3/19/99

K983360

ADMINISTRATIVE INFORMATION

Manufacturer Name:	MacroPore, Inc. 6740 Top Gun Street San Diego, CA 92121
Official Contact:	Christopher J. Calhoun Telephone (619) 458-0900 Fax (619) 458-0994
Representative/Consultant:	Floyd G. Larson Pacific Materials and Interfaces 4329 Graydon Road San Diego, CA 92130 Telephone (619) 792-1235 FAX (619) 792-1236

DEVICE NAME

Classification Name:	Plate, bone
Trade/Proprietary Name:	MacroPore Protective Sheet
Common Name:	Bone Plate

ESTABLISHMENT REGISTRATION NUMBER

MacroPore, Inc. has not yet obtained an Establishment Registration Number.

DEVICE CLASSIFICATION AND PRODUCT CODE

As shown in 21 CFR 872.4760, bone plates intended for the oral cavity are classified as Class II. They have been assigned Product Code 76 JEY.

CONFORMANCE WITH PERFORMANCE STANDARDS

No performance standards have been established under Section 514. Voluntary standards with which the MacroPore Protective Sheet (MPS) complies include American National Standards Institute (ANSI)/Association for the Advancement of Medical Instrumentation (AAMI)/ISO 11137-1994; Sterilization of Health Care Products - Requirements for Validation and Routine Control - Radiation Sterilization.

PACKAGING/LABELING/PRODUCT INFORMATION

MacroPore Protective Sheet and accompanying tacks and screws will be packaged in a heat-sealed aluminum pouch (for moisture protection), which will be packaged in an outer heat-sealed Tyvek pouch. Sterilization will be accomplished by electron beam irradiation. The sterility assurance level (SAL) that MacroPore intends to meet for the MacroPore Protective Sheet is 10^{-6}. The device is not represented to be "pyrogen free."

INTENDED USE

MacroPore Protective Sheet is intended for use in trauma and reconstructive procedures in the oral cavity in conjunction with rigid internal fixation. The following specific indications are included:

1. to maintain the position of bony fragments in bone graft procedures of the mandible or maxilla,
2. for regeneration of bone tissue of the mandible or maxilla.

The system is not intended for full load bearing procedures unless supplemental fixation intended for such procedures is used.

In addition to its function of providing fixation of non-load bearing areas, MPS serves as a protective sheathing to prevent soft tissue prolapse into defects that remain, or to prevent dislocation of autograft, allograft and/or bone graft substitutes that may be necessary in the reconstructive procedures. The macroporosity of the system permits mesenchymal stem cells from surrounding tissues to populate the defect and allows the ingrowth of blood vessels. This, combined with the inherent strength of MPS, facilitates osteogenesis by allowing the natural healing processes of the body to proceed in a protected environment without interference due to undesired interposition of soft tissue.

DEVICE DESCRIPTION

Design Characteristics

MacroPore Protective Sheet is an absorbable, macroporous implant in sheet form manufactured from polylactic acid (PLA). The purpose of the sheet is to provide fixation and to protect non-load and low-load bearing bone defects in the oral cavity from soft tissue interposition from adjacent soft and connective tissues (e.g. musculature) but allow, due to its porosity, for the proliferation of blood vessels and the migration of bone forming cells from such soft tissues into the bone defect. This facilitates bone regeneration.

MPS can be cut with scissors, is thermoplastic when heated to 55C (for example, by the use of sterile hot water) and thus can be conformed three dimensionally to any bone defect. It can be rolled into a tube or used as a flat sheet. It can be used either alone or in conjunction with internal bone fixation devices such as plates and screws, which also can serve to fixate the

MPS and prevent dislocation. In the mandible or in any load bearing region, rigid internal fixation is essential. The system includes a selection of resorbable screws and tacks and associated manual instruments.

MPS is provided in sheets of 20 x 20 mm to 120 x 120 mm and will be provided in other sizes as needed for particular surgical procedures. Its thickness ranges from 250 microns to 1000 microns according to the defect to be treated.

Material Composition

MPS is fabricated from poly(L-lactide-co-D,L-lactide) 70:30.

In Vitro Testing

Accelerated degradation testing showed that the degradation rate of the subject device is very similar to that of the Polypin, which is made of the same material. While the comparison with Lactosorb was limited by the poor ability of the Lactosorb tensile specimens to survive exposure and the handling necessary to flatten them for testing, it appears that the rate of mechanical property degradation of the subject device is significantly lower than that of Lactosorb samples of similar configuration.

Because MPS is intended to be heated in the surgical suite to above the glass transition temperature to facilitate shaping to anatomic structures, testing was performed to determine the effect of prolonged heating in saline at 60C on inherent viscosity. Testing showed that viscosity stayed within an appropriate range even after 120 minutes exposure. Therefore, the relatively brief exposure anticipated during the surgical preparation of MPS is not expected to have a significant effect on its mechanical properties.

To determine the resistance of MPS to deformation under the pressure of soft tissue and muscle, a laboratory test was performed. A cylinder was formed from the material and the force necessary to deform it was determined using a standard indenter. MPS was compared with comercially available Micro Titanium Augmentation Mesh (M-TAM) and reinforced Prolastic Sheeting (a silicone material used for bone regeneration in the craniofacial skeleton, particularly in the orbital floor). The results demonstrate that the stiffness of MPS in this configuration is over nine times that of M-TAM and over two hundred times that of Prolastic Sheeting.

MacroPore has submitted data to FDA on related devices intended for use in craniofacial fixation under K972913. The device, termed MacroPore Protective Sheet or Protego™ System, was determined for this indication to be Substantially Equivalent to legally marketed devices. Significant portions of the data presented in the submission were developed for the craniofacial fixation indication, but are also relevant to the oral cavity indications. In particular, data on mechanical properties of Protego FX plates and screws show that the material has significant strength in tension and bending, and that screws have shear and pullout strength that make them appropriate for supplemental fixation in the configurations that are the subject of this submission. Primary fixation is not an intended use for the device as submitted herein.

In Vivo Testing

The concept of protecting bone defects from soft tissue interposition to facilitate bone regeneration was demonstrated in a landmark study by Lemperle, Calhoun, Curran and Holmes.[1] This study used macroporous titanium sheet to bridge 30 mm (critical size) segmental defects in the edentulated canine mandible and 15 mm x 20 mm full thickness window defects in the parietal bones. New bone formation in the mandibular defects united the cut ends at four months regardless of whether the defects were empty, were implanted with coralline hydroxyapatite blocks or were filled with iliac cancellous bone. This remarkable finding led to the concept of replacing the macroporous titanium sheet with a macroporous bioresorbable polymer to protect bone defects from soft tissue prolapse, contain graft material and facilitate bone regeneration.

An animal study that extends the findings of the Lemperle, et. al., study to the use of resorbable polymers was performed using a 30 mm (critical size) segmental defect in the canine radius. Results confirm the findings of the Lemperle, et. al., study and support the use of MPS for containment of graft material and for regeneration of bone in defects that would not be expected to heal without protection from soft tissue prolapse.

EQUIVALENCE TO MARKETED PRODUCT

MacroPore submits the following information to demonstrate that MacroPore Protective Sheet shares indications and design principles with the following predicate devices, which have been determined by FDA to be substantially equivalent to pre-amendment devices: Micro Titanium Augmentation Mesh (M-TAM™) (K862532) from Leibinger, Lactosorb Panels and Fasteners (K980927) from Biomet and Titanium Ridge Augmentation Material (TRAM) (K963394) from Osteomed.

Intended Use

The intended uses of MacroPore Protective Sheet (MPS) are not new in that they are the same as or are included in those for the predicate device. MPS is intended for use in the oral cavity for fracture fixation and fixation in surgical reconstruction. It also serves as a sheathing to protect skeletal defects from soft tissue prolapse or to stabilize bone grafts, permitting the natural bone healing processes of the body to take place without interference from interposed soft tissue. Specific uses are:

to maintain the position of bony fragments in bone graft procedures of the mandible or maxilla,
for regeneration of bone tissue of the mandible or maxilla.

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[1] Lemperle SM, Calhoun CJ, Curran RW, Holmes RE. Bony healing of large cranial and mandibular defects protected from soft-tissue interposition: A comparative study of spontaneous bone regeneration, osteoconduction and cancellous autografting in dogs. Plast. Reconstr. Surg. 1998 March; 101(3): 660-72

The system is not intended for full load bearing procedures unless supplemental fixation intended for such procedures is used.

The predicate devices share intended uses with MPS as follows: LactoSorb Panels and Fasteners are used to maintain the position of bony fragments in mandibular graft procedures and are used in conjunction with rigid internal fixation. M-TAM and TRAM are used for fixation as well as for reconstruction of bone defects and containment of grafting material.

Design and Materials

The design and functional characteristics of MacroPore Protective Sheet and the predicate devices are similar. The LactoSorb Panels and Fasteners are made from a copolymer of polylactic acid and polyglycolic acid and have low crystallinity. The composition and processing of LactoSorb devices are selected to permit 70% of its strength to be maintained *in vivo* for 6-8 weeks (sufficient time to facilitate fracture fixation), yet to degrade and be cleared from the body within 9 to 15 months. MPS is made from a more stable polymer than LactoSorb Panels and Fasteners. Mechanical stability of MPS is unchanged for nine months, and complete resorption occurs in 12 to 36 months. Both MPS and LactoSorb Panels and Fasteners are essentially amorphous, in contrast with polymers that have significant crystalline regions in an amorphous matrix. Mixed crystallinity polymers, such as PLLA, have been shown to cause late inflammatory reactions, believed to be due to microscopic undegraded crystalline regions.

The physical designs of MPS and all of the predicate devices (Lactosorb and the titanium mesh devices) are similar, consisting of a thin sheet with macroporosity. The sheet serves to prevent the prolapse of soft tissue and to stabilize grafting material. The perforations permit the exchange of fluids and permit cells to migrate through the sheet, allowing the defect to be populated by mesenchymal stem cells. Furthermore, the macroporosity allows for the proliferation of blood vessels from the adjacent soft tissue into the bone defect. Claims made for M-TAM and TRAM include stability (based on materials and design), with sufficient strength against chewing and soft tissue pressure and sufficient rigidity to stabilize autogenous bone grafts. The titanium devices differ from MPS and the Lactosorb device in that they may be left in place permanently or must be removed surgically, whereas the polymer devices are intended to be metabolized by the body and do not require removal.

SUMMARY: TABLE OF SUBSTANTIAL EQUIVALENCE

	Subject Device	Predicate Devices		
	MacroPore Protective Sheet	Micro Titanium Augmentation Mesh (M-TAM™) (K862532) Leibinger	LactoSorb Panels and Fasteners (K980927) Biomet	Titanium Ridge Augmentation Material (TRAM™) (K963394) Osteomed
INTENDED USE	For use in trauma and reconstructive procedures in the oral cavity in conjunction with rigid internal fixation: 1. To maintain the position of bony fragments in bone graft procedures of the mandible or maxilla 2. For regeneration of bone tissue of the mandible or maxilla For use as a protective sheathing to facilitate osteogenesis and to stabilize bone grafts	For use in lower jaw reconstruction to restore bony continuity, for reconstruction of the extremely atrophic maxillary alveolar ridge, for semirigid fixation of fractures and osteotomies, for stabilization of autogenous bone grafts	For use in trauma and reconstructive procedures in the oral cavity in conjunction with rigid internal fixation, to maintain the position of bony fragments in mandibular bone	To build a stable protective space, tent the periosteum and protect a graft site in the mandible or maxilla, while providing enhanced vascularity
DESIGN	Sheets of 250 to 1000 microns thickness, size 20 x 20 mm to 120 x 120 mm or as required	Sheets of 100 and 200 microns thickness, size 60 x 60 mm and 120 x 120 mm	Sheets of 500 and 1000 microns thickness, sizes 25 x 25 mm to 50 x 50 mm	Sheets of titanium with macroporosity
MATERIAL	poly (L-lactide-co-D,L-lactide) 70:30, amorphous	Titanium	poly (L-lactide-co-glycolide) 82:18, low crystallinity	Titanium

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
9200 Corporate Boulevard
Rockville MD 20850

MAR 19 1999

Mr. Floyd G. Larson
Pacific Materials and Interfaces
4329 Graydon Road
San Diego, California 92130

Re: K983360
Trade Name: MacroPore Protective Sheet
Regulatory Class: II
Product Code: JEY
Dated: February 15, 1999
Received: February 22, 1999

Dear Mr. Larson

We have reviewed your Section 510(k) notification of intent to market the device referenced above and we have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration.

If your device is classified (see above) into either class II (Special Controls) or class III (Premarket Approval), it may be subject to such additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 895. A substantially equivalent determination assumes compliance with the Good Manufacturing Practice for Medical Devices: General (GMP) regulation (21 CFR Part 820) and that, through periodic GMP inspections, the Food and Drug Administration (FDA) will verify such assumptions. Failure to comply with the GMP regulation may result in regulatory action. In addition, FDA may publish further announcements concerning your device in the Federal Register. Please note: this response to your premarket notification submission does not affect any obligation you might have under sections 531 through 542 of

the Act for devices under the Electronic Product Radiation Control provisions, or other Federal laws or regulations.

This letter will allow you to begin marketing your device as described in your 510(k) premarket notification. The FDA finding of substantial equivalence of your device to a legally marketed predicate device results in a classification for your device and thus, permits your device to proceed to the market.

If you desire specific advice for your device on our labeling regulation (21 CFR Part 801 and additionally 809.10 for in vitro diagnostic devices), please contact the Office of Compliance at (301) 594-4692. Additionally, for questions on the promotion and advertising of your device, please contact the Office of Compliance at (301) 594-4639. Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR 807.97). Other general information on your responsibilities under the Act may be obtained from the Division of Small Manufacturers Assistance at its toll-free number (800) 638-2041 or (301) 443-6597 or at its internet address "http://www.fda.gov/cdrh/dsmamain.html".

Sincerely yours,

Timothy A. Ulatowski
Director
Division of Dental, Infection Control,
and General Hospital Devices
Office of Device Evaluation
Center for Devices and
Radiological Health

Enclosure

Device Name: MacroPore Protective Sheet

Indications for Use:

MacroPore Protective Sheet is intended to facilitate healing in trauma, reconstruction and bone augmentation procedures of the mandible. The following specific indications are included:

- to maintain the relative position of bony fragments in trauma and bone graft procedures, and
- to contain and prevent migration and shifting of autograft, allograft and/or bone graft substitutes that may be necessary in reconstructive procedures.

The system is not intended for full load bearing procedures unless supplemental fixation intended for such procedures is used.

(PLEASE DO NOT WRITE BELOW THIS LINE - CONTINUE ON ANOTHER PAGE IF NECESSARY)

Concurrence of CDRH, Office of Device Evaluation (ODE)

Susan Runner

Division Sign-off

Division of Dental, Infection Control and General Hospital Devices

510(k) Number K983360

Prescription Use ✓ OR Over-The-Counter Use____