

Summary of Safety and Effectiveness Data

I. General Information

Device Generic Name: Vascular Hemostasis Device

Device Trade Name: StarClose™ Vascular Closure System

Applicant: Abbott Vascular Devices
400 Saginaw Drive
Redwood City, California 94063

Premarket Approval Application (PMA) Number: P050007

Date of Panel Recommendation: None

Date of Notice of Approval to Applicant: December 21, 2005

II. Indications for Use

The StarClose™ Vascular Closure System is indicated for the percutaneous closure of common femoral artery access sites while reducing times to hemostasis, ambulation, and dischargeability in patients who have undergone diagnostic endovascular catheterization procedures utilizing a 5F or 6F procedural sheath.

III. Contraindications

There are no known contraindications to the use of the StarClose™ Vascular Closure System .

IV. Warnings and Precautions

The Warnings and Precautions can be found in the StarClose™ Vascular Closure System labeling.

V. Device Description

A. Materials and Configuration

The StarClose™ Vascular Closure System is designed to deliver a nitinol clip to close femoral artery access sites following percutaneous catheterization procedures.

The StarClose™ Vascular Closure System consists of the StarClose Clip Applier and a StarClose 6F Exchange System. An implantable Clip is mounted on the Clip Applier, which delivers the Clip through the exchange system or introducer sheath for extravascular closure of access sites. The StarClose™ Vascular

Closure System can also be used with the StarClose™ 6F Introducer Set, which is packaged and sold separately.

B. Principles of Operation for the StarClose™ Vascular Closure System:

At the end of the endovascular diagnostic procedure the user ensures placement of either a StarClose™ Exchange Sheath or StarClose™ Introducer Sheath at the access site. Either sheath is used to introduce and position the StarClose™ Clip Applier.

The distal end of the Clip Applier features a vessel locator. The locator is designed as collapsible nitinol bands that extend into an "X" shape. The expanded locator is gently pulled until it meets with the inner surface of the vessel wall. After aligning the clip applier, the clip is deployed, drawing the edges of the arterial puncture together. The vessel locator simultaneously retracts so that the device may be removed.

VI. Alternative Practices and Procedures

Alternative practices for achieving hemostasis of the femoral artery puncture site post-catheterization include manual compression, mechanical compression, collagen-based hemostasis devices, and percutaneous delivery of sutures to the femoral artery access site. Pressure dressings and sandbags are routinely used in combination with compression methods to control oozing.

VII. Marketing History

The StarClose™ Vascular Closure System has not been marketed in the United States but is currently approved for commercial sale for this indication in Australia, Austria, Belgium, Czech Republic, France, Germany, Greece, Hong Kong, Hungary, Ireland, India, Israel, Italy, Kuwait, Lebanon, Malaysia, Netherlands, New Zealand, Norway, Portugal, Poland, Saudi Arabia, South Africa, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. The StarClose™ Vascular Closure System has not been withdrawn from marketing for any reason relating to the safety and effectiveness of the device.

VIII. Potential Adverse Effects of the Device on Health

The use of the StarClose™ Vascular Closure System in diagnostic catheterization patients was evaluated in a pivotal, prospective, multi-center, open-label, randomized clinical study involving 208 diagnostic patients and 275 interventional patients (483 total randomized patients) enrolled at 17 United States clinical centers. The first randomized patient was enrolled on 3/15/04 and enrollment in the diagnostic arm of the study was completed on 9/15/04. In the diagnostic arm the StarClose device was compared to standard compression (SC) methods following cardiac and peripheral vascular catheterization procedures utilizing 5F and 6F sheath sizes. The diagnostic patients were randomized using a 2:1 scheme (StarClose device vs. SC control). Of the 208 diagnostic patients, 136 patients (65.4%) were randomized to the StarClose device and 72 patients (34.6%) were randomized to SC. All primary analyses comparing the 2 randomized

groups were based on an intent-to-treat (ITT) analysis in which patients were assigned to the treatment group to which they were randomized.

The numbers and percentages of major and minor complications for the diagnostic patients in the clinical study are shown in Table 1.

Table 1: Major and Minor Complications Through 30 Days – Diagnostic ITT Patients

Description of Event	CLIP Device (N=136)	Standard Compression (N=72)	All Patients (N=208)	Difference [95% C.I.]	P-value
Major Vascular Complications (Combined)	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Vascular Injury Requiring Repair	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Surgery	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Angioplasty	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Ultrasound Guided Compression	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Thrombin injection or Other Percutaneous Procedure	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
New Ipsilateral Lower Extremity Ischemia	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Access Site-related Bleeding Requiring Transfusion	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Access Site-related Infection Requiring Intravenous Antibiotics or Prolonged Hospitalization	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Access Site-related Nerve Injury Requiring Intervention	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Complications					
Death	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Minor Vascular Complications (Combined)	2.2% (3/136)	1.4% (1/72)	1.9% (4/208)	0.8% [–2.8%,4.5%]	1.000
Pseudoaneurysm	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Arteriovenous Fistula	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Hematoma (≥6 cm)	0.7% (1/136)	1.4% (1/72)	1.0% (2/208)	-0.7% [–3.7%,2.4%]	1.000
Late access site-related bleeding	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Transient lower extremity ischemia	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Ipsilateral deep vein thrombosis	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Transient access site-related nerve injury	1.5% (2/136)	0.0% (0/72)	1.0% (2/208)	1.5% [–0.6%,3.5%]	0.545
Access site-related vessel injury	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Access site wound dehiscence	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Access site-related bleeding requiring >=30 minutes to re-achieve hemostasis	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
Localized access site infection treated with IM or oral antibiotics	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--
UADE	0.0% (0/136)	0.0% (0/72)	0.0% (0/208)	0.0% [–,–]	--

Numbers are % (events/sample size).

Minor vascular complications include only patients who did not have a major vascular complication.

IX. Summary of Preclinical Studies

Bench and *In-vitro* Device Characterization Testing

A. Biocompatibility

Biocompatibility testing of the StarClose™ Vascular Closure System was conducted in accordance with FDA’s-modified matrix of ISO 10993-1, “Biological Evaluation of Medical Devices, Part 1 Evaluation and Testing”. As seen in the Tables 2 & 3 below, samples passed all testing and results concluded that the StarClose™ Vascular Closure System is non-toxic, non-sensitizing, non-irritant, non-mutagenic, and non-hemolytic.

Table 2: StarClose™ Clip Biocompatibility Testing

Test	Standard Method	Test System	Extract Conditions	Test Results
Cytotoxicity (ISO Elution Method)	ISO 10993-5	Mouse Fibro L-929 Monolayer, 48 hrs	1X MEM 37°C for 24 hours	Pass
ISO Sensitization (Maximization Method)	ISO 10993-10	Guinea Pig	Sodium Chloride (SC) Cottonseed Oil (CSO) 50°C for 72 hours	Pass
ISO Acute Intracutaneous Reactivity	ISO 10993-10	Rabbits	Sodium Chloride (SC) Cottonseed Oil (CSO) 50°C for 72 hours	Pass
USP and ISO Acute Systemic Toxicity	ISO 10993-11	Mice	Sodium Chloride (SC) Cottonseed Oil (CSO) 50°C for 72 hours	Pass
<i>In Vitro</i> Hemolysis (Modified ASTM Extraction Method)	ISO 10993-4 ASM F756	Rabbit Blood 37 degrees 4 hours	Sodium Chloride (SC) 50°C for 72 hours with agitation	Pass
Genotoxicity: Bacterial Reverse Mutation (Ames) Test, Salmonella and <i>E.Coli</i> strains	ISO 10993-3	Bacterial Reverse Mutation (Ames) Test <i>Salmonella</i> and <i>E. Coli</i> strains	Sodium Chloride (SC) Dimethyl sulfoxide (DMSO) 50°C for 72 hours (SC) Room temperature for 72 hours (DMSO)	Pass
ISO Muscle Implant Study – 2 week.	ISO 10993-6	Rabbit	None	Pass

Table 3: StarClose™ Clip Applier and Exchange System Biocompatibility Testing

Test	Standard Method	Test System	Extract Conditions	Test Results
Cytotoxicity (ISO Elution Method)	ISO 10093-5	Mouse Fibro L-929 Monolayer. 48 hrs	1X MEM 37°C for 24 hours	Pass
ISO Sensitization (Maximization Method)	ISO 10093-10	Guinea Pig	Sodium Chloride (SC) Cottonseed Oil (CSO) 50°C for 72 hours	Pass
ISO Acute Intracutaneous Reactivity	ISO 10093-10	Rabbits	Sodium Chloride (SC) Cottonseed Oil (CSO) 50°C for 72 hours	Pass
USP and ISO Acute Systemic Toxicity	ISO 10093-11	Mice	Sodium Chloride (SC) Cottonseed Oil (CSO) 50°C for 72 hours	Pass
<i>In Vitro</i> Hemolysis (Modified ASTM Extraction Method)	ISO 10093-4	Rabbit Blood 37degrees 4 hours	Sodium Chloride (SC) 50°C for 72 hours with agitation	Pass

B. Functionality

A series of in-vitro tests (Table 4) were conducted to characterize the mechanical performance of the StarClose™ Vascular Closure System. Results from the mechanical tests demonstrated that the StarClose™ Vascular Closure System met the acceptance criteria for each test.

Table 4: StarClose™ Clip Applier and Exchange System Mechanical Testing

<i>In-vitro Test</i>	<i>Method(s)</i>	<i>Acceptance Criteria (AC)/ Results</i>	<i>Results</i>
<i>StarClose™ Clip</i>			
Closure Force	The clip is positioned to measure the force required to move the “tines” (clip teeth) to ~ 45 °	≥ 150 grams	N= 20 152 Min. 230 Max. Mean: 191 SD: 23
Austenitic _{final} Temperature	Measure the transformation temperature of the nitinol. To determine the temperature range of the elasticity of the material.	Af = 10 ° C ± 10 ° C Note: PMA set AC @ -5 – 20 ° C	N= 20 9 ° C Min. 14 ° C Max. Mean: 12 ° C SD: 1
Plastic Deformation Test	Measure the clip deformation when loaded and pushed off the applier. Head thickness and length of the OD to the tip of the long tine are measured.	Plastic deformation ≤5%	N= 20 -0.2 % Min. 1.1 % Max. Mean: 0.6 % SD: 0.3%
Clip Diameter Inspection	Measure clip diameter.	Clip diameter ≤ 0.200”	N= 20 0.1702” Min. 0.1716” Max. Mean: 0.1709” SD: 0.0004”

Fracture Test	Clip will remain intact when pushed off the applicator. (similar to Plastic Deformation above.)	Number of cycles to failure ≥ 3 cycles	N= 20 No devices failed after 3 cycles.
<i>Clip Applicator Tests</i>			
Visual/Dimensional	Finished Goods Inspection requirements. P/N 00712 QCI Clip Applicator Assembly.	Meet finished goods inspection requirements (not provided)	N= 30 No devices failed. However, in 7/30 devices the Thumb Lever was found displaced.
Positioning Wings (PW) Expansion and Collapse	Expand after user input and collapse after clip is deployed w/o breakage or failure modes.	Positioning wings will withstand 6 cycles of expansion/collapse w/o failure.	N= 30 No devices failed.
Clip Applicator/Introducer Hub Attachment	Attach and ensure functionality of the connection.	The sheath must not disengage once attached.	N = 30 (15 6 Fr. & 15 7 Fr.) No failures.
Clip Deployment into Air w/ 6 and 7 Fr. Sheath Splitting	Uses devices and camera to assess the reaction time of the components.	Audible click, clip 3-6 video frames; PW 2-4 video frames.	N = 30 (15 6 Fr. & 15 7 Fr.) No failures.
Positioning Wings Tensile Test	The test pulls on the wings measuring the force to pull wire/wire controller and/or pusher body assembly to failure.	Withstand 15 N (3.37 lb) w/o failure. V2.10 – 3.85 lbf	Mean/SD Min/Max. Pull wire 18.17/2.09 lb 13.27/ > 20 Obturator Shaft 14.14/1.38 11.14/16.63 V2.10 – PASS
Garage Tube to Garage Block Tensile Test	Pull component attachment to failure.	Withstand 15 N (3.37 lb) w/o failure. V2.10 – 9.0 lbf min.	N = 30 Mean/SD 19.99/0.06 Min/Max. 11.14/16.63 V2.10 – PASS
Pusher Tube to Pusher Block Tensile Test	Pull component attachment to failure.	Withstand 15 N (3.37 lb) w/o failure. V2.10 – 9.0 lbf min.	N = 30 All devices exceeded the 20 lb load cell. V2.10 – PASS
Carrier Tube to Slider Block Tensile Test	Pull component attachment to failure.	Withstand 15 N (3.37 lb) w/o failure. V2.10 – 9.0 lbf min.	N = 30 All devices exceeded the 20 lb load cell. V2.10 – PASS
Support Tube to Support Block Tensile Test	Pull component attachment to failure.	Withstand 15 N (3.37 lb) w/o failure. V2.10 – 9.0 lbf min.	N = 30 All devices exceeded the 20 lb load cell. V2.10 – PASS
Positioning Wings Release Rod to Release Rod Nut Tensile Test	Pull component attachment to failure.	Withstand 15 N (3.37 lb) w/o failure. V2.10 – NA	N = 30 All devices exceeded the 20 lb load cell. V2.10 – NA
Clip Deployment into Swine Vessel w/ 6/7 Fr. Sheath Splitting	Deployed into excised swine artery in simulated clinical use.	Audible click, clip must fire, wings must retract, applicator must initiate.	N = 15 All devices passed.

		propagate and completely split the sheath.	
Positioning Wings Testing			
Swine Model	Device/broken device tested for adverse reactions to the wings.		Superficial endothelial cell damage, but no difference between whole and broken devices.
FEA model	Fatigue modeling of the clip to assess in vivo cyclic loading.	Worst-case heart rate was placed at 200 beats per minute and worst-case hemostasis at 240 (4 hrs.) minutes. Under those conditions the clip would experience 48,000 cardiac cycles. The model assumes the cyclic force to be 0.055 lbf on each tine. The sponsor states that the nitinol can be cycled over 1,000,000 times at a cyclic strain of 0.38% w/o a fatigue failure. Confirmatory test data was not provided.	
StarClose Exchanges System Design			
Sheath & Dilator Extrusion, Tensile		≥ 3.37 lbf	PASS
Sheath Hub to Clip Applier, Tensile		≥ 7.5 lbf	PASS
Sheath Extrusion to Hub, Tensile		V2.10 – ≥ 7.0 lbf	
Hemostatis Valve Leak Test @ 5.5 – 6.1 psi		No Water Leakage	PASS

C. Animal/Cadaver Studies

Earlier versions of the device were tested in animal (porcine) and pressurized (120 – 140 mmHg) arteries in cadavers to assess hemostasis and functionality.

D. Sterilization and Shelf Life

The StarClose™ Vascular Closure System is sterilized using Ethylene Oxide (EtO) to a Sterility Assurance Level (SAL) of 10^{-6} . The system has been validated and approved for a 6 month shelf life.

X. Clinical Studies

A. StarClose™ Vascular Closure System U.S. IDE Multi-Center, Randomized Clinical Trial

The use of the StarClose™ Vascular Closure System in diagnostic catheterization patients was evaluated in a pivotal, prospective, multi-center, open-label, randomized clinical study involving 208 diagnostic patients and 275 interventional patients (483 total randomized patients) enrolled at 17 United States clinical centers. The first randomized patient was enrolled on 3/15/04 and enrollment in the diagnostic arm of the study was completed on 9/15/04. In the diagnostic arm the StarClose device was compared to standard compression (SC) methods following cardiac and peripheral vascular catheterization procedures with 5F and 6F sheath sizes. The diagnostic patients were randomized using a 2:1

scheme (StarClose device vs. SC control). Of the 208 diagnostic patients, 136 patients (65.4%) were randomized to the StarClose device and 72 patients (34.6%) were randomized to SC. All primary analyses comparing the 2 randomized groups were based on an intent-to-treat (ITT) analysis in which patients were assigned to the treatment group to which they were randomized.

The randomized diagnostic and interventional patients in the study had to meet general inclusion criteria, general exclusion criteria, access site exclusion criteria (including some criteria evaluated via limited femoral artery angiogram), and procedural exclusion criteria. The diagnostic patients consisted of 68.4% men ranging in age from 34 to 83 years and 31.6% women ranging in age from 36 to 80 years. The diagnostic patients who were randomized to the StarClose device were asked to ambulate 2 hours after the diagnostic procedure was complete, and the diagnostic patients who were randomized to SC were ambulated according to institutional standards and guidelines.

The primary safety endpoint for the study was the combined rate of major complications within 30 ± 7 days following the catheterization procedure. The secondary safety endpoint for the study was the combined rate of minor complications within 30 ± 7 days following the catheterization procedure. The null hypothesis for safety was that the StarClose Vascular Closure System had a primary safety endpoint rate exceeding that of the standard of care (standard compression) by δ . The alternative hypothesis was that the StarClose Vascular Closure System had a primary safety endpoint rate less than that of standard compression or exceeding that of standard compression by no more than δ ; i.e.,

$$H_0: \pi_{IC} > \pi_{SC} + \delta$$

$$H_a: \pi_{IC} \leq \pi_{SC} + \delta$$

where π_{IC} was the primary endpoint rate estimated for the StarClose Vascular Closure System and π_{SC} was the primary endpoint rate estimated for the standard of care (standard compression).

For the diagnostic patients, the StarClose device demonstrated safety. By Day 30, a combined total of 0 (0.0%) major complications was reported for the randomized diagnostic patients who received the StarClose device, and a combined total of 0 (0.0%) major complications was reported for the randomized diagnostic patients who received SC.

The rates of minor complications were low between the 2 randomized treatment groups. Of the 4 minor vascular complications noted, 3 occurred in the StarClose device group (one hematoma ≥ 6 cm and two transient access site-related nerve injuries) and one minor complication occurred in the control group (a hematoma ≥ 6 cm). The most common minor complication was transient access site-related nerve injury. The combined total rates of minor complications at Day 30 were

2.2% for the randomized diagnostic StarClose device patients and 1.4% for the randomized diagnostic SC patients.

The primary effectiveness endpoint for the study was time to hemostasis. The secondary effectiveness endpoints for the study were time to ambulation, time to eligibility for hospital discharge (time to dischargeability), procedure success at discharge, and device success.

Time to hemostasis was defined as the elapsed time between sheath removal and first observed hemostasis.

Time to ambulation was defined as the elapsed time between sheath removal and the time when the patient stands and walks at least 20 feet without re-bleeding.

Time to dischargeability was defined as the elapsed time between sheath removal and the time when the patient is medically able to be discharged based solely on the assessment of the access site, as determined by the patient's physician (for diagnostic patients only).

Procedure success was defined as the attainment of final hemostasis using any method and freedom from major vascular complications.

Device success was defined as the attainment of final hemostasis using the StarClose Vascular Closure System alone or with adjunctive compression ≤ 5 minutes and freedom from major vascular complications.

The effectiveness results for the diagnostic patients in the clinical study are shown in Table 5, Table 6, and Table 7.

Table 5: Primary Effectiveness Endpoint – Diagnostic ITT Patients

Time to Hemostasis (Mins)	CLIP Device (N=136)	Standard Compression (N=72)	All Patients (N=208)	Difference [95% C.I.]	P-value***
Mean \pm SD (N)*	1.46 \pm 4.52 (135)**	15.47 \pm 11.43 (72)	6.33 \pm 10.15 (207)	-14.01 [-16.21, -11.81]	<0.001
Median	0.28	15.00	0.80		
Range (min, max)	(0.0,42.4)	(0.0,103.1)	(0.0,103.1)		

* The mean Time to Hemostasis value includes 3 diagnostic patients (2/120, 4/102, 4/104) with reported times of '0' that were queried and confirmed by the investigator.

** Patient 1/131 had missing Time (T5) Introducer Sheath removed.

*** Time to Hemostasis p-value was determined using two-sample t-test and Wilcoxon rank sum test.

Table 6: Secondary Effectiveness Endpoints – Diagnostic ITT Patients

Endpoint	CLIP Device (N=136)	Standard Compression (N=72)	All Patients (N=208)	Difference [95% C.I.]	P-value****
Procedure Success	100.0% (136/136)	100.0% (72/72)	100.0% (208/208)	0.0% [---]	--
Device Success*	94.1% (127/135)	N/A	N/A	N/A	N/A
Time to Ambulation (Mins)***					
Mean ± SD (N)	162.98 ± 104.60 (131)	269.27 ± 134.76 (70)	200.00 ± 126.31 (201)	-106.29 [-140.14, -72.43]	<0.001
Median	134.00	249.00	147.00		
Range (min, max)	(100.0, 1093.0)	(125.0, 1049.0)	(100.0, 1093.0)		
Time to Ambulation (Hours)***					
Mean ± SD (N)	2.72 ± 1.74 (131)	4.49 ± 2.25 (70)	3.33 ± 2.11 (201)	-1.77 [-2.34, -1.21]	--
Median	2.23	4.15	2.45		
Range (min, max)	(1.67, 18.22)	(2.08, 17.48)	(1.67, 18.22)		
Time to Dischargeability (Hours)**					
Mean ± SD (N)	3.53 ± 2.08 (135)	5.24 ± 2.12 (71)	4.12 ± 2.24 (206)	-1.70 [-2.31, -1.10]	<0.001
Median	3.08	4.85	3.33		
Range (min, max)	(1.9, 19.7)	(2.5, 15.9)	(1.9, 19.7)		

Numbers are % (counts/sample size) or Mean ± 1 Standard Deviation.

N/A = Not Applicable

* Patient 1/131 had missing Time (T5) Introducer sheath removed.

** The Time to Dischargeability is calculated by subtracting IVC005, Q.1 (procedure date) and Q.11.7 (Time Introducer sheath removed) from CRF IVC012, Q.2.1 & 2.2 (Time Eligible for discharge). Patient 1/107 had missing Time (T8) Eligible for Discharge. Patient 1/131 had missing Time (T5) Introducer sheath removed.

*** The Time to Ambulation is calculated by subtracting IVC005, Q.1 (procedure date) and Q.11.7 (Time Introducer sheath removed) from CRF IVC011, Q.1.8 (Time first Ambulation). Patients 1/107, 1/108, 1/113, 1/114, 2/131, 4/103 had missing Time (T7) of first ambulation (≥ 20 feet). Patient 1/131 had missing Time (T5) Introducer sheath removed.

**** Time to Dischargeability and Time to Ambulation p-values were determined using two-sample t-test.

Table 7: Effectiveness Results by Post-Procedure Time Interval for Diagnostic ITT Patients

Percentage of Patients Achieving Hemostasis Within Time Interval		$\leq 5 \text{ min}$	$\leq 10 \text{ min}$	$\leq 15 \text{ min}$	$\leq 30 \text{ min}$	$\leq 60 \text{ min}$	$\leq 120 \text{ min}$
	CLIP Device	94.07% (127/135)	97.04% (131/135)	98.52% (133/135)	99.26% (134/135)	100% (135/135)	100% (135/135)
	Standard Comp	5.56% (4/72)	9.72% (7/72)	36.11% (26/72)	97.22% (70/72)	98.61% (71/72)	100% (72/72)
Percentage of Patients Ambulating Within Time Interval		$\leq 2 \text{ hrs}$	$\leq 3 \text{ hrs}$	$\leq 4 \text{ hrs}$	$\leq 6 \text{ hrs}$	$\leq 12 \text{ hrs}$	$\leq 20 \text{ hrs}$
	CLIP Device	3.05% (4/131)	83.97% (110/131)	90.84% (119/131)	96.18% (126/131)	99.24% (130/131)	100% (131/131)
	Standard Comp	0% (0/70)	18.57% (13/70)	45.71% (32/70)	82.86% (58/70)	98.57% (69/70)	100% (70/70)
Percentage of Patients Eligible for Discharge Within Time Interval		$\leq 2 \text{ hrs}$	$\leq 3 \text{ hrs}$	$\leq 4 \text{ hrs}$	$\leq 6 \text{ hrs}$	$\leq 12 \text{ hrs}$	$\leq 20 \text{ hrs}$
	CLIP Device	1.48% (2/135)	35.56% (48/135)	82.96% (112/135)	94.81% (128/135)	98.52% (133/135)	100% (135/135)
	Standard Comp	0% (0/71)	7.04% (5/71)	25.35% (18/71)	70.42% (50/71)	98.59% (70/71)	100% (71/71)

B. Supplementary Clinical Data

1. Venezuela Study

Twenty-three patients were enrolled in a feasibility study to evaluate the hemostasis attributes of the clip. The study results are summarized in Table 8 below.

Table 8: Venezuela feasibility study effectiveness results

Outcome measure	Mean Time (range)	
	Clip	Manual compression
Time to Hemostasis (min.)	N=11 Avg. = 2.1 (0-4)	N=10 Avg. = 33 (10-90)
Time to Ambulation (min.)	N=11 Avg. = 103 (62-135)	N=9 Avg. = 328 (186-400)

Adverse events identified in the study were: pseudoaneurysm (1); hematoma (4); vasovagal episode (1); peripheral nerve injury (1); groin pain (2), with 2 patients lost to follow-up.

2. German Study

This feasibility study involved 31 patients who were assessed for Adverse Events; Time to Hemostasis, and Time to Ambulation. The study results are summarized in Table 9 below.

Table 9: German feasibility study effectiveness results

Outcome measure	Mean Time (range)
	Clip average, (min.-max.)
Clip delivery time	N=27 Avg. = 1 (1-2)
Time to Hemostasis (min.)	N=28 Avg. = 1 (0-4)
Time to Ambulation (min.)	N=28 Avg. = 120 (120-840) 1 patient ambulated @ 14 hrs.

Adverse events identified in the study were: oozing of blood @ 2 hours post procedure (1); bruising/hematoma (2) and an AV fistula (1). The summary also stated that there were 2 failures to deliver the clip, one due to training and the other manufacturing.

3. Repuncture Through StarClose and Reclosure

The safety of repuncture at any time through any part of a previously deployed StarClose™ Clip, and the safety of subsequent closure of this repuncture using the StarClose™ Vascular Closure System, have not been fully established. The following information is provided to assist the operator in assessing the possible risks that may be associated with such repuncture and repuncture closure, which include Clip dislodgement, Clip embolization, and bleeding.

Two bench studies with a porcine aorta model were performed to assess the safety and effectiveness of needle puncture and sheath passage, as well as the security of reclosure with the StarClose™ device on or adjacent to a previously placed Clip. The reclosure success criterion was pass/fail aquastasis. The porcine aorta model was pressurized to 130 mm Hg in one of the bench studies and to 260 mm Hg in the other bench study. These studies were performed in a simulated setting because a clinical trial would not be adequate in testing the worst case scenario since the likelihood of hitting the Clip in the clinical setting is very low.

Each study evaluated 4 positions of a second Clip relative to a previously placed Clip, with the second Clip deployed in the center of or inferior, lateral, or superior to the first Clip, and evaluated 2 sheath sizes, which were 5F and 8F (which “bracket” the 5F and 6F sizes used in the clinical study), resulting in a 4 x 2 matrix that established 8 different Clip position/sheath size groups. For each of the 8 groups, 32 Clips were tested, resulting in 256 Clip deployments. The sample size of 32 Clips for each group was statistically determined. Fewer than 32 pieces of porcine aortic tissue were used in each group. Each piece of tissue was used until there was no reasonable surface space left on the tissue for further

deployments, at which time the tissue was replaced with a fresh, unused piece of tissue.

In each study the StarClose™ Clip was deployed, and then intentionally repunctured through the center of the Clip. Subsequent Clips were then deployed and intentionally repunctured incrementally at the inferior, then lateral, and then superior aspect of the Clip surface, resulting in a total of 4 Clips incrementally added through/around the first Clip. All needles used for the initial puncture and subsequent repunctures were commercially available 18 gauge x 7.0 cm percutaneous entry needles (compatible with 0.038" guide wires), which are the standard needles used in the majority of femoral artery access procedures. Following the repunctures, 5F and 8F sheaths were inserted. In every case, the sheath was successfully inserted and a catheter could easily pass through the sheath.

Then, in each case the indwelling sheath was exchanged for a 6F StarClose sheath and the StarClose™ device was used to close the repuncture. In every case, a second Clip was successfully deployed and secure closure was achieved. There were no cases where the first Clip was dislodged.

XI. Conclusions Drawn from Studies

Results of the biocompatibility testing, *in vitro* bench testing, animal studies, cadaver study and clinical investigations provide valid scientific evidence and reasonable assurance that the StarClose™ Vascular Closure System is safe and effective when used in accordance with its Instructions for Use.

XII. Panel Recommendation

In accordance with the provisions of section 515(c)(2) of the act as amended by the Safe Medical Devices Act of 1990, this PMA was not referred to the Circulatory System Devices Panel, an FDA advisory committee, for review and recommendation because the information in the PMA substantially duplicates information previously reviewed by the panel.

XIII. CDRH Decision

FDA issued a PMA approval order to Abbott Vascular Devices on December 21, 2005. FDA also performed an inspection of the manufacturing facilities and found the applicant in compliance with the Quality System Regulation (21 CFR Part 820).

XIV. Approval Specifications

- A. Instructions for Use: See the labeling.
- B. Hazards to Health from Use of the Device: See Indications, Contraindications, Warnings, Precautions, and Adverse Events sections of the labeling.
- C. Post Approval Requirements and Restrictions: See approval order.