

The use of collagen-coated polypropylene meshes for nasal reconstructive surgery

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REZUMAT – ABSTRACT

Utilizarea plaselor din polipropilenă acoperite cu colagen pentru chirurgia reconstructivă nazală

Chirurgia reconstructivă a peretelui abdominal și toracic utilizează frecvent diverse materiale pentru a repara defectele mari. Plasele din polipropilenă sunt un exemplu. În chirurgia reconstructivă nazală sunt rar folosite pentru restaurarea cartilajelor.

Scopul acestui studiu este de a demonstra utilitatea plaselor din polipropilenă acoperite cu colagen în chirurgia reconstructivă nazală, deoarece acestea sunt materiale ușor de utilizat, cu o incidență redusă a reacțiilor la corpul străin și cu un preț foarte mic comparativ cu al altor produse.

A fost efectuat un studiu privind utilizarea plaselor din polipropilenă acoperite cu colagen, care include, de asemenea, o comparație cu alte tipuri de materiale utilizate pentru reconstrucția cartilajului nazal. Mai mult, a fost efectuat un studiu retrospectiv asupra pacienților spitalizați în Departamentul de Chirurgie Plastică al Spitalului Clinic de Urgență din București.

Cea mai bună opțiune și, în același timp, standardul de aur pentru reconstrucția cartilajului nazal este considerat a fi transplantul de cartilaj autolog. În clinica noastră am observat rezultate bune atunci când s-au utilizat grefe de cartilaj autolog septal sau auricular.

Polipropilena este rar utilizată în chirurgia reconstructivă nazală, fiind efectuat, până în prezent, un număr restrâns studii privind beneficiile și dezavantajele acestei materii prime la fabricarea de dispozitive medicale pentru implanturi nazale.

Plasele din polipropilenă sunt utilizate pe scară largă în reconstrucția peretelui abdominal și în chirurgia pentru prolapsul organelor pelvine. În acest domeniu chirurgical, se utilizează și plasele din polipropilenă acoperite cu colagen, însă studiile viitoare vor demonstra dacă acestea sunt suficient de eficiente și în chirurgia reconstructivă nazală.

Cuvinte-cheie: plase, colagen, cartilaj nazal, chirurgie reconstructivă

The use of collagen-coated polypropylene meshes for nasal reconstructive surgery

Reconstructive surgery of the abdominal and thoracic wall frequently utilizes various materials in order to repair large defects. Polypropylene meshes are an example. In nasal reconstructive surgery they are rarely used for cartilage restoration.

The purpose of this paper is to demonstrate the utility of the collagen-coated polypropylene meshes in nasal reconstructive surgery, as they are easy-to-use materials, with reduced incidence of foreign body reactions and with a very small price compared with other compounds.

We conducted a literature review on the usage of the collagen-coated polypropylene meshes which also includes a comparison with other types of materials applied for nasal cartilage reconstruction. Moreover, we performed a retrospective study, on the patients hospitalized in the Plastic Surgery Department of the Clinical Emergency Hospital, Bucharest.

The best option and in the same time the gold standard for nasal cartilage reconstruction is considered to be autologous cartilage transplantation. In our clinic we observed good results when autologous septal or auricular cartilage grafts were used.

Polypropylene is seldom used in nasal reconstructive surgery, having been conducted so far, a limited number of studies related to benefits and disadvantages of this type of material in the accomplishment of the medical devices used as a nasal implant. Polypropylene meshes are largely used in abdominal wall reconstruction and in the surgery for pelvic organ prolapse. In this surgical field, collagen-coated polypropylene meshes are also used, but future studies will demonstrate if they are effective enough in the nasal reconstructive surgery as well.

Keywords: nets, collagen, nasal cartilage, reconstructive surgery

INTRODUCTION

Nasal cartilage reconstruction still remains a challenge for every plastic surgeon. The nose, an aesthetic unit of the face, located central, has a great aesthetic value for patient's life quality with a considerable social impact. Furthermore, it has its own respiratory and phonetic roles [1].

Nasal reconstruction is performed in several phases, depending on the type of defect. It is important to take into consideration the anatomical features of the nose with the purpose of restoring the cutaneous, cartilaginous and osseous layers, but also the nasal mucosa in order to preserve the functionality and to create an appearance as close as possible to the patients' expectations [1].

Nasal cartilage reconstruction can be achieved with using autologous or allogenic grafts, either synthetic or biologic. For abdominal or thoracic wall reconstruction, polypropylene meshes are largely used currently while there are also numerous studies regarding the use of collagen-coated polypropylene meshes in this type of surgery [1].

THE PURPOSE OF THE STUDY

The purpose of this literature review is to demonstrate the adequacy of collagen-coated polypropylene meshes in nasal reconstructive surgery, as they are easy-to-use materials, with reduced incidence of foreign body reactions and with a very small price compared with other compounds.

Moreover, we performed a retrospective study, on the patients hospitalized in the Plastic Surgery Department of the Emergency Clinical Hospital, Bucharest, in order to establish the feasibility of alternative methods such as the reconstruction with allogenic materials.

MATERIALS AND METHODS

We conducted a review of the relevant literature on the use of collagen-coated polypropylene meshes for nasal cartilage reconstruction and includes as well a comparison between this type of material and others. Each compound is studied in terms of its structure, purpose/indications and possible complications.

The retrospective study was conducted on 110 patients from the Clinical Emergency Hospital Bucharest, department of Plastic Surgery and Reconstructive Microsurgery over the period 2012–2013.

We applied simple correlations to the factors involved in the study, followed by outlining the significant results. Thereafter, the results were statistically analysed and explained in the charts and tables below.

RESULTS

Biomaterials

Biomaterial is a term used for describing a substitute of different tissues or a tissue defect enhancer, being either a natural or a synthetic substance with the aim of making a diagnostic or a treatment [2–3].

Macroscopic properties of an ideal biomaterial are: to be compatible with the tissue that will eventually be replaced, to be nonresorbable over time, not to migrate from the original implantation site, to be easily removed in case of complications such as infections or necrosis, to be cheap [3]. The ideal biomaterial should be flexible and readily accessible [4], resistant to sterilisation and infection [5], unable to pass on any disease, non-carcinogenic, biocompatible. In addition, the foreign body reaction and surface contamination should be minimum [6].

Nasal reconstruction requires, besides the aesthetic aspect, the improvement of functionality, thus maximising results. The biomaterials used in nasal reconstruction should provide a natural, aesthetic result, therefore increasing patient's satisfaction [2].

The implants used for nasal reconstruction

In order to be used as a replacement for nasal cartilage, biomaterials should have several specific properties. The functionality and the aesthetic aspect of this face unit are paramount, with a tremendous emotional impact on the patient, affecting his life quality in a significant manner.

The meshes allow to be embedded in the surrounding tissues, can be easily reshaped, are more smoothly inserted at their predefined location and reduce the infectious risk. Their pores can have various sizes and their composition is adapted as to be compatible with the host [1, 7].

Autologous cartilage

Autologous cartilage is the ideal cartilage to use for nasal reconstruction, as currently indicated by the relevant literature figure 1 [1]. They also have some disadvantages, owing to the donor site morbidity, the limited amount of tissue and the rise in surgical time [8].

Autologous cartilage is most frequently harvested from the nasal septum, the auricle and the rib [9]. The nasal septum

graft is preferred if there is enough tissue to be harvested, because it shares the same location with the initial/nasal surgical field and due to its resemblance with the adjacent nasal cartilages [2].



Fig. 1. Auricular cartilage [1]

Alloplastic materials

The silicone (polydimethylsiloxane) was widely used in the past for facial reconstruction such as for augmentation of dorsum nasi, but with progressively fewer indications in present. Unfortunately, it creates a dead space between the implant and the surrounding tissues, it gets more easily infected and has a greater risk of extrusion, migration, calcification and inflammation [10].

The silicone is found in a liquid or gel state and as rubber [11]. The former is responsible for a cellular response similar to the foreign body reaction (giant cells with silicone inclusions, surrounded by neutrophils, plasmocytic and lymphocytes) [12].

Polypropylene nets (eg. POLYPROPYLENE MESH) are widely used in the abdominal and thoracic wall reconstruction surgery, but there are few studies concerning their use in nasal cartilage reconstruction [13].

These are nonresorbable materials that trigger a minimal and self-limited inflammatory reaction, embedding the mesh into the surrounding tissue [14]. The polypropylene is also used for utero-vaginal reconstruction, facial reconstruction and for several endoscopic procedures [14].

Dacron (polyethylene terephthalate (PET)) is used in general surgery for hernia repair, as suture material, as vascular prosthesis, in thoracic wall reconstruction and for chin and nose augmentation. It is biocompatible, flexible and nonresorbable [15].

Mersilene (polyethylene terephthalate) is used in reconstructive surgery and as part of arterial prostheses as well. PET is used in abdominal and thoracic wall reconstruction, but also for genioplasty – facial augmentation [16], head and neck surgery [17]. In addition, it is used for dorsum nasi augmentation [18]. Mersilene was mostly abandoned in favor of **Gore-tex SAM (subcutaneous augmentation material)** [2]. So far, it has proven to have good aesthetic results for temporal fossa reconstruction and few complications, including implant extrusion or exposure and infection. Moreover it is cheap, it can be easily folded and it restores the defect to its natural appearance [19].

Medpor (high-density porous polyethylene) is biocompatible, nonresorbable, resistant to stress [20], it allows osseous and soft tissues growth, has a small rate of infection and generates few foreign body reactions [21]. The most frequent complications quoted in the relevant literature regarding this type of mesh are: lateral displacement of the implant, fistula or abscess formation, implant extrusion and infection. [1, 22]. Medpor is used for malar and chin augmentation [23].

Polytetrafluoroethylene (Teflon, Gore-Tex) is used in facial reconstruction, rhinoplasty or dorsum nasi augmentation [2]. PTFE creates a fibrous tissue layer attached to the bone, but does not ensure structural support [24] and can also induce a foreign body reaction [5]. Gore-Tex is extensively used in vascular surgery [25], for chin augmentation and in corrective rhinoplasty [26] with an impressive biocompatibility [25]. Gore-Tex is employed with excellent results by general and vascular surgery [18]. It generates a rather modest host immune response, has good biocompatibility with reasonable costs [27]. Gore-Tex is used to manage a wide variety of nasal defects with exceptional results [28].

Biological materials

Collagen

The collagen is a structural protein found in animals [29]. Its structural unit is called triple helix [29]. The materials produced using collagen triple-helices elongated fibrils are currently widely used throughout the biomedical science and nanotechnologies [29].

Regenerative medicine and nasal cartilage reconstruction

Regenerative medicine makes use of biomaterials, growth factors and stem cells in order to repair, replace or regenerate tissues and organs [9]. Currently, tissue engineering is headed towards developing implantable biohybrids formed from biodegradable matrices in combination with in vitro cell cultures as a regenerative strategy [30]. Autologous cartilage grafts obtained from tissue engineering allow the safe reconstruction of the alar lobe with excellent functional results [31].

The retrospective study

The retrospective study took into account 18 factors and measured the incidence of each one. It is important to determine the adequacy of alloplastic materials for nasal cartilage reconstruction.

Table 1

THE INCIDENCE OF THE ANALYSED FACTORS IN PATIENTS WITH POSTTRAUMATIC OR POSTEXCISIONAL NASAL DEFECTS [1]			
Factor	Type of factor	No. of cases	% cases
Type of reconstruction	Closure by secondary intention	10	9,09
	Primary suture	56	50,9
	Graft STSG + FTSG	8	7,26
	Various flaps	7	6,35
	Nasogenianflap	14	12,72
	Free transfer	3	2,72
	Other flaps	8	7,25
	Total rhinoplasty	3	2,72
Complications	Koenig graft	1	0,90
	Yes	9	8,18
Comorbidities	No	101	91,81
	Yes	29	26,36
Defect depth	No	81	73,63
	Tegument and subcutaneous tissue	79	71,81
	Cartilage damage	7	6,36
Concomitant lesions	Nasal bones	24	21,81
	Yes	32	29,09
	No	78	70,90

Posttraumatic and post excisional defects reconstruction depended on the type of defect, its location and other concomitant lesions in a statistically significant proportion. The emphasis was put on maximising the good results and minimising the postoperative complications thus increasing patient's satisfaction and improving their life quality.

Composite grafts with autologous cartilage in their structure were seldom used, in selected case. Only one Koenig graft (0,90%) was used.

According to the figure 1 only 7 patients (6.36%) had cartilage defects as well, which is a very small percentage from the total number of cases. Most of them were addressed by direct suture of the nasal cartilages (figures 2, 3).

Polypropylene meshes and collagen-coated polypropylene meshes

Yucebas K. et al used polypropylene meshes for nasal perforations in laboratory rabbits. This material generates a small amount of fibrosis and a limited foreign body reaction with a very high biocompatibility in nasal cartilage reconstruction [32]. Simple

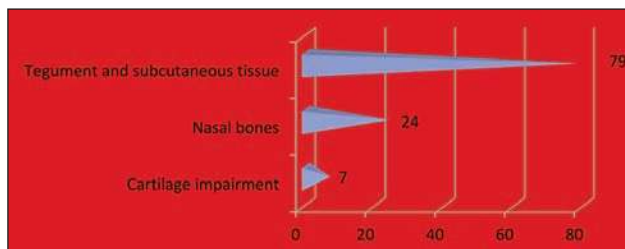


Fig. 2. Depth of the defect among included patients [1]

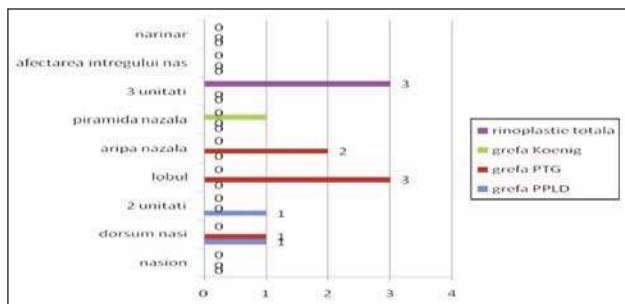


Fig. 3. Types of nasal reconstruction according to defect location [1]

polypropylene meshes and collagen coated-polypropylene meshes are used in abdominal wall reconstruction with impressive results [33].

Goulart F. et al. studied highly purified collagen-coated polypropylene meshes in rat models and demonstrated their capability to modulate angiogenesis and some immune metalloproteinase-mediated reactions at the implant site. These may be used for pelvic surgery [34], but also for nasal reconstructive surgery.

Collagen-coated polypropylene meshes implanted intraperitoneally, may reduce the risk of visceral adhesions. An experiment was performed using polypropylene meshes with a collagen coating. The collagen was extracted from laboratory rats using acetic acid. The results exceed expectations, with very few complications and a very good biocompatibility [35]. These meshes are used with a low incidence of adhesions and with an excellent biocompatibility for laparoscopic abdominal wall defects [36]. Polypropylene meshes provide good mechanical resistance and are largely used for abdominal wall defects and pelvic organ prolapse. The inflammatory response is diminished considerably if biological matrices are used, such as the ECM (extracellular matrix) hydrogel-coated polypropylene mesh [37]. The Proceed ventral patch used for umbilical hernia repair generates tissue adhesions which involve parts of the intestine, outnumbering the Parietex and Ventralex variants. Parietex and Ventralex on the other hand, will be covered in a mesothelial shell as a response to their presence, resulting in minimal formation of adhesions [38].

Fibroblast or mesenchymal stem cells (MSC) coated Parietex (polyester) mesh, SoftMesh (light-weight monofilament polypropylene), TIGR (polylactide composite mesh) or Strattice (porcine skin-derived collagen) are some types of mesh studied and used

today. The cellular coverage of the mesh may influence the biocompatibility and may become a key aspect in refining their properties, figure 4 [39]. The meshes can also be coated with human dermal fibroblasts (HFs) or with normal rats' kidney (NRK) cells or with rat's mesenchymal stem cells (MSCs). These coated meshes, either synthetic or biologic, modulate the host immune response and therefore enhance their adaptability [40]



Fig. 4. Collagen-coated polypropylene mesh

CONCLUSION

The best option for nasal cartilage reconstruction is the use of autologous cartilage, which represents the gold-standard for nasal cartilage reconstruction. Regarding corrective rhinoplasty, where the amount of autologous cartilage is limited, the allogenic implants are employed/used with good results [41]. The silicone is used to augment dorsum nasi and the columella [41]. Porous high-density polyethylene (Medpor) may ensure an important structural support [41]. These implants are seldom used due to their high incidence of complications: implant extrusion or infection [42]. Medpor is also used in trauma surgery and not just in rhinoplasty [43]. Mersilene (polyethylene terephthalate) is used for volume correction in nasal reconstruction; though it cannot be used for structural support [44]. Gore-tex is most frequently used for chin augmentation [45], for dorsum nasi or lateral walls augmentation, premaxillary graft, lobule or supralobule [42].

Polypropylene is an affordable synthetic material, easy to implant, with a wide availability and flexibility, being found in different and numerous forms. Its use in nasal cartilage reconstruction is currently, a subject of great interest.

Collagen-covered polypropylene meshes are used nowadays internationally for abdominal and thoracic wall reconstructive surgery and for pelvic surgery. As a consequence, this material has the potential to be implemented in cartilage reconstruction as well.

As we have already noticed, there are too few patients in our clinic who need cartilage reconstruction which is usually achieved with only autologous auricular or septal cartilage graft. As such, the small number of cases and the possibility of autologous transplant obviate the necessity of alloplastic materials.

However, if we take into account the low incidence of complications at the donor site and the reduction in the time of surgery, particularly for patients in poor condition, we stress the need for future studies in

order to establish the adequacy for the introduction of alloplastic materials in the current reconstructive techniques.

Polypropylene is rarely used in nasal reconstructive surgery with few studies on its benefits and disadvantages as a nasal implant. Polypropylene meshes

are widely used in abdominal wall reconstruction and pelvic prolapse surgery [46]. Collagen-coated polypropylene meshes are used as well in these surgical fields, but future studies will determine if it can really be confirmed as a practical and durable solution in nasal reconstructive surgery.

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