Review

Textiles for Plastic Surgery

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Here in this paper a review was done to find out the significant role of textile fibers and polymers in plastic surgery. The development of inorganic materials for surgical application has produced significant changes in the scope and procedures of operations in plastic surgery. In case of the polymers used it has been seen that all the polymers are being largely used by the surgeons and all of them are performing well in plastic surgery because of their distinct characteristics. The surgeons are using all the materials successfully and they are aware of all the textile products they are using.

Key words: Textile Fibers and Polymers, Inorganic materials, Plastic Surgery, Distinct Characteristics of Polymers.

INTRODUCTION

The textile scenario is fast changing from conventional textiles of apparel and household industry to hi-tech areas of industrial application in the world market (Anonymous, 2000). Textile materials in the medical field gradually have taken on more important roles. As more research has been completed, textiles have found their way into a variety of medical applications, like; textiles for implantation (sutures, vascular grafts, fabrics for heart valves and repair, surgical reinforcement meshes, fibrous bone plates, etc.), non-implantable textiles (bandages, wound dressings, plasters, etc.), textiles in extracorporeal devices (artificial kidney, liver, lung, etc.); and textiles in healthcare and hygiene products (beddings, protective clothing, surgical gowns, clothes, wipes, etc.). The development of inorganic materials for surgical application has produced significant changes in the scope and procedures of operations in all surgical specialties; plastic surgery in particular is a beneficiary of these devices (Adanur, 1995).

The polymer chemists and metallurgists have developed significant tools for the plastic surgeon. Metals and polymers plastics have been altered by structural and compositional changes in an effort to create a chemical and physical composition that is relatively resistant to immunologic attack. The extreme versatility of contemporary implantable surgical prosthetic devices and the rapidity with which technology is now advancing suggest that we are on the threshold of an era of biologically acceptable inorganic implant materials (John, 1977). The word plastic comes from the Latin plasticus and the Greek plastikos which means "to shape or mold".

The term plastic surgery refers to the molding or shaping of matter, particularly the renewal of destroyed or injured tissue. In a practical sense, plastic surgery is the specialty that deals with the correction of congenital and acquired externally visible defects. The aim of the plastic surgeons is to improve function or the appearance of the deformity or both. Plastic surgery may be done to correct a birth defect, reconstruct a breast after mastectomy, restore the use of a hand after injury, or repair tissue after burns or disease such as skin cancer. It can also be performed to provide a more pleasing appearance, counteract effects of aging, and boost the self-confidence of those who are troubled with some aspects of the way they look. There is an element of artistry in plastic surgery, the plastic surgeon has to be able to interpret and analyze whatever defect is present, to visualize what tissues are involved, and to determine what tissues are to be used or shifted around in the reconstruction. He must then decide how the tissues should be altered, removed, or added to in order to obtain the desired result or correction. Plastic surgery is often elective surgery. The goal is to achieve the best possible result, in terms of both aesthetics and function (Park, 1979).

MATERIALS AND METHODS

The textile fibers and polymers are basically used in plastic surgery as Implants

Implants made from alloplastic (synthetic or artificial)
Injectable implant materials have many uses in plastic surgery to reconstruct large defects; act as "scaffolding" for human tissue to grow into; and to act as "glue". The basic requirements of an implant to be an ideal substitute are as follows:

- Not physically modified by soft tissue.
- Not capable of inciting an inflammatory or foreign body reaction.
- Not capable of producing a state of allergy or hypersensitivity.
- Chemically inert.
- Non-carcinogenic.
- Capable of resisting strain.
- Capable of fabrication in the form desired.
- Capable of sterilization.

As a general concept, implant materials can be divided into two categories:

1. Hard implants. Hard implants are composed of polymers
2. Soft implants. Soft implants are the injectable implants e.g., silicone or injectable collagen (Leonard, 1983) figure 1.

**HARD IMPLANTS**

**TEFLON**

Teflon is prepared by polymerization of tetrafluoroethylene gas at a high temperature and pressure. Teflon is used to conform to the orbital floor and can be used as prosthesis in this area as well as in a variety of facial fractures of both children and adults. Teflon sheets are usually used as 0.0010 to 0.0015 inches in thickness. The use of Teflon implants in this area is well established. The benefits include:

- It is non-carcinogenic.
- It can be sterilized.
- It is chemically inert with no known solvent.
- They are inexpensive.
- They are controllable with gentle pressure.
- They are easily sutured.
- They can easily be fitted into a specific defect.

**PROPLAST**

Proplast was the first of the synthetic biomaterials developed specifically for implantation in humans. It was initially developed as a coating for the stabilization of skeletal implants; but the tissue ingrowth property led to applications in many surgical specialties. Today, block and sheet forms of proplast may be easily shaped and contoured at the operating room table for the desired defect. In addition, preformed proplast implants can be made for augmentation of the chin, zygoma, and per orbital rim area. Other uses of this material includes reconstruction of the orbital rim, contour deformities of the maxilla and mandible, frontal bone defects, and nasal defects, as well as the correction of extensive pectus excavatum, rib cage deformities, and other hand and maxillofacial reconstructions. Size distribution of standard Proplast has been found to be optimal between 80 and 400 µm, at which point it has found that rapid tissue in growth occurs maximally. The benefits include:

- Rapid stabilization of the implant by tissue ingrowth.
- Ability to modify the implant and sculpt it.
- An inherent firmness that maintains the prepared shape and contours while allowing flexibility for adaptation to the underlying bony contour.
- Ability for vacuum impregnation of antibiotic solutions.

Proplast has been found to be a good alternative to autogenous material and can often be prepared preoperatively. It is rapidly stabilized through fibrous tissue ingrowth, which provides dependable fixation and predictable results with less chance of extrusion. In addition, the porosity of the proplast allows added protection against infection because it can be impregnated with antibiotics preoperatively.

**METHYLMETHACRYLATE**

Methylnethacrylate is a transparent resin with remarkable clarity. It has tensile strength in the range of 8500 lbs per square inch, is stable, does not discolor in ultraviolet light, and has remarkable aging properties. It is chemically stable to heat and can be molded as a thermoplastic material at approximately 125°C. As do all resins, it exhibits a tendency to take up water by a process of imbibition, which is why people who wear dentures in a moist environment when they are not in the mouth. In plastic surgery it has been used to replace hard tissues, as in the chin area or the jaws, or as a replacement for missing cranial bone. Further application of self-curing acrylic has been in the external fixation
devices for holding mandibular fragments together.

Methylmethacrylate may be either cold- or heat-cured. In either case the density changes as the monomer is polymerized, causing shrinkage of the material. Consequently, when fitting acrylic into a defect, it must be constantly molded until it is fully set to ensure the fit of the final prosthesis (William et al., 1997).

**The benefits include:**

- It is relatively inexpensive.
- It can be hand-molded to fit a defect.
- It can easily be trimmed during the setting phase.
- Once it is set, it may still be trimmed using burrs and sanding instruments.
- Using a moulage, it can be custom-fabricated preoperatively and later trimmed as needed.
- As for denture construction, additional material may be added in selected locations even after the final set has been achieved.

**POLYETHYLENE**

Marlex is a popular surgical grade polyethylene that has been successfully used to reinforce hernia repairs as well as other abdominal and chest wall defects. Marlex has been used to reinforce large abdominal wall defects created after harvesting myocutaneous flaps in this area. When rigid support is needed, Marlex is perhaps the most commonly used foreign body. Marlex mesh on either side of a methylmethacrylate center has been used successfully for chest wall reconstruction.

**POLYESTER**

Polyethylene terephthalate (Dacron) is a biocompatible, flexible, non-absorbable polymer that is used as a suture material as a prosthetic material for arterial replacement, and as a mesh. It is suitable implant for applications that require both tensile strength and stability, and has been used for abdominal and chest wall reconstruction, as well as for chin and nasal augmentation (Figure 2).

**POLYAMIDE (Supramid, Nylamid)**

The polyamide compound nylon is an available as a mesh implant. Supramid consists of long chains of amide units that are twisted and then used. Nylamid is biocompatible, can easily shaped and possess stability as a result of fibrous tissue ingrowth has been successfully as an implant for the repair of the orbital floor defects. Polyamide compounds do not undergo resumption over time and their applications in reconstruction and augmentation are therefore limited.

**POLYPROPYLENE**

The substitution of one methyl group for a hydrogen atom in each polyethylene unit results in a loosely woven, high-density polypropylene polymer, with biological properties similar to those of polyethylene. Polypropylene is one of the most inert biomaterials used in surgery, and is available as a woven mesh. It is easy to suture, has good tensile strength, and demonstrates early fibrous tissue ingrowth that serves to fix and incorporate the mesh.

**CYANOACRYLATES**

The cyanoacrylates are quick setting, biodegradable, polymeric tissue adhesives that have become useful tissue bonding agents. They form a strong, durable bond with most human tissues, particularly those that contain a large amount of protein such as skin and tendon. In addition to their role in bonding tissues, these polymers have also been used as hemostatic and embolic agents.

The cyanoacrylate tissue adhesives polymerize by an exothermic reaction in the presence of water and hydroxyl groups on the wound surface, and thus are effective on moist surfaces. The first of the cyanoacrylate compounds to be synthesized was methyl-2-cyanoacrylate followed by the development of other adhesives including ethyl-2-cyanoacrylate (krazy Glue), isobutyl cyanoacrylate (Bucrylate), and butyl-2-cyanoacrylate (Histoacryl). Degradation of the cyanoacrylates yields the tissue toxic metabolites, alkyl cyanoacrylates and formaldehyde. The chain compounds such as Histoacryl degrade more slowly than the methyl and ethyl cyanoacrylates, and therefore cause less tissue toxicity since the host tissues are able to clear the toxic metabolites more readily. Histoacryl is the safest of the cyanoacrylate tissue adhesives.

Experimental and clinical applications of cyanoacrylates include suture less skin closure, fixation of bone and cartilage grafts, and fixation of craniofacial...
fractures, tendon repair, tarsorrhaphy, and repair of retinal detachments and corneal perforations (William et al., 1997).

**SILICONE**

The use of silicone in the practice of medicine has become widespread. This is a group of polymers ("mixtures") composed of silicon, oxygen, and other organic materials. The most commonly used silicone for medical implantation is dimethylsiloxane (a mixture of silicone, oxygen and methane), which may be liquid, gel or solid. Solid Silicone has been used as a material for facial implants since about 1956. The silicone facial implants are solid, yet flexible. They are manufactured in different durometers (strengths) to be soft or quite hard. These implants are designed to enhance soft tissue areas and not the underlying bone structure. They come in clear, flesh, blue (normally for demonstration) and white. They are easily removed as they are quickly encapsulated by scar tissue.

The properties that make silicones the perfect candidates for implant material are:

(i) The chemical stability associated with their structure and desired properties are considered impossible to be degraded in a biological environment.

(ii) Silicones can be readily sterilized without destroying their physical properties also contributes to its choice as implant material.

(iii) Silicones make good elastomers because the bonds between a silicon atom and the two oxygen atoms attached to it are very flexible. The angle formed by these bonds can open and close like a scissors without much trouble. This makes the whole backbone chain flexible.

(iv) Silicone implants do not wear out. If you have an implant it will only be necessary to change it if you put on or lose weight or develop a capsular contracture (formation of tough, fibrous tissue around the implant), which may cause problems.

**EXPANDED POLYTETRAFLUOROETHYLENE (ePTFE)**

These implants are also porous and utilize the benefits of tissue integration as well to keep it in place.

**Gore-Tex (Gore Industries Worldwide)**

This material is made from expanded polytetrafluoroethylene (ePTFE) it is known as Gore S.A.M. (Gore sub-cutaneous augmentation material) and is made of biocompatible, micro-porous ePTFE which supports rapid tissue incorporation. The implant used is a white oval or flat type of "rubbery" material. It is a non-reactive, nontoxic polymer that has been used in medical implants throughout the body without ill-effects. (ePTFE) has been shown NOT to be rejected by the body. There are approximately 4 million (ePTFE) implants, in all forms, to date. The Gore-Tex implant has pores 10-30 microns in diameter therefore allowing the body's tissue to attach itself to the implant. It is extremely strong and is not likely to tear or disintegrate. It is flexible, soft and yet very strong. S.A.M. is available in pre-formed configurations (facial implants and the like) as well as sheets and blocks. The pre-formed TRIMENSIONAL 3-D shapes improve the outcome of malar, chin and nasal reconstructions. An added bonus is that it can also be easily carved for further customization. Easily carved for further customization.

Gore-Tex "Strings": It comes individually like single thread rubber band or can come solid on the ends and resembling shredded strips (or more like rubber bands) in the middle. This design makes tissue incorporation more feasible yet this could be its drawback. The good thing is this design allows more mobility in your lips due to the flexible structure of the threads. Whereas in the strips it is difficult to pucker the lips rather well or whistle easily. Actually some doctors may use two strips (one cut in half) and place them in this fashion in the upper lips. That way the each of the two strips will end at the Cupid’s bow and corner of the mouth, respectively. Although there is a learning curve to either technique as mentioned before the ends must be trimmed in a rounded fashion or increased infection and palpability is possible.
Soft Form (Collagen Aesthetics): The Soft Form implant is made of a synthetic material, called ePTFE (expanded polytetrafluoroethylene), there have been reports from several surgeons featured on this website that these implants have a high rate of "shifting".

MEDPOR

Medpor (Porex): MEDPOR Biomaterial: MEDPOR is made of a lightweight, porous form of high-density polyethylene. This material has a long history of medical applications without any reported harmful effects. This implant's porous texture allows tissue to incorporate into the implant, to prohibit "shifting". The shape and size can be customized by your surgeon to fit your individual needs. MEDPOR is also widely used for facial repair following trauma and for corrections of congenital defects. Although its porous feature can be its downfall, for a porous implant, after tissue incorporation, is more difficult to remove without destruction of tissues.

HYDROXYAPATITE

The benefits from almost anything oceanic are numerous. For years we have known that coral's make up is almost identical to that of bone. Medical Science has come up with a way to alter coral into an even closure match to bone and that is called Hydroxyapatite or HA. It is used to coat implants placed into bones, to stimulate new bone formation. It has both the porous structure and chemical make-up of bone so that the body accepts it wholeheartedly and even incorporates normal tissue integration and not cap-solmization like synthetic implants.

A patented process converts Calcium Carbonate into hydroxyapatite while maintaining the three-dimensional integrity of the coral yielding Coralline Hydroxyapatite (CH). All the proteins are removed by intense heat. This renders the structure totally non-immunogenic so it becomes a nearly perfect bone lattice. Closest to bone grafts but without the bone.

SOFT IMPLANTS

INJECTABLE SILICONE FLUID

Silicones are synthetic polymers and are made by combining oxygen and silicon and in high temperatures and pressures can produce polydimethylsiloxane (PDMS), popularly known as injectable liquid silicone. The fluids are made from linear chains of PDMS whereas the gels are lightly cross-linked to give it a thicker cohesive-ness. PDMS is what is found in silicone-filled breast implants and the highly-cross-linked version of silicone is what the breast implant shells are made from.

COLLAGEN

Collagen is a protein found in the skin of all mammals. Injectable collagen (brand names are Zyderm and Zyplast) is derived from purified bovine (cow) collagen. It is used to replace the collagen you lose naturally as you age. In lips, Collagen puffs up the tissue making lip wrinkles disappear and make the lips fuller and more lush. Collagen is not a permanent solution, since collagen is completely biodegraded it persists for only up to six months, and therefore repeated injections may be necessary. Collagen is used primarily to fill wrinkles, lines.
and scars on the face and sometimes the neck, back and chest (Fredrick H.S. (1994)).

**FIBREL**

Fibril is a mixture of gelatin powder (denatured porcine collagen) and epsilon aminocaproic acid that is mixed with the patient's own plasma. It has been used in the treatment of depressed scars and for facial wrinkles. Fibril is believed to promote production of collagen at the site of infection, thereby providing a longer-lasting correction than that allowed by the injectable bovine cartilage materials.

**ALLODERM**

Alloderm is the newest type of lip implant available. It's derived from human skin and is inserted through tiny incisions located inside each corner of the mouth. Lips can maintain their increased size with Alloderm for over one year, making this an excellent treatment choice. Alloderm is inserted under local anesthetic and requires about 30 minutes. Swelling lasts for 1 week and firmness lasts for several weeks. Cymetra is micronized Alloderm which is derived from donor tissue. It is used in fine wrinkles, frown lines, nasolabial folds and lips. It fills in the depressions in the skin leaving smoother, younger looking skin. It lasts up to one year.

**FAT INJECTIONS**

Fat injection is used to plump out the lips and the furrows on either side of the upper lip. Fat injections will last up to 6 months. Additional injections may allow you to achieve a result that lasts up to several years.

Fat injections are performed under local anesthesia, and involve removing fat from one area such as your outer thigh and injecting it into the area you want to modify. Fat removed with liposuction can also be used. Fat injections may result in some swelling and bruising, but discomfort is minimal. Normal activities can be resumed within several days.

**BOTOX**

Botox is an injectable agent derived from the bacterium, Clostridium Botulinum. It works to paralyze muscles and can be used to eliminate wrinkles on certain parts of the face. It is typically used to treat the vertical lines between your eyebrows, forehead lines, and lines at the corners of your eyes (crow's feet). Botox is injected into the muscle using a very fine needle. Usually 1-3 injections are given per muscle. Some patients report minor and temporary discomfort from treatment. A numbing cream can be used if needed. Botox usually will take effect within several days but may take up to 14 days and will last about 3-4 months.

**DERIVALOGEN**

Dermalogen is injectable dermis derived from human donor tissue. It is used in the treatment of fine wrinkles, frown lines, nasolabial folds and lips. It fills in the depressions in the skin leaving smoother, younger looking skin. Multiple treatments are required for optimal results. It can be used by patients that are allergic to Collagen and lasts up to 6 months.

**CONCLUSION**

By this review it was found that there is a significant role of textile fibers and polymers in plastic surgery. The development of inorganic materials for surgical application has produced significant changes in the scope and procedures of operations in plastic surgery.

In case of the polymers used it has been seen that all the polymers are being largely used by the surgeons and all of them are performing well in plastic surgery because of their distinct characteristics. Among all the polymers being used in surgery silicone is the best polymer because of its properties like it can be readily sterilized, it is chemically stable, it is flexible, it is non-wearable, it is inert so, it does not react with other materials to cause allergies etc.

After talking to plastic surgeons and medical representatives of both the private as well as government hospitals it was found that the surgeons are using all the materials successfully and they are quite aware of all the textile products they are using and they are quite satisfied with the materials and also expected new things to come.