0.9% (1/112)*	1.9% (2/106)*	1.8% (1/55)*

*Includes two cases of caudal migration of the proximal graft and two cases of cranial migration of the distal graft. All patients have an aortic neck diameter at the location of actual graft placement that does not meet the recommended oversizing of at least 10%. Additionally, three also have placement of the pertinent barbed stent in a neck that is either an acutely angled segment or in an area of thrombus.

Table 6.16 reports the percent of patients with device integrity findings at each follow-up time point based on the results from core lab analysis. One patient was noted to have a device integrity finding: entanglement of neighboring struts of the distal bare stent, which has not been associated with migration, endoleak, or the need for secondary intervention.

Table 6.16 Percent of Endovascular Treatment Patients with Device Integrity Findings by Core Lab

Finding	Time point				
	Pre-discharge	30-day	6-month	12-month	24-month
Stent fracture	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)
Barb separation	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)
Stent-to-graft separation	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)
Component	0% (0/152)	0% (0/136)	0% (0/127)	0% (0/123)	0% (0/63)

separation					
Other	0.7% (1/152)[1]	0% (0/136)	0% (0/127)	0.8% (1/123)[1]	0% (0/63)

[1]Entanglement of neighboring struts of distal bare stent; same patient at pre-discharge and 12 months; finding not associated with migration, endoleak, or the need for secondary intervention.

Table 6.17 reports the results from core lab assessment for endovascular graft kink (evidence of reduced graft diameter or narrowing of lumen in the presence of acute aortic angulation), compression (evidence of reduced graft diameter or narrowing of the lumen in the absence of aortic angulation), and loss of patency. Three patients were noted to have a kink at one or more time points and two patients were noted to have compression at one or more time points. None required a secondary intervention.

Table 6.17 Endovascular Graft Kink, Compression, and Loss of Patency by Core Lab Analysis

	Time point				
Finding	**Pre-discharge**	**30-day**	**6-month**	**12-month**	**24-month**
Kink	1.9% (3/155)	0.7% (1/139)	0.8% (1/127)	1.6% (2/123)	0% (0/63)
Compression	1.4% (2/142)[a]	0.8% (1/124)[a]	0.9% (1/117)[a]	0.9% (1/108)[a]	2.1% (1/47)[a]
Loss of patency	0% (0/138)	0% (0/126)	0% (0/114)	0% (0/103)	0% (0/57)

[a] Concentric constriction of one mid-body stent of the device not associated with tortuosity or flow limitation with expansion of the stents above and below the compressed segment -- this should be distinguished from the phenomena of endovascular graft collapse described in literature for other (non-Zenith) grafts.

Seven (4.4%) endovascular treatment patients (6 aneurysm, 1 ulcer) and four (5.7%) open surgical control patients (2 aneurysm, 2 ulcer) underwent at least one re-intervention within 365 days subsequent to the initial aneurysm/ulcer repair procedure. The reasons for re-intervention are reported in Table 6.18. There have been no conversions to open surgical repair in the endovascular treatment group.

Table 6.18 Reasons for Secondary Intervention

Reason	**Endovascular**			**Open Surgical**		
	0-30 days	**31-365 days**	**366-730 days**	**0-30 days**	**31-365 days**	**366-730 days**
Aneurysm rupture	0	0	0	0	0	0
Component separation	0	0	0	n/a	n/a	0
Symptoms	0	0	0	1[f]	0	0
Occlusion	0	0	0	0	0	0
Device stenosis	0	0	0	n/a	n/a	n/a
Device kink	0	0	0	n/a	n/a	n/a
Device migration	0	0	0	n/a	n/a	n/a
Infection	0	0	0	0	0	0
Endoleak	3	2[a]	0			
Proximal Type I	1[b]	0	0			
Distal Type I	1[c]	2[a]	0			
Type IIa	0	0	0	n/a	n/a	n/a
Type IIb	0	0	0			
Type III	1[d]	0	0			
Type IV	0	0	0			
Unknown	0	0	0			
Other	0	3[e]	1[f]	3[f,g]	1[h]	0

n/a – not applicable

[a] One aneurysm patient with two interventions for a distal Type I endoleak – bare stent placement and stent placement/coil embolization/distal extension placement.

[b] Aneurysm patient treated with proximal main body extension placement.
[c] Aneurysm patient treated with molding balloon angioplasty and distal extension placement
[d] Aneurysm patient underwent angiogram to rule out endoleak.
[e] Includes one ulcer patient with iliac artery occlusion, treated with femoral-femoral bypass; one aneurysm patient with growth, treated with distal extension placement in overlap and distal end of graft; and one aneurysm patient who developed a pseudoaneurysm at follow-up, treated with proximal extension placement.
[f] One ulcer patient with multiple reasons of symptoms and other (continued bleeding), treated with re-exploration and hemostatic sealing agents.
[g] Includes one aneurysm patient with intrapleural hematoma, treated with exploratory thoracotomy and evacuation; one ulcer patient with bleeding and tamponade, treated with intercostal vessel ligation.
[h] One aneurysm patient who developed an aorto-esophageal fistula at follow-up, treated with custom endograft placement.
[i] One aneurysm patient with growth, treated with placement of additional endovascular graft components, who also underwent secondary intervention for growth at 31-365 days, as discussed in note 'e'.

Clinical Utility

Another secondary hypothesis was superior clinical utility in the endovascular treatment group compared to the open surgical control group. All clinical utility measures were superior in the endovascular treatment group compared to the open surgical control group ($p<0.01$), as reported in Table 6.19.

Table 6.19 Clinical Utility Measures

Measure	Endovascular	Open Surgical	Diff (95% CI)[1]	*p* value [2]
Number of blood transfusions	0.3 ± 1.0 (160)	1.7 ± 1.9 (70)	-1.4 (-1.9, -0.9)	<0.01
Duration of intubation (hrs)	2.8 ± 4.6 (147)	53.1 ± 85.4 (66)	-50 (-71, -29)	<0.01
Duration of ICU stay (days)	2.2 ± 6.2 (153)	9.4 ± 16.9 (70)	-7.2 (-11, -3.1)	<0.01
Days to ambulation	1.6 ± 2.5 (148)	5.5 ± 5.6 (63)	-3.9 (-5.4, -2.5)	<0.01
Days to resumption of oral fluid intake	0.7 ± 1.9 (155)	4.0 ± 5.6 (60)	-3.3 (-4.8, -1.8)	<0.01
Days to resumption of regular diet	1.9 ± 2.7 (156)	5.2 ± 3.7 (58)	-3.3 (-4.4, -2.3)	<0.01
Days to resumption of bowel function	2.9 ± 2.3 (94)	5.5 ± 3.3 (61)	-2.6 (-3.6, -1.7)	<0.01
Days to hospital discharge	5.0 ± 8.6 (159)	16.1 ± 18.7 (70)	-11 (-16, -6.4)	<0.01

[1] Confidence interval on difference in means utilized the T-distribution and is unadjusted for multiplicity.
[2] *p* values are unadjusted for multiplicity.

Summary

All primary and secondary hypotheses were met. Specifically, 30-day mortality was non-inferior in the endovascular treatment group compared to the open surgical control group; 30-day morbidity was non-inferior in the endovascular treatment group compared to the open surgical control group; there were no ruptures in either the endovascular treatment group or open surgical control group; and all clinical utility measures were superior in the endovascular treatment group compared to the open surgical control group. There were no conversions to the open surgical repair in the endovascular treatment group, and the percent of patients requiring secondary interventions were similarly low between the endovascular treatment group and open surgical control group. Aneurysm/ulcer size stabilized or decreased in most endovascular patients at 12 months, and the rates of endoleak, migration, and device integrity findings were low at 12 months. Follow-up beyond 12 months remains on-going.

7. PATIENT SELECTION AND TREATMENT
(See **Section 4, WARNINGS AND PRECAUTIONS**)

7.1 Individualization of Treatment

Cook recommends that the Zenith TX2 TAA Endovascular Graft component diameters be selected as described in **Tables 10.1 and 10.2**. All lengths and diameters of the devices necessary to complete the procedure should be available to the physician, especially when pre-operative case planning measurements (treatment diameters/lengths) are not certain. This approach allows for greater intra-operative flexibility to achieve optimal procedural outcomes. The risks and benefits should be carefully considered for each patient before use of the Zenith TX2 TAA Endovascular Graft. Additional considerations for patient selection include but are not limited to:

- Patient's age and life expectancy.
- Co-morbidities (e.g., cardiac, pulmonary or renal insufficiency prior to surgery, morbid obesity).
- Patient's suitability for open surgical repair.
- The risk of aneurysm rupture compared to the risk of treatment with the Zenith TX2® TAA Endovascular Graft.
- Ability to tolerate general, regional, or local anesthesia.
- Ability and willingness to undergo and comply with the required follow-up.
- Ilio-femoral access vessel size and morphology (thrombus, calcification and/or tortuosity) should be compatible with vascular access techniques and accessories of the delivery profile of a 20 French to 22 French vascular introducer sheath.
- Vascular morphology suitable for endovascular repair, including:
  - Adequate iliac/femoral access compatible with the required introduction systems,
  - Radius of curvature greater than 35 mm along the entire length of aorta intended to be treated.
- Non-aneurysmal aortic segments (fixation sites) proximal and distal to the aneurysm or ulcer:
  - with a length of at least 25 mm,
  - with a diameter measured outer wall to outer wall of no greater than 38 mm and no less than 24 mm, and
  - with an angle less than 45 degrees.

The final treatment decision is at the discretion of the physician and patient.

8. PATIENT COUNSELING INFORMATION

The physician and patient (and/or family members) should review the risks and benefits when discussing this endovascular device and procedure including:

- Risks and differences between endovascular repair and open surgical repair.
- Potential advantages of traditional open surgical repair.
- Potential advantages of endovascular repair.
- The possibility that subsequent interventional or open surgical repair of the aneurysm or ulcer may be required after initial endovascular repair.

In addition to the risks and benefits of an endovascular repair, the physician should assess the patient's commitment to and compliance with post-operative follow-up as necessary to ensure continuing safe and effective results. Listed below are additional topics to discuss with the patient as to expectations after an endovascular repair:

- The long-term performance of endovascular grafts has not yet been established. All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and the performance of their endovascular graft. Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the endovascular graft) should receive enhanced follow-up. Specific follow-up guidelines are described in **Section 12, IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP.**
- Patients should be counseled on the importance of adhering to the follow-up schedule, both during the first year and at yearly intervals thereafter. Patients should be told that regular and consistent follow-up is a critical part of ensuring the ongoing safety and effectiveness of endovascular treatment of thoracic aortic aneurysms/ulcers. At a minimum, annual imaging and adherence to routine post-operative follow-up requirements is required and should be considered a life-long commitment to the patient's health and well-being.
- The patient should be told that successful aneurysm or ulcer repair does not arrest the disease process. It is still possible to have associated degeneration of vessels.
- Physicians must advise every patient that it is important to seek prompt medical attention if he/she experiences signs of graft occlusion, aneurysm or ulcer enlargement or rupture. Symptoms of graft occlusion include, but may not be limited to, pulse less legs, pain, ischemia of intestines, and cold extremities. Aneurysm or ulcer rupture may be asymptomatic, but usually presents as back or chest pain, persistent cough, dizziness, fainting, rapid heartbeat, or sudden weakness.
- Due to the imaging required for successful placement and follow-up of endovascular devices, the risks of radiation exposure to developing tissue should be discussed with women who are or suspect they are pregnant. Men who undergo endovascular or open surgical repair may experience impotence.

The physician should complete the Patient Card and give it to the patient so that he/she can carry it with him/her at all times. The patient should refer to the card anytime he/she visits additional health practitioners, particularly for any additional diagnostic procedures (e.g., MRI). For additional information, please refer to the Zenith TX2 TAA Endovascular Graft Patient Guide.

9. HOW SUPPLIED

- The Zenith TX2 TAA Endovascular Graft is supplied sterile and pre-loaded in peel-open packages.
- The device is intended for single use only. Do not re-sterilize the device.
- Inspect the device and packaging to verify that no damage has occurred as a result of shipping. Do not use this device if damage has occurred or if the sterilization barrier has been damaged or broken. If damage has occurred, do not use the product and return to COOK.
- Prior to use, verify correct devices (quantity and size) have been supplied for the patient by matching the device to the order prescribed by the physician for that particular patient.
- The device is loaded into a 20 French or 22 French Flexor® Introducer Sheath. Its surface is treated with a hydrophilic coating that, when hydrated, enhances trackability. To activate the hydrophilic coating, the surface must be wiped with a 4X4 gauze pad soaked in saline solution.
- Do not use after the expiration date printed on the label.
- Store in a dark, cool, dry place.

10. CLINICAL USE INFORMATION

10.1 Physician Training

CAUTION: Always have a qualified surgery team available during implantation or reintervention procedures in the event that conversion to open surgical repair is necessary.

CAUTION: The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System should only be used by physicians and teams trained in vascular interventional techniques (endovascular and surgical) and in the use of this device. The recommended skill/knowledge requirements for physicians using the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System are outlined below:

Patient selection:

- Knowledge of the natural history of thoracic aortic aneurysms (TAA) or ulcers, and co-morbidities associated with TAA repair.
- Knowledge of radiographic image interpretation, patient selection, device selection, planning and sizing.

A multidisciplinary team that has combined procedural experience with:

- Femoral and brachial cutdown, arteriotomy, and repair or conduit technique
- Percutaneous access and closure techniques
- Non-selective and selective wire guide and catheter techniques
- Fluoroscopic and angiographic image interpretation
- Embolization
- Angioplasty
- Endovascular stent placement
- Snare techniques
- Appropriate use of radiographic contrast material
- Techniques to minimize radiation exposure
- Expertise in necessary patient follow-up modalities

10.2 Inspection Prior to Use

Inspect the device and packaging to verify that no damage has occurred as a result of shipping. Do not use this device if damage has occurred or if the sterilization barrier has been damaged or broken. If damage has occurred, do not use the product and return to COOK.

Prior to use, verify correct devices (quantity and size) have been supplied for the patient by matching the device to the order prescribed by the physician for that particular patient.

10.3 Materials Required

(Not included in two-piece modular system)

- A selection of Zenith TX2 TAA Endovascular Graft Proximal and Distal ancillary components in diameters compatible with the two-piece system are available.
- Fluoroscope with digital angiography capabilities (C-arm or fixed unit)
- Contrast media
- Power injector
- Syringe
- Heparinized saline solution
- Sterile 4X4 gauze pads

10.4 Materials Recommended

(Not included in two-piece modular system)

The following products are recommended for implantation of any component in the Zenith product line. For information on these products, refer to the individual product's Suggested Instruc-

tions For Use.

- .035 inch (0.89 mm) extra stiff wire guide, 260 cm; for example:
  - Cook Amplatz Ultra Stiff Wire Guides (AUS)
  - Cook Lunderquist Extra Stiff Wire Guides (LESDC)
- .035 inch (0.89 mm) standard wire guide; for example:
  - Cook .035 inch wire guides
  - Cook .035 inch Bentson Wire Guide
  - Cook Nimble® Wire Guides
- Molding Balloons; for example:
  - Cook CODA® Balloon Catheter
- Introducer sets; for example:
  - Cook Check-Flo® Introducer Sets
- Sizing catheter; for example:
  - Cook Aurous® Centimeter Sizing Catheters
- Angiographic radiopaque marker catheters; for example:
  - Cook Beacon® Tip Angiographic Catheters
  - Cook Beacon® Tip Royal Flush Catheters
- Entry needles; for example:
  - Cook single wall entry needles

10.5 Device Diameter Sizing Guidelines

The choice of diameter should be determined from the outer wall to outer wall vessel diameter and **not** the lumen diameter. Undersizing or oversizing may result in incomplete sealing or compromised flow. In order to ensure accurate diameter measurements for the purpose of graft sizing, particularly when in curved segments of the aorta, measuring the aortic diameter using 3D reconstructed views perpendicular to the aortic centerline of flow may be important.

Table 10.1 Main Body Graft Diameter Sizing Guide*

Intended Aortic Vessel Diameter[1,2] (mm)	Graft Diameter[3] (mm)	Overall Length of Proximal Component (mm)	Overall Length of Distal Component (mm)	Overall length of Proximal Tapered Component (mm)	Introducer Sheath (Fr)	Introducer Sheath Outer Diameter (OD) (mm)
24	28	120/140/200	127/147/207	N/A	20	7.7
25	30	120/140/200	127/147/207	N/A	20	7.7
26	30	120/140/200	127/147/207	N/A	20	7.7
27	30	120/140/200	127/147/207	N/A	20	7.7
28	32	120/140/200	127/147/207	160/200	20	7.7
29	32	120/140/200	127/147/207	160/200	20	7.7
30	34	127/152/202	136/186	157/197	20	7.7
31	36	127/152/202	136/186	157/197	22	8.6
32	36	127/152/202	136/186	157/197	22	8.6
33	38	127/152/202	136/186	152/202	22	8.6
34	38	127/152/202	136/186	152/202	22	8.6
35	40	108/135/162/2	144/198	158/208	22	8.6
36	40	108/135/162/2	144/198	158/208	22	8.6
37	42	108/135/162/2	144/198	158/208	22	8.6
38	42	108/135/162/2	144/198	158/208	22	8.6

*All dimensions are nominal.
[1]Maximum diameter along the fixation site, measured outer wall to outer wall.
[2]Round measured aortic diameter to nearest mm.
[3]Additional considerations may affect choice of diameter.

Table 10.2 Proximal and Distal Extension Graft Diameter Sizing Guide*

Intended Aortic Vessel Diameter[1,2] (mm)	Graft Diameter[3] (mm)	Overall Length of Component (mm)	Introducer Sheath (Fr)	Introducer Sheath Outer Diameter (OD) (mm)
24	28	80	20	7.7
25	30	80	20	7.7
26	30	80	20	7.7
27	30	80	20	7.7
28	32	80	20	7.7
29	32	80	20	7.7
30	34	77	20	7.7
31	36	77	22	8.6
32	36	77	22	8.6
33	38	77	22	8.6
34	38	77	22	8.6
35	40	81	22	8.6
36	40	81	22	8.6
37	42	81	22	8.6
38	42	81	22	8.6

*All dimensions are nominal.
[1]Maximum diameter along the fixation site, measured outer wall to outer wall.
[2]Round measured aortic diameter to nearest mm.
[3]Additional considerations may affect choice of diameter.

11. DIRECTIONS FOR USE

Anatomical Requirements

- Iliofemoral access vessel size and morphology (minimal thrombus, calcium and/or tortuosity) should be compatible with vascular access techniques and accessories. Arterial conduit technique may be required.
- Proximal and distal aortic neck lengths should be a minimum of 25 mm.
- Aortic neck diameters measured outer wall to outer wall between 24-38 mm.
- Proximal neck diameter of at least 4 mm larger than the distal neck diameter requires the use of a proximal tapered component.
- Measurements to be taken during the pre-treatment assessment are described in **Fig. 5 and 6.**

Proximal and Distal Component Overlap

A minimum overlap of 2 stents (~50 mm) is required; a 3-4 stent (~75-100 mm) overlap is recommended, however, the proximal sealing stent of the proximal component or distal sealing stent of the distal component should not be overlapped.

The following instructions embody a basic guideline for device placement. Variations in the following procedures may be necessary. These instructions are intended to help guide the physician and do not take the place of physician judgment.

General Use Information

Standard techniques for placement of arterial access sheaths, guiding catheters, angiographic catheters and wire guides should be employed during use of the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System. The Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is compatible with .035 inch diameter wire guides.

Pre-Implant Determinants

Verify from pre-implant planning that the correct device has been selected. Determinants include:

1. Femoral artery selection for introduction of the delivery system(s).
2. Angulation of aorta, aneurysm and iliac arteries.
3. Quality of the proximal and distal fixation sites.
4. Diameters of proximal and distal fixation sites and distal iliac arteries.
5. Length of proximal and distal fixation sites.

Patient Preparation

1. Refer to institutional protocols relating to anesthesia, anticoagulation, and monitoring of vital signs.
2. Position patient on imaging table allowing fluoroscopic visualization from the aortic arch to the femoral bifurcations.
3. Expose femoral artery using standard surgical technique.
4. Establish adequate proximal and distal vascular control of femoral artery.

11.1 The Zenith TX2 TAA Endovascular Graft System Component Preparation/Flush/Placement – Proximal and Distal Components

1. Remove yellow-hubbed shipping stylet. Remove cannula protector tube. Remove Peel-Away® sheath from back of valve assembly. (**Fig. 7**)
2. Elevate distal tip of system and flush through the hemostatic valve until fluid emerges from the sideport near the tip of the introduction sheath. (**Fig. 8**) Continue to inject a full 20 cc of flushing solution through the device. Discontinue injection and close stopcock on connecting tube.

NOTE: Ensure that the side-arm adapter is securely connected to the side of the valve body.

NOTE: Graft flushing solution of heparinized saline is often used.

3. Attach syringe with heparinized saline to the hub on the inner cannula. Flush until fluid exits the distal sideports and dilator tip. (**Fig. 9**)
4. Ensure that the black pin vise on the control handle is tight.
5. Soak 4X4 gauze pads in saline solution and use to wipe the Flexor® Introducer Sheath to activate the hydrophilic coating. Hydrate both sheath and dilator liberally.

11.1.1 Placement of Proximal Component

1. Puncture the selected artery using standard technique with an 18 gage access needle. Upon vessel entry, insert:
   - Wire guide – standard .035 inch, 260 cm, 15 mm J tip or Bentson wire guide
   - Appropriate size sheath (e.g., 5.0 French)
   - Pigtail flush catheter (often radiopaque-banded sizing catheters; i.e., Cook Centimeter Sizing CSC-20 catheter)
2. Perform angiography at the appropriate level. Using radiopaque markers, adjust position as necessary and repeat angiography.
3. Ensure graft system has been flushed and primed with heparinized saline (appropriate flush solution), and all air has been removed.
4. Give systemic heparin. Flush all catheters and wet all wire guides with heparinized saline. This should be repeated following each exchange.
5. Replace the standard wire guide with a stiff .035 inch, 260 cm –LESDC wire guide and advance through the catheter and up to the aortic arch.
6. Remove pigtail flush catheter and sheath.

NOTE: At this stage, the second femoral artery can be accessed for angiographic catheter placement. Alternatively, a brachial approach may be considered.

7. Introduce the freshly hydrated delivery system over the wire guide and advance until the desired graft position is reached.

CAUTION: To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.

NOTE: The dilator tip will soften at body temperature.

NOTE: To facilitate introduction of the wire guide into the delivery system, it may be necessary to slightly straighten the delivery system dilator tip.

8. Verify wire guide position in the aortic arch. Ensure correct graft position.

CAUTION: Care should be taken not to advance the sheath while the stent graft is still within it. Advancing the sheath at this stage may cause the barbs to perforate the introducer sheath.

9. Ensure that the Captor Hemostatic Valve on the Flexor Introducer Sheath is turned to the open position. (**Fig. 10**)
10. Stabilize the grey positioner (delivery system shaft) and withdraw the sheath until the graft is fully expanded and the valve assembly docks with the control handle.

CAUTION: As the sheath is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.

CAUTION: During sheath withdrawal, the proximal barbs are exposed and are in contact with the vessel wall. At this stage it may be possible to advance the device, but retraction may cause aortic wall damage.

151

NOTE: If extreme difficulty is encountered when attempting to withdraw the sheath, place the device in a less tortuous position which enables the sheath to be retracted. Very carefully withdraw the sheath until it begins to retract, and stop. Move device back to original position and continue deployment.

11. Verify graft position and adjust it forward, if necessary. Recheck graft position with angiography.

NOTE: If an angiographic catheter is placed parallel to the stent graft, use this to perform position angiography.

12. Loosen the safety lock from the green trigger-wire release mechanism. Withdraw the trigger-wire slowly until the proximal end of the graft opens. (**Fig. 11**) Withdraw the trigger-wire completely to release the distal attachment to the introducer.

NOTE: Check to make sure that all trigger-wires are removed prior to withdrawal of the delivery system.

13. Remove the introduction system, leaving the wire guide in the graft.

11.1.2 Placement of Distal Component (when required)

1. If an angiographic catheter in the femoral artery is in use, it should be withdrawn to a position to demonstrate the aortic anatomy where the distal component is to be deployed.
2. Introduce the freshly hydrated delivery system over the wire guide until the desired graft position is reached, with a recommended 3-4 stent overlap (75-100 mm), but no less than a 2 stent overlap (50mm) with the proximal component. Do not overlap proximal and distal sealing stents.

NOTE: To facilitate introduction of the wire guide into the delivery system, it may be necessary to slightly straighten the delivery system dilator tip.

3. Check the position by angiography and adjust if necessary.
4. Ensure that the Captor Hemostatic Valve on the Flexor Introducer Sheath is turned counter-clockwise to the open position. (**Fig. 10**)
5. Stabilize the grey positioner (delivery system shaft) and begin withdrawing the sheath.

CAUTION: As the sheath or wire guide is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.

NOTE: If extreme difficulty is encountered when attempting to withdraw the sheath, place the device in a less tortuous position which enables the sheath to be retracted. Very carefully withdraw the sheath until it just begins to retract, and stop instantly. Move back to original position and continue deployment.

6. Withdraw the sheath until the graft is fully expanded. Continue sheath withdrawal until the valve assembly docks with the control handle.
7. Release the distal attachment by first unscrewing the trigger-wire safety lock on the white trigger-wire release mechanism (labeled number "1"). (**Figs. 12** and **13**)
8. Unscrew and remove the safety lock on the telescoping handle (labeled number "2"). (**Figs. 14** and **15**)
9. Stabilize the delivery system and slide the telescoping handle together with the grey tube and the outer sheath in a distal direction until the distal attachment stent is released. The telescoping handle should be retracted as far as it will travel distally until it locks automatically into position. (**Figs. 16** and **17**)
10. Loosen the safety lock from the green trigger-wire release mechanism. Withdraw the trigger-wire slowly until the proximal end of the graft opens, then withdraw and remove the trigger-wire and release mechanism (labeled number "3").

NOTE: Check to make sure that all trigger-wires are removed prior to withdrawal of the delivery system.

11. Remove the inner introduction system entirely, leaving the sheath and wire guide in the graft.
12. Close the Captor Hemostatic Valve on the Flexor Introducer Sheath by turning it in a clockwise direction until it stops.

CAUTION: To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

11.1.3 Main Body Molding Balloon Insertion-Optional

1. Prepare molding balloon as follows and/or per the manufacturer's instructions.
   - Flush wire lumen with heparinized saline.
   - Remove all air from balloon.
2. In preparation for the insertion of the molding balloon, open the Captor Hemostatic Valve by turning it counter-clockwise.
3. Advance the molding balloon over the wire guide and through the hemostatic valve of the main body introduction system to the level of the proximal fixation/seal site. Maintain proper sheath positioning.
4. Tighten the Captor Hemostatic Valve around the molding balloon with gentle pressure by turning it clockwise.

CAUTION: Do not inflate balloon in aorta outside of graft.

5. Expand the molding balloon with diluted contrast media (as directed by the manufacturer) in the area of the proximal covered stent, starting proximally and working in the distal direction.

CAUTION: Confirm complete deflation of balloon prior to repositioning.

6. If applicable, withdraw the molding balloon to the proximal component/distal component overlap and expand.
7. Withdraw the molding balloon to the distal covered stent and expand.
8. Open the Captor Hemostatic Valve, remove the molding balloon and replace it with an angiographic catheter to perform completion angiograms.
9. Tighten the Captor Hemostatic Valve around the angiographic catheter with gentle pressure by turning it clockwise.
10. Remove or replace all stiff wire guides to allow aorta to resume its natural position.

Final Angiogram

1. Position angiographic catheter just above the level of the endovascular graft. Perform angiography to verify correct positioning. Verify patency of arch vessels and celiac plexus.
2. Confirm that there are no endoleaks or kinks, and verify position of proximal and distal gold radiopaque markers. Remove the sheaths, wires and catheters.

NOTE: If endoleaks or other problems are observed, refer to **Section 11.2, Ancillary Devices.**

3. Repair vessels and close in standard surgical fashion.

11.2 Ancillary Devices

General Use Information

Inaccuracies in device size selection or placement, changes or anomalies in patient anatomy, or procedural complications can require placement of additional endovascular grafts and extensions. Regardless of the device placed, the basic procedure(s) will be similar to the maneuvers required and described previously in this document. It is vital to maintain wire guide access.

Standard techniques for placement of arterial access sheaths, guiding catheters, angiographic catheters and wire guides should be employed during use of the Zenith TX2 TAA Endovascular Graft ancillary devices.

The Zenith TX2 TAA Endovascular Graft ancillary devices with the H&L-B One-Shot Introduction Systems are compatible with .035 inch diameter wire guides.

11.2.1 Proximal Extensions

Proximal extensions are used for extending the proximal body of an *in situ* endovascular graft.

Proximal Extension Preparation/Flush

1. Remove yellow-hubbed shipping stylet. Remove cannula protector tube. Remove Peel-Away sheath from back of valve assembly. (**Fig. 18**)
2. Elevate distal tip of system and flush through the hemostatic valve until fluid emerges from the sideport near the tip of the introduction sheath. (**Fig. 8**) Continue to inject a full 20 cc of flushing solution through the device. Discontinue injection and close stopcock on connecting tube.

NOTE: Ensure that the side-arm adapter is securely connected to the side of the valve body.

NOTE: Graft flushing solution of heparinized saline is often used.

3. Attach syringe with heparinized saline to the hub on the inner cannula. Flush until fluid exits the distal sideports and dilator tip. (**Fig. 9**)
4. Ensure that the black pin vise on the control handle is tight.
5. Soak 4X4 gauze pads with saline and use to wipe the Flexor introducer sheath to activate the hydrophilic coating. Hydrate both sheath and dilator liberally.

Placement of the Proximal Extension

1. Puncture the selected artery using standard technique with an 18 gage access needle. Upon vessel entry, insert:
   - Wire guide–standard .035 inch, 260 cm, 15 mm J tip or Bentson wire guide
   - Appropriate size sheath (e.g., 5.0 French)
   - Pigtail flush catheter (often radiopaque-banded sizing catheters; i.e., Cook Centimeter Sizing CSC-20 catheter)
2. Perform angiography at the appropriate level. Using radiopaque markers, adjust position as necessary and repeat angiography.
3. Ensure introducer system has been primed with heparinized saline, and all air has been removed.
4. Give systemic heparin. Flush all catheters and wire guides with heparinized saline. This should be repeated following each exchange.
5. Replace the standard wire guide with a stiff .035 inch, 260 cm–LESDC wire guide and advance through the catheter and up to the aortic arch.
6. Remove pigtail flush catheter and sheath.

NOTE: At this stage, the second femoral artery can be accessed for flush catheter placement. Alternatively, a brachial approach may be considered.

7. Introduce the freshly hydrated delivery system over the wire guide and advance until the desired graft position is reached. Ensure there is a minimum overlap of 2 stents.

CAUTION: To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.

NOTE: The dilator tip softens at body temperature.

NOTE: To facilitate introduction of the wire guide into the delivery system, it may be necessary to slightly straighten the delivery system dilator tip.

NOTE: The proximal extension contains barbs which should not be placed within other graft components.

8. Verify wire guide position in the aortic arch. Ensure correct graft position.

CAUTION: Care should be taken not to advance the sheath while the stent graft is still within it, advancing the sheath at this stage may cause the barbs to perforate the introducer sheath.

9. Ensure that the Captor Hemostatic Valve on the Flexor Introducer Sheath is turned counter-clockwise to the open position.
10. Stabilize the grey positioner (delivery system shaft) and withdraw the sheath until the graft is fully expanded and the valve assembly docks with the control handle.

CAUTION: As the sheath or wire guide is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.

CAUTION: During sheath withdrawal, the proximal barbs are exposed and are in contact with the vessel wall. At this stage it may be possible to advance the device, but retraction may cause aortic wall damage.

NOTE: If extreme difficulty is encountered when attempting to withdraw the sheath, place the device in a less tortuous position which enables the sheath to be retracted. Very carefully withdraw the sheath until it just begins to retract, and stop instantly. Move back to original position and continue deployment.

11. Verify graft position and adjust it forward, if necessary. Recheck graft position with angiography.

NOTE: If an angiographic catheter is placed parallel to the stent graft, use this to perform position angiography.

12. Loosen the safety lock from the green trigger-wire release mechanism. Withdraw the trigger-wire slowly until the proximal end of the graft opens. (**Fig. 11**) Withdrawing the trigger-wire completely will also release the distal attachment to the introducer.

NOTE: Check to make sure that all trigger-wires are removed prior to withdrawal of the delivery system.

13. Remove the inner introduction system entirely, leaving the sheath and wire guide in the graft.

CAUTION: To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

14. Close the Captor Hemostatic Valve on the Flexor Introducer Sheath by turning it in a clockwise direction until it stops.

Proximal Extension Molding Balloon Insertion-Optional

1. Prepare molding balloon as follows and/or per the manufacturer's instructions.
   - Flush wire lumen with heparinized saline.
   - Remove all air from balloon.
2. In preparation for the insertion of the molding balloon, open the Captor Hemostatic Valve by turning it counter-clockwise.
3. Advance the molding balloon over the wire guide and through the Captor Hemostatic Valve of the introduction system to the level of the proximal fixation/seal site. Maintain proper sheath positioning.
4. Tighten the Captor Hemostatic Valve around the molding balloon with gentle pressure by turning it clockwise.

CAUTION: Do not inflate balloon in aorta outside of graft.

5. Expand the molding balloon with diluted contrast media (as directed by the manufacturer) in the area of the proximal covered stent, starting proximally and working in the distal direction.

CAUTION: Confirm complete deflation of balloon prior to repositioning.

6. Withdraw the molding balloon to the proximal extension /proximal component overlap and expand.
7. Open the Captor Hemostatic Valve, remove the molding balloon and replace it with an angiographic catheter to perform completion angiograms.
8. Tighten the Captor Hemostatic Valve around the angiographic catheter with gentle pressure by turning it clockwise.
9. Remove or replace all stiff wire guides to allow aorta to resume its natural position.

Final Angiogram

1. Position angiographic catheter just above the level of the endovascular graft. Perform angiography to verify correct positioning. Verify patency of arch vessels.
2. Confirm there are no endoleaks or kinks, and verify position of proximal gold radiopaque markers. Remove the sheaths, wires and catheters.
3. Repair vessels and close in standard surgical fashion.

11.2.2 Distal Extensions

Distal extensions are used for extending the distal end of an *in situ* endovascular graft or increasing the length of overlap between graft components.

Distal Extension Preparation/Flush

1. Remove yellow-hubbed shipping stylet. Remove cannula protector tube. Remove Peel-Away sheath from back of valve assembly. (**Fig. 18**)
2. Elevate distal tip of system and flush through the hemostatic valve until fluid emerges from the sideport near the tip of the introduction sheath. (**Fig. 8**) Continue to inject a full 20 cc of flushing solution through the device. Discontinue injection and close stopcock on connecting tube.

NOTE: Ensure that the side-arm adapter is securely connected to the side of the valve body.

NOTE: Graft flushing solution of heparinized saline is often used.

3. Attach syringe with heparinized saline to the hub on the inner cannula. Flush until fluid exits the distal sideports and dilator tip. (**Fig. 9**)
4. Ensure that the black pin vise on the control handle is tight.
5. Soak 4X4 gauze pads with saline and use to wipe the Flexor introducer sheath to activate the hydrophilic coating. Hydrate both sheath and dilator liberally.

Placement of the Distal Extension

1. Puncture the selected artery using standard technique with an 18 gage access needle. Upon vessel entry, insert:
   - Wire guide–standard .035 inch, 260 cm, 15 mm J tip or Bentson wire guide
   - Appropriate size sheath (e.g., 5.0 French)
   - Pigtail flush catheter (often radiopaque-banded sizing catheters; i.e., Cook Centimeter Sizing CSC-20 catheter)
2. Perform angiography at the appropriate level. Using radiopaque markers, adjust position as necessary and repeat angiography.
3. Ensure graft system has been primed with heparinized saline, and all air has been removed.
4. Give systemic heparin. Flush all catheters and wire guides with heparinized saline. This

should be repeated following each exchange.

5. Replace the standard wire guide with a stiff .035 inch, 260 cm–LESDC wire guide and advance through the catheter and up to the aortic arch.
6. Remove pigtail flush catheter and sheath.

NOTE: At this stage, the second femoral artery can be accessed for flush catheter placement. Alternatively, a brachial approach may be considered.

7. Introduce the freshly hydrated delivery system over the wire guide and advance until the desired graft position is reached. Ensure there is a minimum overlap of two stents (plus the distal uncovered stent).

CAUTION: To avoid twisting the endovascular graft, never rotate the delivery system during the procedure. Allow the device to conform naturally to the curves and tortuosity of the vessels.

NOTE: The dilator tip softens at body temperature.

NOTE: To facilitate introduction of the wire guide into the delivery system, it may be necessary to slightly straighten the delivery system dilator tip.

8. Verify wire guide position in the aortic arch. Ensure correct graft position.
9. Ensure that the Captor Hemostatic Valve on the Flexor Introducer Sheath is turned counter-clockwise to the open position.
10. Stabilize the grey positioner (delivery system shaft) and withdraw the sheath until the graft is fully expanded and the valve assembly docks with the control handle.

CAUTION: As the sheath or wire guide is withdrawn, anatomy and graft position may change. Constantly monitor graft position and perform angiography to check position as necessary.

NOTE: If extreme difficulty is encountered when attempting to withdraw the sheath, place the device in a less tortuous position which enables the sheath to be retracted. Very carefully withdraw the sheath until it just begins to retract, and stop instantly. Move back to original position and continue deployment.

11. Verify graft position and adjust it forward, if necessary. Recheck graft position with angiography.

NOTE: If an angiographic catheter is placed parallel to the stent graft, use this to perform position angiography.

12. Loosen the safety lock from the green trigger-wire release mechanism. Withdraw the trigger-wire slowly until the proximal end of the graft opens. (**Fig. 11**) Withdraw the trigger-wire completely to release the distal attachment to the introducer.

NOTE: Check to make sure that all trigger-wires are removed prior to withdrawal of the delivery system.

13. Remove the inner introduction system entirely, leaving the sheath and wire guide in the graft.

CAUTION: To avoid impaling any catheters left *in situ*, rotate the delivery system during withdrawal.

14. Close the Captor® Hemostatic Valve on the Flexor® Introducer Sheath by turning it in a clockwise direction until it stops.

Distal Extension Molding Balloon Insertion

1. Prepare molding balloon as follows and/or per the manufacturer's instructions.
    - Flush wire lumen with heparinized saline.
    - Remove all air from balloon.

2. In preparation for the insertion of the molding balloon, open the Captor Hemostatic Valve by turning it counter-clockwise.
3. Advance the molding balloon over the wire guide and through the Captor Hemostatic Valve of the introduction system to the level of the distal component/distal extension overlap. Maintain proper sheath positioning.
4. Tighten the Captor Hemostatic Valve around the molding balloon with gentle pressure by turning it clockwise.

CAUTION: Do not inflate balloon in aorta outside of graft.

5. Expand the molding balloon with diluted contrast media (as directed by the manufacturer) in the area of the overlap, starting proximally and working in the distal direction.

CAUTION: Confirm complete deflation of balloon prior to repositioning.

6. Withdraw the molding balloon to the distal covered stent and expand.
7. Loosen the Captor Hemostatic Valve, remove the molding balloon and replace it with an angiographic catheter to perform completion angiograms.
8. Tighten the Captor Hemostatic Valve around the angiographic catheter with gentle pressure by turning it clockwise.
9. Remove or replace all stiff wire guides to allow aorta to resume its natural position.

Final Angiogram

1. Position angiographic catheter just above the level of the endovascular graft. Perform angiography to verify correct positioning. Verify patency of arch vessels.
2. Confirm there are no endoleaks or kinks, and verify position of proximal and distal gold radiopaque markers. Remove the sheaths, wires and catheters.
3. Repair vessels and close in standard surgical fashion.

12. IMAGING GUIDELINES AND POST-OPERATIVE FOLLOW-UP

12.1 General

The long-term performance of endovascular grafts has not yet been established. All patients should be advised that endovascular treatment requires life-long, regular follow-up to assess their health and performance of their endovascular graft. Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the endovascular graft) should receive additional follow-up. Patients should be counseled on the importance of adhering to the follow-up schedule, both during the first year and at yearly intervals thereafter. Patients should be told that regular and consistent follow-up is a critical part of ensuring the ongoing safety and effectiveness of endovascular treatment of thoracic aortic aneurysms and ulcers.

Physicians should evaluate patients on an individual basis and prescribe their follow-up relative to the needs and circumstances of each individual patient. The recommended imaging schedule is presented in **Table 12.1.** This schedule continues to be the minimum recommendation for patient follow-up and should be maintained even in the absence of clinical symptoms (e.g., pain, numbness, weakness). Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or ulcers, or changes in the structure or position of the stent graft) should receive follow-up at more frequent intervals.

Annual imaging follow-up should include chest radiographs and both contrast and non-contrast CT examinations. If renal complications or other factors preclude the use of image contrast media, chest radiographs and non-contrast CT may be used in combination with a transesophageal echocardiography for assessment of endoleak.

- The combination of contrast and non-contrast CT imaging provides information on device migration, aneurysm diameter or ulcer depth change, endoleak, patency, tortuosity, progressive disease, fixation length, and other morphological changes.
- The chest radiographs provide information on device integrity (separation between components, stent fracture, and barb separation) and device migration.

Table 12.1 lists the minimum requirements for imaging follow-up for patients with the Zenith TX2 TAA Endovascular Graft. Patients requiring enhanced follow-up should have interim evaluations.

Table 12.1 Recommended Imaging Schedule for Endograft Patients

	Angiogram	CT (contrast and non-contrast)	Chest Radiographs
Pre-procedure		X[1]	
Procedural	X		
1 month		X[2]	X
6 month		X[2]	X
12 month (annually thereafter)		X[2]	X

[1]Imaging should be performed within 6 months before the procedure.
[2]If Type I or III endoleak, prompt intervention and additional follow-up post-intervention recommended, **See Section 12.5, Additional Surveillance and Treatment.**

12.2 Contrast and Non-Contrast CT Recommendations

- Film sets should include all sequential images at lowest possible slice thickness (≤3 mm). DO NOT perform large slice thickness (>3 mm) and/or omit consecutive CT images/film sets, as it prevents precise anatomical and device comparisons over time.
- All images should include a scale for each film/image. Images should be arranged no smaller than 20:1 images on 14" x 17" sheets if film is used.
- Both non-contrast and contrast runs are required, with matching or corresponding table positions.
- Pre-contrast and contrast run slice thickness and interval must match.
- DO NOT change patient orientation or re-landmark patient between non-contrast and contrast runs.

Non-contrast and contrast enhanced baseline and follow-up imaging are important for optimal patient surveillance. It is important to follow acceptable imaging protocols during the CT exam. **Table 12.2** lists examples of acceptable imaging protocols.

Table 12.2 Acceptable Imaging Protocols		
	Non-contrast	Contrast
IV contrast	No	Yes
Acceptable machines	Spiral CT or high performance MDCT capable of >40 seconds	Spiral CT or high performance MDCT capable of >40 seconds
Injection volume	n/a	Per Institutional Protocol
Injection rate	n/a	>2.5 cc/sec
Injection mode	n/a	Power
Bolus timing	n/a	Test bolus: Smart Prep, C.A.R.E. or equivalent
Coverage-start	Neck	Subclavian aorta
Coverage-finish	Diaphragm	Profunda femoris origin
Collimation	<3 mm	<3 mm
Reconstruction	2.5 mm throughout-soft algorithm	2.5 mm throughout-soft algorithm
Axial DFOV	32 cm	32 cm
Post-injection runs	None	None

12.3 Chest Radiographs

The following views are required:

- Two films: supine-frontal (AP) and cross-table lateral.
- Record the table-to-film distance and use the same distance at each subsequent examination.
- Ensure entire device is captured on each single image format lengthwise.

- The middle photocell should be used for all views to ensure adequate penetration of the mediastinum.

If there is any concern about the device integrity (e.g., kinking, stent breaks, barb separation, relative component migration), it is recommended to use magnified views. The attending physician should evaluate films for device integrity (entire device length, including components) using 2-4X magnification visual aid.

12.4 MRI Safety and Compatibility

Non-clinical testing has demonstrated that the Zenith TX2® TAA Endovascular Graft is MR Conditional. It can be scanned safely under the following conditions:

1.5 Tesla Systems:

- Static magnetic field of 1.5 Tesla
- Spatial gradient field of 450 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning.

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.4 °C at a maximum whole body averaged specific absorption rate (SAR) of 2.8 W/kg for 15 minutes of MR scanning in a 1.5 Tesla Magnetom, Siemens Medical Magnetom MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 2.8 W/kg, which corresponds to a calorimetry measured value of 1.5 W/kg.

3.0 Tesla Systems:

- Static magnetic field of 3.0 Tesla
- Spatial gradient field of 720 Gauss/cm
- Maximum whole-body-averaged specific absorption rate (SAR) of 2 W/kg for 15 minutes of scanning

In non-clinical testing, the Zenith TX2® TAA Endovascular Graft produced a temperature rise of less than 1.9 °C at a maximum whole body averaged specific absorption rate (SAR) of 3.0 W/kg for 15 minutes of MR scanning in a 3.0 Tesla, Excite, GE Electric Healthcare MR scanner. The maximum whole-body-averaged specific absorption rate (SAR) was 3.0 W/kg, which corresponds to a calorimetry measured value of 2.8 W/kg.

The image artifact extends throughout the anatomical region containing the device, obscuring the view of immediately adjacent anatomical structures within approximately 20 cm of the device, as well as the entire device and its lumen, when scanned in nonclinical testing using the sequence: Fast spin echo in a 3.0 Tesla, Excite, GE Electric Healthcare, with G3.0-052B software, MR system with body radiofrequency coil.

For all scanners, the image artifact dissipates as the distance from the device to the area of interest increases. MR scans of the lower extremities may be obtained without image artifact. Image artifact may be present in scans of the abdominal, upper extremity, and head and neck region, depending on distance from the device to the area of interest.

Clinical information is available on six patients who received MRI scans during the course of the clinical trial. There have been no reported adverse events or device problems in any of these patients as a result of having received an MRI. Additionally, there have been approximately 3,000 patients implanted with Zenith TAA Endovascular Grafts world wide, in which there have been no reported adverse events or device problems as a result of MRI.

Cook recommends that the patient register the MR conditions disclosed in this IFU with the MedicAlert Foundation. The MedicAlert Foundation can be contacted in the following manners:

Mail: MedicAlert Foundation International
2323 Colorado Avenue
Turlock, CA 95382

Phone: 888-633-4298 (toll free)
209-668-333 from outside the US

Fax: 209-669-2450

Web: www.medicalert.org

12.5 Additional Surveillance and Treatment
(Refer to **Section 4, WARNINGS AND PRECAUTIONS**)

Additional surveillance and possible treatment is recommended for:

- Aneurysms or ulcers with Type I endoleak
- Aneurysms or ulcers with Type III endoleak
- Aneurysm or ulcer enlargement, >5 mm of maximum aneurysm diameter or ulcer depth (regardless of endoleak status)
- Migration
- Inadequate seal length

Consideration for reintervention or conversion to open repair should include the attending physician's assessment of an individual patient's co-morbidities, life expectancy, and the patient's personal choices. Patients should be counseled that subsequent reinterventions, including catheter-based and open surgical conversion, are possible following endograft placement.

13. PATIENT TRACKING INFORMATION

In addition to these Instructions for Use, the Zenith TX2 TAA Endovascular Graft with the H&L-B One-Shot Introduction System is packaged with a **Device Tracking Form** which the hospital staff is required to complete and forward to COOK INCORPORATED for the purposes of tracking all patients who receive the Zenith TX2 TAA Endovascular Graft (as required by U. S. Federal Regulation).