COMPATIBLE BIOMATERIALS USED IN ENT PRACTICE – LITERATURE REVIEW

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Abstract. In the last years otolaryngology was influenced by newly developed implants which are based on both, innovative biomaterials and novel implant technologies. Since the biomaterials are integrated into biological systems they have to fulfill all technical requirements and accommodate biological interactions. Aside from all technological challenges the selective organization of the cell-implant interaction is of decisive relevance. The implant may be comprised of polymers, metals, ceramics. In order to stimulate tissue regeneration biodegradable polymers can be utilized. Technical functionality relating to implant specific mechanical properties, a sufficiently high stability in terms of physiological conditions, and good biocompatibility are the demands with regard to suitability of biomaterials. The goal in applying biomaterials for implants is to maintain biofunctionality over extended periods of time. These general demands to biomaterials are equally valid for use in otorhinolaryngology.

Keywords: biomaterials, implants, polymers, otorhinolaryngology

1. INTRODUCTION

Biomaterials are represented by any substance used for replacement and augmentation of natural or synthetic tissues. These are used to replace a part of the body which has lost its functions because of a disease and also as a support in the process of regeneration. The quality of a material used for an implant has to respect two criteria: a biochemical and a biomechanical one. According to the biochemical criteria the applicability of a material is determined by its biocompatibility and strength [1].

An implant material will always be positioned in a lesion and as a result local reactions will be ongoing. The foreign body will be surrounded of a fibrous capsule, which is an indicator of cellular activity. It should be taken into account that any biomaterial will be absorbed to a certain extent depending on the ionic activity of the surface; since the contact area is larger the cellular response to the biomaterial will be of much more importance.

Biomaterials corrosion can lead to the elimination of toxic substances such as nickel, cobalt, chromium causing severe allergic reactions. Therefore the material has to be analyzed depending on the place and where it will be implanted [2]. In reconstructive surgery there are three classes of materials used: metals, polymers and ceramics. They have advantages and disadvantages regarding biocompatibility, integration capability and their applicability in surgery.

2. RHINOLOGIC SURGERY

Several categories of biomaterials are used in rhinologic surgery, such as: autogenous cartilage, homografts, alloplastics. Alloplastics are: silicon, high density polyethylene (Medpor), polyethylene terephthalate (Mersilene) and polytetrafluoroethylene (Goretex).

Normal functionality of the sinus occurs when there is a patent ostium, an ostium which is permanently open and allows sinus drainage. In many occasions after surgery is used a sinus balloon to maintain the ostium open or a stent (frequently used for the frontal sinus recess). The stent may be made of silastic, dacron, gold [3] (Figure 1).

Also in rhinologic surgery, in postoperative period internal nasal splints are used and can be made of silicon, fluoroplastic, providing support and some of them allow postoperative nasal breathing through the integrated septal nasal tubes. Septal buttons which are made of silicon, titanium can be used in septal perforations (Figure 2).

Figure 1. Balloon for sinoplasty
Figure 2. Nasal splint

Chronic dacryocystitis develops secondary to partial or total obstruction of the nasolacrimal duct caused by infection or inflammation. Dacryocystorhinostomy is the best method to treat this pathology using general or local anesthesia. The surgeon creates a connection between the lacrimal sac and nose using a stent to maintain the ostium open as long as possible [4] (Figure 3).

Figure 3. Stent for lacrimal stenosis

In choanal imperforation, the rear region of the nasal passages, is usually blocked by forming abnormal bone or soft tissue membranous; special prosthetics made of silicon can be used [5].

Ozena is a disease of the nose in which the bony ridges and mucous membranes of the nose waste away. Ozena is also called atrophic rhinitis. Several techniques are used for recovery such as implant of acrylic tabs or paraffin [6].

3. OTOLOGIC SURGERY

Serous otitis media is a collection of non-infected fluid in the middle ear. There is usually a clear or straw coloured fluid behind the ear drum. Surgical treatment of chronic serous otitis media may be recommended to reestablish ventilation of the middle ear and keep the hearing at a normal level. Myringotomy (an incision in the eardrum membrane) is performed to remove middle ear fluid, which is drained with a ventilation tube. There are many types of tubes, but all of them serve the same function: they keep the eardrum open, allow air to enter the middle ear space, and permit fluid from the middle ear to drain. Most tubes will gradually be rejected by the ear and work their way out of the eardrum. Tubes will last four to six months in the eardrum before they come out. T tubes do not extrude by themselves. These have to be physically removed. Ventilation tubes can be made of titanium, silastic or tephlon (Figure 4).

Figure 4. Middle ear T-tube

Otosclerosis is a disease of the bones of the middle and inner ear where the ossicles become knit together into an immovable mass. For conductive hearing loss, the surgical procedure is stapedectomy where the stapes is removed and replaced with a prosthetic device. There are lots of models for pistons used for stapedectomy depending on the local anatomy of each patient. The pistons can be made out of hydroxyapatite, polyethylene, tephlon or titanium. Each material has advantages and disadvantages but in time the titanium has proven to be the best choice because is biocompatible, flexible and easily adapted, light weighted and creates a good contact with the middle ear ossicles [7].

Otologic dressings made out of silastic are recommended for temporary sheeting of the external auditory canal due to the lack of adherence to tissue and by that reducing the trauma caused by getting them out. For the reconstructive surgery of the middle ear one can use the ionomeric cement SerenoCem to establish the continuity of the middle ear ossicles, to reconstruct the posterior wall of the external auditory canal, revision stapedectomy or to stabilize the electrode of the cochlear implant to the cochleostoma due to the optimal biocompatibility to metal and bone [8].

PAW1 biovitroceramic is a synthetic bioactive material that contains fluorhydroxyapatite micro crystals and β-wollastonite embedded in a vitreous matrix and it is used due to the osteoinductive feature, being well tolerated without necrosis and foreign body reaction in the surrounding tissues [9].

The BAHA system can offer a solution to people who need hearing amplification but have ear canal problems. This system uses the principle of osteointegration with a small titanium screw implanted behind the ear. A cochlear implant is a small, complex electronic device that can help to provide a sense of sound to a person who is profoundly deaf or severely hard-of-hearing. The implant consists of an external portion that sits behind the ear, a second portion that is surgically placed under the skin and the electrode made out of titanium (Figure 5).
4. LARYNGEAL SURGERY

In laryngeal pathology there are several types of stenosis: posttraumatic, tumoral, iatrogenic. Laryngeal stenting is practiced in laryngo-tracheal trauma with silicone tube, and for the prevention of adhesions, silastic is placed in the anterior commissure. Besides permeation methods, techniques in maintaining the luminal patency are also required. One of the first types of stents used was the Montgomery stent (T-tube) in 1965 (Figure 6).

In addition to the silicone, also metal or hybrid stents occurred but with multiple disadvantages (interference with mucociliary clearance, stent intolerance in subglottis placing, granuloma formation, reduced flexibility in tortuous tracks). The Montgomery stent (T-tube) has the ability to dilate in the presence of the human body heat [10]. Also in hypopharyngeal esophageal strictures and can be applied pharyngeal tube [11].

The medialization is one of the first treatment techniques for the paralysis of vocal cords. When the vocal cords are not close phonation is not achieved, then the space between them (glottis) remains open. For the vocal fold phonatory functions, vocal cords must come into contact and then the paralysed vocal cord has to be medialized. This can be done with a Gore-Tex implant, silastic, titan which is inserted into the vocal cords to support them [12].

There are recommended materials for injection into the vocal cords in treating congestive glottis. Intracordial injection of different materials (PTFE) was firstly used by Brunings in 1911. He used paraffin, but this leads to the phenomenon of paraffin granuloma, so that was abandoned. Arnold was the first to use tephlon in combination with glycerin in the treatment of this type of paralysis. The temporary materials may be: bovine gelatin, products based on collagen, hyaluronic acid, carboxymethyl cellulose; permanent materials can be: fat, dacron, calcium hydroxyapatite, polydimethylsiloxane (Figure 7).

Intramuscular injections can be practiced (cricoarytenoidian tiroarytenoidian or posterior), bilateral botulinum toxin (type A), guided by electromyography. Injections have a chemical denervation effect of the flaccid muscle paralysis and can be repeated after 3-6 months and require phoniatic treatment to extend this period [13].

5. CONCLUSIONS

In conclusion, several criteria must be met before performing an implant in the human body (the biomaterial one, a preoperative preparatory plan, a well-established operative technique and postoperative follow-up). Different classes of materials can be used as biomaterials. Polymer materials are best tolerated within otorhinolaryngology. It is essential that any type of surgery performed preserves the organs' function as long as possible. Increased knowledge in the field of biomaterials result in the development of several innovative materials and simultaneously emphasizes the importance of collaboration between engineering and medicine.

6. REFERENCES


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