DEVELOPMENTS IN MEDICAL TEXTILES

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Abstract: *Medical textile is one of the most rapidly growing sectors of technical textiles. It accounts for approximately 10% of the total market share of technical textiles. It is mainly categorized into health care hygiene, extracorporeal devices, implantable and non-implantable textiles. Use of textile materials in this field ranges from simple gauze or bandage material to scaffolds for tissue culturing and large variety of prostheses for permanent body implants and extracorporeal devices. The products and constructions developed are primarily used for first aid, clinical and hygienic purposes. Medical textile improves the quality of health care through disposable products and enhances the standard in health care by minimizing the risk of infections. This paper discusses the details and some recent developments in medical textiles.*

Keywords: *Medical Textiles, Technical Textiles, Sutures, Compression garments, Artificial heart*

1. Introduction

Textiles are no more limited for use in apparels. Clothing is just one but not the only purpose of textiles with the rapid changes in the socio-economic structure of our society. Textile technology has joined hands with medical science with the result that medical textile has emerged as a new field with high potential. Medical textile has achieved a significant growth in the recent times due to the constant improvements in textile technology and medical sciences. Developments in medical textiles are really meant for converting the painful days of patients into comfortable days.

2. Categories of medical textiles

Based on applications the medical textiles can be broadly categorised as follows:

- **Personal health care/hygienic products:** Bedding, clothing, surgical gowns, cloths, wipes surgical curves, surgical hosiery, diapers, etc.
- **Non-implantable material or medical dressings & auxiliaries:** Wound dressing, bandage, plasters, gauge, lint wadding, etc.
- **Implantable materials:** Sutures, vascular grafts, artificial ligaments, and artificial joints.
- **Extra corporal devices:** Artificial kidneys, liver & lungs[1], etc.

2.1 Characteristics of materials for medical use[2]:

The major requirements for biomedical polymers to be used for medical pupose are:

- Non toxicity
- Nonallergenic response
- Mechanical properties
- Strength
- Elasticity
- Durability
- Biocompatibility
- The ability to be sterilized

2.2 Fibers used in medical textiles:

Fibers used in medical field may vary from natural fibre such as cotton, silk, regenerated wood fluff (absorbent layer), to, manmade fibers like polyester, polyamide, polyethylene, glass, Kevlar, Nylon[3] etc.
In the past few years some more developments have taken place in these categories of medical textiles. An attempt has been made in the following section to discuss an overview of these developments.

3. Recent developments: an overview

3.1Spun lace wound dressings using bamboo fibers

The main function of wound dressing is to avoid the strike through and to protect the wounded site from contamination and further injuries[4].

SITRA has developed a spun lace non-woven wound dressings consisting of four layers:
Wound contact layer: Made up of 100% polyester spun lace fabric to helps wick and transmit the wound exudates.

Absorbing layer: Made up of bamboo spun lace fabric to absorb the blood, liquid and provide the cushioning effect to protect the wound. The use of bamboo fibre is to reduce the frequency of dressing changes and to increase the antimicrobial activity of wound dressing.

Activated carbon layer: Introduced for absorbing the odorous/volatile micro-organisms.

Back layer: Made up of polyester spun-lace fabric, to cover and avoid the further injuries from outside.
It is claimed that tensile strength and elongation of spun lace wound dressings are higher than the commercially available wound dressings by 35% and 1.6% respectively. Antimicrobial activity, water vapor transmission and water absorption capacity are also higher than the commercially available wound dressings. Further such dressings with a single layer have 8% higher air-permeability and absorption capacity as compared to commercially wound dressings[5].

3.2 Sutures

Sutures are the bio-textile implantable devices which are used in surgical procedures to achieve wound closure. Sutures are made of silk, cotton, nylon, PP, PET, polyglycolic acid, polyglactic acid, polytrimethylene-carbonate, and plain gut .Sutures may be absorbable and non-absorbable[6].

Developments in sutures

Antimicrobial sutures: Some antimicrobial agents are introduced in to the sutures which behave as germicide reservoir to prevent proliferation of micro-organism. Delivery of antimicrobial agents near the wound closure remarkably improves the healing process and also inhibits the growth of microbes.

Nano-sutures: Nano-sutures allow the separation and repair of tissue at a molecular level with far less trauma and blood loss.

Absorbable bi-directional barbed suture: It is made up of polydioxanone with a knotless design which has significant potential in reducing scars due to the absence of foreign body reaction caused by the knot. It heals the wound under minimum pressure and residual tension by providing the adequate tissue adhesion. These sutures are used in dermal tissue approximation, internal wound closure and tendon repair. This suture is advantageous because there will be no visible signs of a wound closure device during and after healing and there is no need of removing after the repair is healed[7].

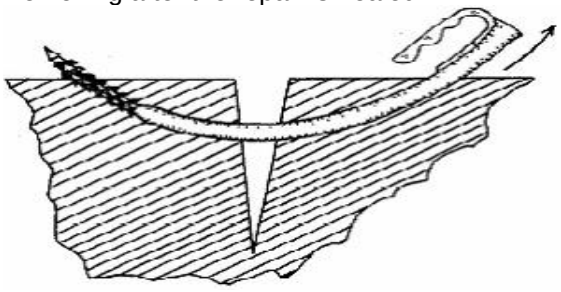

Figure 1: Bi-directional suture

3.3 Surgical gown Surgical gowns with impermeable areas and edges will block the transfer of bacteria, viruses, infections, blood borne pathogens, and other harmful agents and chemicals to and from the patient.

Figure 2: Surgical gowns are widely considered to be the foremost item of protective equipment[8].

Developments in surgical gown

Plasma treated gown: When textile materials without any treatment is used as a surgical gown then they are more prone to bacterial growth. So surgical gown should not only provide the protection against microbial attack, but should also provide blood barrier properties. Plasma treated materials show higher blood and water resistance as compared to other treatments. These treatments also show a zone of inhibition and provide a barrier against microbes[9].

Nano-finishes treated gown: Nano-finishes are applied on cotton and polyester/cotton fabric which improves the breathability in terms of water vapour resistance, air-permeability and wicking as compared to the fabrics treated with normal finishes. There is less reduction in tensile and tear strength as compared to the normal finished fabrics. Even after 50 Home launderings it has been found effective in controlling the bacterial growth[10].

3.4 Compression garments

Compression garments diminish the swelling from a surgical procedure and accelerate the healing process and flushing out harmful fluids out of the body from specific area. These are manufactured by the flat knit or by circular knitting. In circular knitting seamless garments are manufactured and same number of meshes and needles are used. But plat knitting number of meshes and needles can be varying as per patient body measurement. Compression garments are different from regular garments because medical compression garments can be used without losing its integrity and effectively remove perspiration from the skin. They also reduce the muscle oscillation, increase blood circulation. Compression garments also provide the antimicrobial protection, antistatic protection, breathability, enhanced fabric durability, moisture management, stain release technology, temperature regulation and protection against UV radiation.

Different types of compression garments

Compression sleeves: These are used after arm surgery which covers the shoulders, biceps, elbows and a part of the fore-arms. Also used for the patients suffering from lymphedema, also used for the females in multiple plastic surgeries.

a. b. c. d.

Figure 3: Compression: a. sleeves, b. stockings, c. pants, and d. face wraps

Compression girdles: Compression girdles are used to cover the mid-section of the body, hips, flanks and legs. These are also effective in controlling swelling during recovery of tummy or liposuction and apply full compression around the abdominal area

Compression binders: These are also used for recovery of tummy tuck or abdominal liposuction

Compression pants: These pants are effective during the recovery of multiple lower body liposuctions.

Full compression suits: Suits are used during the recovery of multiple surgical procedures liposuction with breast augmentation, tummy tuck with breast augmentation.

Compression face wraps: These are soft cotton lined perforated elastic material with two detachable stabilizing straps. These are used for face lift, facial surgery mentoplasty chin implant, neck surgery and oral surgery

Gauntlets: Gauntlets are used for hand but separate from compression sleeve and used for partial finger coverage, leave the finger tips exposed which are known as finger stubs[10]

Compression stockings: compression stockings support the venous and lymphatic systems of the leg. Medical compression stockings are designed to provide compression on the leg. This accelerates the flow of

blood in the veins thus reducing the occurrence of thrombosis, oedema and leg ulcers. Medical compression stockings are available in full length, thigh length and knee length. Pressure exerted by the medical compression stockings is a function of the amount of extension in the fabric which is determined by the yarn and fabric properties as well as the garment contour and dimensions. Stretch yarns (rubber or spandex) are generally responsible for the elastic nature of the fabric[11]

3.5 Developments in non-wovens to be used in medical field:
Non–woven fabrics are mainly used because of their disposability and good resistance to mildew, bacteria, fungi, mildew and stain. These fabrics are also used as a artificial skin made of chitin for treating burn wounds[12].

Types of barrier performance of Non- woven

Level1: Spunbond PP and spunlace PET/Wood pulp very light material is used where there is little or no contact with blood or bodily fluid.

Level2: When there is light contact with blood and bodily fluids medium weight SMS (spunbond-meltblown-spunbond) and spunlace PET/wood pulp are used.

Level3: Heavy weight SMS are used in cases of moderate exposure to blood and bodily fluids.

Level 4: When there is high contact with blood and bodily fluids then poly coated –made from SMS PP or spun lace PET/wood pulp material coated with PE. PP is light and comfortable and PE gives a strong barrier to fluids[13].

Applications of Non-woven materials: Non-woven are used in wipes, baby diapers, sanitary napkins, hospital beddings, surgical masks, shoe covers and surgeon caps.

3.6 Applications of Lenzing PROFILEN PTFE fibers in medical textiles:
Because of excellent bio-compatibility, softness and non-sticking nature these fibers are used in surgical sutures and yarns for permanent implants (heart valves), also used in hospital beddings and garments for patients suffering from Psoriasis due to low friction of fiber on the skin, nonsticking behavior and perfect moisture management of fabric[13].

3.7 Artificial heart:
The artificial heart is planned for use in patients whose hearts have been irreparably spoiled left and/or right ventricles, and for those, offered methods of surgical involvement and/or drug therapy are not enough. The artificial heart is planned for use in patients whose hearts have been irreparably spoiled left and/or right ventricles, and for those, offered methods of surgical involvement and/or drug therapy are not enough.

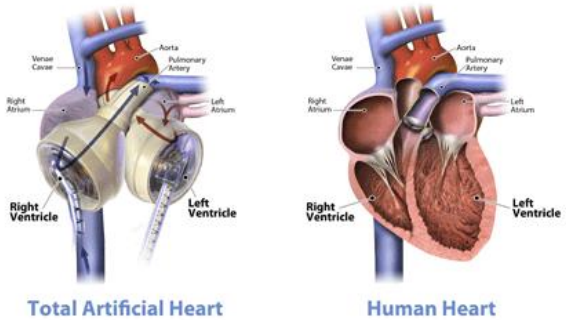

Figure 4: Comparison between artificial and human heart

In India about 20 million patients suffer from heart failure each year. The number of heart failures is increasing by two million. The artificial heart is planned for use in patients whose hearts have been irreparably spoiled left and/or right ventricles, and for those, offered methods of surgical involvement and/or drug therapy are not enough. However, the device is very expensive at Rs 34 lakh and the overall cost of surgery as Rs 40 lakh. The cost of artificial heart is set to fall with improvements in technology.

3.8 Artificial liver

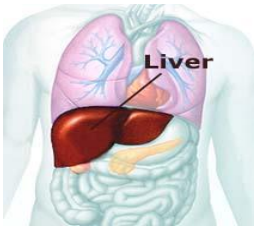

Figure 5: Artificial Lungs

Artificial livers are used to separate and dispose of patient's plasma and supply fresh plasma. Hollow viscose fiber is mainly used because of blood Compatibility and adsorptive activity. The principal goal of ELAD(extracorporeal liver assist device) is to circulate the patient's plasma extra- corporeally through a bio-reactor that contains metabolically active heptocytes. ELAD is a semi permeable membrane with low molecular weight Organ cells are placed around the fibers and blood flows inside the fiber. Blood nutrients pass through the fiber wall to the organ cells and enzymes pass from the cells to the blood and this allows the separation of waste plasma and permitting the cells to secrete vital molecules back in to the patient[14].

4. 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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