

Recent Developments in Medical Textiles Implantable Devices – An Overview

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KEYWORDS :

Introduction

From their first appearance as sutures more than 4000 years ago to their present use in products ranging from gowns and wound dressings to arterial and skin grafts, textile materials have been explored as potential materials for novel applications in medicine and surgery. This continuous interest has its basis in the unique properties of fibres which in many respects resemble biological materials and in their ability to be converted into a wide array of desired end products.

Textile fibres have long played a vital role in the medical and health care sector. However, the role played by fibre-based materials has advanced dramatically in recent years. For example, Bioglass fibres are now used in tissue engineering to create new bone structures, and textile scaffolds are being used to promote cell growth and build cell structures. The small cylindrical tubes made from biocompatible materials, are helping to support and keep open veins and arteries.

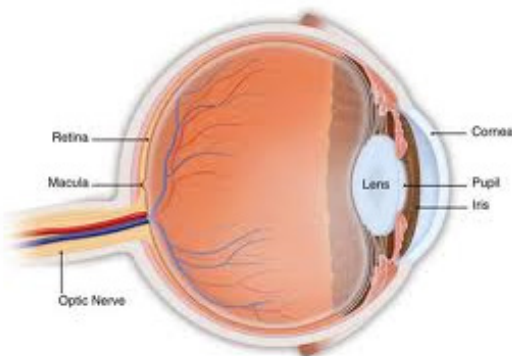
A Medical Textile is one of the areas which requires immense attention as it is directly connected to the human beings. The medical textile products are available in woven, knitted and non-woven forms based on the area of application.

Classification of Medical Textiles

- **Non-implantable materials:** dressings
- Implantable materials: sutures
- **Extracorporeal devices:** artificial leg ,artificial kidney ,artificial liver.
- Health and hygienic Care

Implantable Materials and Devices – An Overview

An implant is a medical device manufactured to replace a missing biological structure, support a damaged biological structure, or enhance an existing biological structure. Medical implants are man-made devices, in contrast to a transplant, which is a transplanted biomedical tissue. The surface of implants that contact the body might be made of a biomedical material such as titanium, silicone or apatite depending on what is the most functional. In some cases implants contain electronics e.g. artificial pacemaker and cochlear implants. Some implants are bioactive, such as subcutaneous drug delivery devices in the form of implantable pills or drug-eluting stents.



1. Artificial Eye Lenses (Pseudophakos)

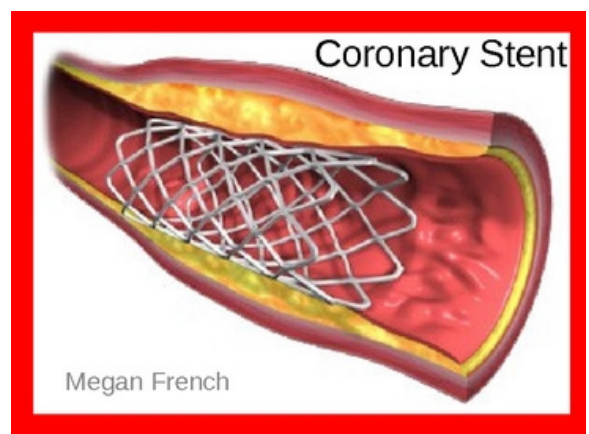
Cataracts are a problem faced by millions of elderly Americans yearly, many of whom will require surgical replacement of their own lens with an artificial one, known as a pseudophakos or intra-ocular lens. These

lenses come in many configurations, such as single-focus (like glasses for distance vision), multi-focal lenses (like bifocal glasses), and hi-tech variable-focus lenses (like real eyes).



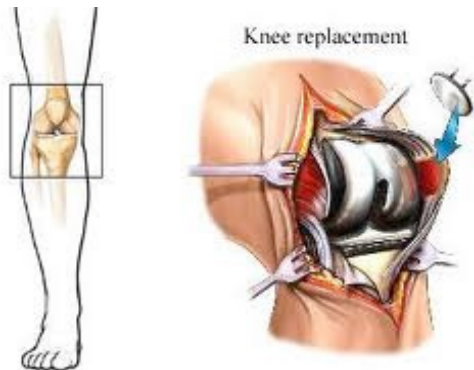
2. Ear Tubes (Tympanostomy Tubes)

Otitis Media, or middle ear infection, is one of the most frequently diagnosed childhood diseases with at least 80% of pre-school aged children affected. The surgery itself, known as myringotomy and tube placement, is the most commonly performed pediatric operation. It's very safe, very quick, and has very low complication rates. Due to the incredibly low cost of the tubes, and the fact that they have been evolving for well over 50 years, no one manufacturer appears to dominate the market.



3. Coronary Stents

Coronary stents are small tubes, usually coated with a drug (drug-eluting stents), that are placed into the arteries that supply blood to the heart. Stents are regularly implanted into patients with unstable angina (unpredictable chest pain) and recent heart attack patients whose coronary arteries have been partially blocked by atherosclerotic lesions (cholesterol). Complications from stents include stent thrombosis (clots), stent fracture, and re-occlusion (blood-vessel blockage). However, the risks of these complications are hard to quantify when overall decrease in death and disability is taken into account.



4. Artificial Knees

As the other major, replaceable weight bearing joints in the leg, knees frequently wear down faster and in a more disabling fashion than other joints. The constant friction and shifting of weight in the joint leads to a breakdown of cartilage and bone, making knees the most frequently replaced joint in the body. Over 90% of total knee replacements lead to a reduction or elimination of pain and an increase in mobility.

5. Metal Screws, Pins, Plates, and Rods (Traumatic Fracture Repair)



Bone fractures are one of the most common injuries, occurring in all age groups for a multitude of reasons. Of over one million fractures that are admitted to the hospital every year, roughly half require surgical intervention to realign and stabilize the bone, a procedure called open reduction and internal fixation.

6. IUDs (Intra-Uterine Devices)

IUDs are extremely popular worldwide and are the preferred method of contraception for almost 25% of women in the rest of the developed world

7. Spine Screws, Rods, and Artificial Discs (Spinal Fusion Hardware)

Spinal fusion surgeries are performed for a variety of back problems, mainly for pain and weakness. The surgery essentially fuses two or more vertebrae with the help of hardware such as screws and rods.

8. Breast Implants

Breast augmentation with implants is the most frequently performed plastic surgery procedure

9. Heart Pacemakers

As with ICDs, pacemakers are used to treat abnormal rhythms in the heart. While ICDs treat otherwise fatal rhythms, pacemakers are used

when the heart's internal clock is not maintaining a fast enough pace. Pacemakers override the aberrant signals in the heart by passing small jolts of electricity to multiple parts of the heart muscle, providing its own rhythm. Modern pacemakers will increase with exercise and decrease with rest to meet the body's minute to minute needs



10. Artificial Hips

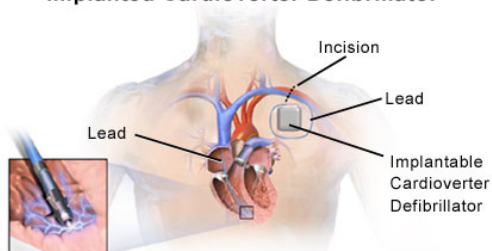
As people age and gain weight the wear and tear on their joints builds up. As one of three major weight bearing joints in the leg (the others being knees and ankles), hips are put under a lot of stress over a lifetime. This stress commonly leads to the wearing down of cartilage and the painful friction of bone rubbing against bone. Hip replacement can lead to a decrease in pain and an increase in mobility in over 90% of recipients.



11. Implantable Cardioverter Defibrillators

Cardiac arrhythmia, or improper electric signaling in the heart, occurs in millions of people a year. Implantable cardioverter defibrillators (ICDs) are devices that monitor and treat these rhythms when they are detected by sending a large jolt of electricity to the heart, and basically pressing the reset button. Newer models can also function as pacemakers, combining two devices into one.

Implanted Cardioverter Defibrillator



Tip of lead in right ventricle of the heart

12. Artificial Heart Valves

Artificial heart valves are implanted in the heart of the patients who need treatment for valve related diseases. The natural heart valve needs a replacement when two or more valves stop functioning properly. The mechanical heart valve consists of Ultra high molecu-

lar weight-polyethylene (UHMW-PE) disc, Low density polyethylene plastic with knitted polyester sewing ring and a metallic housing. **The Sewing Ring is fabricated from extensively implant tested, 100% polyester material.**

Biological valve
(human or porcine)



Mechanical valve

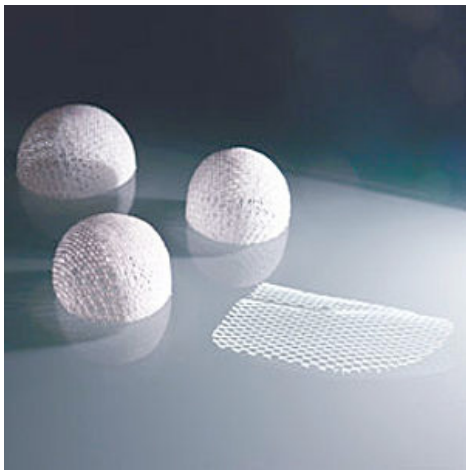


13. Artificial Vascular Grafts



Vascular diseases are characterized by variations to the geometry and structure of the walls of the blood vessels. Variations in the mechanical characteristics of the vessels result in multiple complications like Thrombosis, Aneurysm and Arteriosclerosis. In order to function effectively, the grafts need to have special characteristics like – non-thrombogenic surface, elasticity and compliance, long-term tensile strength, bio-compatibility, durability. Most textile grafts for large and medium artery replacement are made of either PET or PTFE

14. Artificial Tendon (Mesh)



Artificial Tendons or meshes are used in hernia repair and abdominal wall replacement, where mechanical strength and fixation are very important. . Polypropylene, Polyester mesh is primarily used in hernia repair as it is resistant to infections.

15.. Artificial Joints

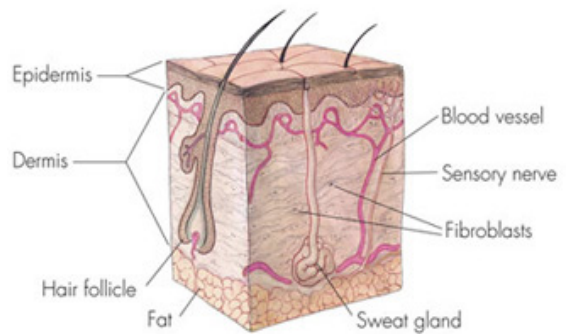


The orthopedic joints are used for patients suffering from arthritis and accidental damage of joints. The technical textile component in joints is Ultra High Molecular Weight High Density Polyethylene (UHMWHDPE) material. The UHMWHDPE is a technical textile product which varies based on the product or type of joint replacement.

16. Artificial Ligaments



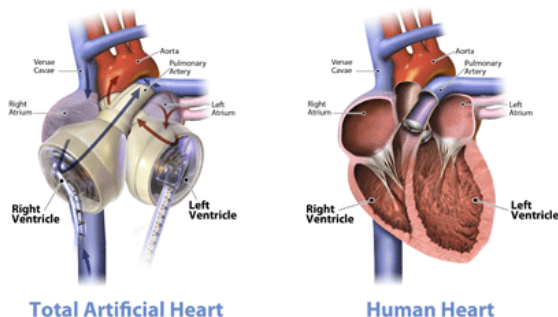
An artificial ligament is medical device for joining ends of two bones. The artificial ligaments are made from man-made fibres like polyester. Ligament is a multilayered or tubular woven structure having intra-articular region, at least one bend region and end regions. Each region is woven so as to possess the required flexibility and strength. Polyethylene Teraphthalate (PET) is primarily used for manufacturing artificial ligaments.



17. Artificial Skin

Skin grafting is the procedure of replacing dead skin with live skin. The artificial skin is used in the skin grafting process. . Artificial skin consists of two layers. The bottom layer, which is designed to regenerate the lower layer of real skin, is composed of a **matrix of interwoven bovine collagen** and a sticky carbohydrate molecule called glycosaminoglycan, which mimics the fibrous pattern of the bottom layer of skin.

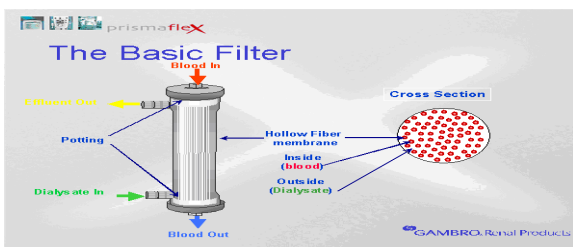
18. Artificial Heart



The artificial heart is intended for use in patients whose hearts have been irreparably damaged left and /or right ventricles, and for whom, existing methods of surgical intervention and/or drug therapy are inadequate. Heart transplantation is limited by availability of donor organs.

19. Artificial Kidney / Dialyzers

Kidney serves the filtering mechanism of the blood. The kidney has a mechanical substitute in kidney dialysis machine. The kidney dialysis machine is outside the body and purifies the blood using a filter called the haemodialysor. The haemodialysor is made primarily of polysulphone and polyacetate. The primary function of the artificial kidney is to purify the blood. The filtration medium used is hollow viscose or hollow polyester fibre. An external artificial kidney, a hemodialyser, is used which can perform many of the functions of a kidney. It is attached to the blood circulation via, an artery and a vein. It is made up from a bundle of hollow fibres through which the blood circulates.



20. Artificial Lung

Totally artificial lungs are not completely commercial. The artificial lung device is connected to the heart's right ventricle. It relies on the heart – not a mechanical pump – to send blood through the lung, where it receives oxygen (and offloads carbon dioxide) as it flows through the arrays of microbubblers or membrane oxygenators. Oxygen rich blood passes from the device into the left atrium and then to the rest of the body. The micro-fibers or the membrane oxy-generator are the technical textile component in the device.



21. Artificial Liver

The major artificial liver support systems are – Peritoneal dialysis, Haemodialysis, Hemofiltration, Continuous renal replacement therapy, Charcoal Haemoperfusion, Plasma exchange, Biologic – DT sorbent System and Molecular adsorbent re-circulating system. In this system, patient's blood or plasma is pumped into bioreactors, which are hollow fibre devices, seeded on the dialysate side with freshly isolated or cryopreserved porcine hepatocytes or transformed human hepatoma cell line.

Major challenges in the field of medical textiles

- Clear understanding is critically needed about the structure-property relationship of novel textile products, so that precise simulation of mechanical parameters for specific clinical applications can be achieved.
- Tissue engineering research: Development of efficient manufacturing processes for preparing novel polymeric biomaterials, fibrous scaffolds
- Scalable, cost-effective production under GMP (Good Manufacturing Practice) conditions.
- Multidisciplinary cooperation : There is urgent need to encourage the formation of consortia that work on challenging topics (chronic wound management, low back pain, diabetic ulcers, joint trauma, arthritis etc), to improve interdisciplinary networking (among textile and polymer technologists, material scientists, chemical engineers, biotechnologist, computational biologists, genetic engineers, biochemists, clinicians, pathologists and industry). Ideal strategy should be to bring different groups into one specific area, rather than making one group mastering all fields.

Conclusion

The application of textile in high performance and specialised fields are increasing day by day including medical field. As the medical textiles are directly linked to human beings, its importance cannot be neglected. Indian textile industries with medical field experts have an important role to play in this niche market as medical textiles not only have great demand in the domestic market but also have export potential.

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