

Main problems of the septal surgery

In traditional sub-mucous septum resections the most bothering deformed sections of the cartilaginous and osseous septum framework were removed. Many a times, it was the removal of the supporting parts putting the surgeon in a difficult situation: either leave the deformities untouched, what rendered functional results unsatisfactorily; or try to remove more cartilage from these areas, what lead to significant cosmetic changes of the saddle nose and retraction of the columella later on.

In addition, post surgically, an important part of the septum consisted of blades of mucous membrane only, what caused vibrations when inhaling or exhaling deeply. Furthermore, unwanted complications developed frequently, especially perforations of the septum. On account of the disadvantages portrayed above a new surgical method has step by step removed the hitherto existing septum resection from the nineteen fifties on: septoplasty. This development was not always an easy one and frequently accompanied by conflicts; today however, we regard septum resection as obsolete.

Not all septal deformities can be corrected with a conventionally septoplasty. For the uncompromising straightening of these so called "difficult septums" the advantages of septoplasty are not so evident. The problem scilicet is that the surgical manipulations used to straightening, e.g. serial incisions, crushing, island formation, etc. weaken the cartilage mechanically, and thus it loses its supporting function.

In the last forty years surgical solutions were aimed for which allowed correcting both of cosmetic and functional deformities in one session also

in case of “difficult septum”. Such surgical techniques were published under synonymous names, e.g. full septum reconstruction, extra corporal septal reconstruction. The concept of this surgical solution is, that even a massively deviated septum is composed of individual parts, which are in itself straight; this then gave rise to the idea that the deformed cartilage could be dissected into its small straight sections and a straight septum be reconstructed with these.

However, even the introduction of the extra corporal septoplasty failed to be the perfect solution for the correction of a difficult septum. The intervention remained a unique surgical technique, performed only by a few very experienced surgeons; because the deformed septum cartilage had to be segmented into several smaller sections, thereafter it was rather technically complex and time consuming to retain the sutures. The hyaline cartilage is extremely difficult to stitch end to end because the fragments retained in such a way snap off easily under stress and shift.

Compound graft makes the extra corporal septoplasty easy

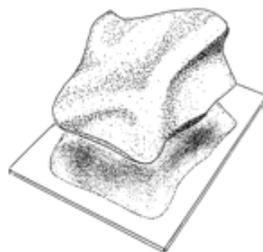
Like any other surgeon, I have had problems performing the extra corporal septoplasty. In the end the fixation of the 6-7 smaller and larger cartilage fragments was never satisfying. Not only the operation time has been prolonged by one hour on average, but I never was completely convinced that the mechanical quality of the cartilage graft was going to be sufficient to support the nasal dorsum. Despite meticulous suturing of the cartilage fragments a slight saddle deformity occurred almost in all cases 6 months after surgery.

In a search for a better solution it came to my mind that we had successfully used an alloplastic material, Polydioxanone (PDS), to correct posttraumatic deformities of the orbital floor. The PDS foil can bridge the bony defect and supports the eye ball until it will be fixed at the callus. After a few months the implant degrades and is resolved from the body.

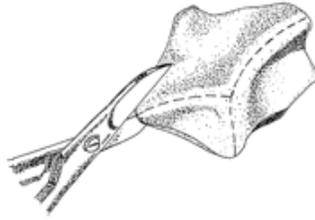
The situation in extra corporal septal reconstruction is similar, and it seems to be an advantage to support divided fragments of cartilage, as long as solid tissue formation eventually ensues in order to strengthen the nasal dorsum.

PDS or polydioxanone (produced by the Ethicon Company, Norderstedt, Germany) is degradable by hydrolysis and completely resorbed by the body, thus excluding the long-term complications of other artificial implants. PDS foils are available in various sizes and gauges, serves as carrying material. The trimmed fragments of the removed septal cartilage can be fixed to the foil by PDS suture material easily.

The herewith created graft, consisting of autologous cartilage and the PDS foil, was called by me as „Compound Graft“. The main steps to build a compound graft are:



The removed septal cartilage is copied onto the foil to determine the exact size of the needed graft



The cartilage is divided into its straight pieces



The cartilage fragments are sutured to the PDS foil

Aims and Hypothesis

After searching the literature, no data could be found concerning the biological properties of PDS foil in combination with hyaline cartilage. Therefore we started two series of animal experiments with young rabbits. We wanted to investigate the following questions concerning the healing process:

1. How long remains the continuity of the implant unchanged?
2. How long takes the resorption procedure?
3. Remains the form stability and the continuity of the implant as long as the healing process of the supporting tissue is finished?
4. Which kind are the side effects (inflammatory or foreign body reaction), occurring whilst the resorption procedure?

5. How many scar tissue remains after resorption in the implantation area?
6. Is there a modification of the cartilage underneath the foil, or at the border of the cartilage defect?
7. Is the PDS-Foil a guideline for regenerated cartilage ?
8. Is the PDS-Foil able to prevent overlapping of cartilage fragments ?
9. Is there an effect on the histological properties of the new formed cartilage ?

At the first study 5 rabbits aged 4 weeks have been operated on under general anaesthesia. A PDS foil has been implanted in combination with cartilage into the outer ear.

In the second group we studied the influence of the most typical surgical manipulations (the elevation and reposition of the mucoperichondrium, the excision, the excision and reimplantation of crushed and non crushed septal cartilage) on growing septal cartilage in 40 New Zealand White female rabbits. A 10x10mm piece of cartilage was resected, manipulated and reimplanted, with and without PDS foil.

The animals were sacrificed 2, 4, 10, 16 and 25 weeks after surgery. For histologic examinations the specimen were resected, fixated in 5% formaldehyde and cut in serial sections with 4µm and stained with HE and PAS.

Up to the 10th week after the implantation the foil remained untouched from degradation and the continuing form stability enabled the desired supporting function. If the foil was implanted subperichondrial directly covering the cartilage thin reactive tissue, forming a pseudo capsule.

The PDS foil inserted on one side of the cartilage causes no significant inflammatory and foreign body reactions and after 25 weeks after complete resorption of the foil almost no fibrous scar tissue could be found, thus excluding unilateral scarring, which can lead to postoperative deformation and bending of the septal cartilage, as well as persistent postoperative thickening of the septum.

The elevation of the mucoperichondrium does not induce significant histological reactions and has no affection on the growth of the septal cartilage.

After cartilage resection the regeneration occurs and forms a bridge between the anterior and posterior fragments of the original cartilage. But even after 25 weeks this new formed cartilage remains histologically different from the original cartilage with smaller chondrocytes and without any columnar arrangement. This type of cartilage has a tendency of bending, causing secondary septal deviations. The insertion of a PDS foil after cartilage resection which covers the area of the cartilage defect seems to work as some sort of guiding material for the regenerated cartilage. This helps significantly to decrease the secondary deviation of the new formed cartilage. It even seems to have an effect on the histological appearance of this regenerated cartilage, because in some specimen we could find no difference between the original and regenerated cartilage.

After resection and reimplantation of the original septal cartilage as a free graft, there is always a tendency of overlapping and angulation between the original septal cartilage and the graft. The specimen with PDS foil showed significantly less secondary deviations, and in some specimen even the cut edges could not be identified after 25 weeks.

After implantation of crushed cartilage grafts secondary deviations occur as a result of bending of the cartilage graft itself. This bending can be reduced significantly by combining the crushed cartilage with a PDS foil.

Extra corporal septoplasty with Compound Graft

Surgery can be performed under local- or general anaesthesia. We usually start with a broken columella incision followed by marginal incisions for an external approach, which is very appropriate in case of an extra-corporal septoplasty. If surgery is performed under general anaesthesia, a mild controlled hypotension is recommended. Local infiltration of the inner and outer nose is the same (without nerve blockage) because of the need for vasoconstriction.



The next step, as usual in an external approach is the decollement of the skin and the soft tissue over the tip, the cartilaginous and bony dorsum in the right surgical plane.



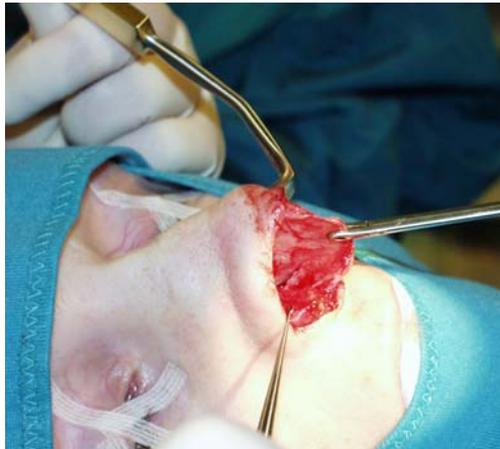
After separation of the medial crura of the lower laterals, we reach the caudal end of the septum.



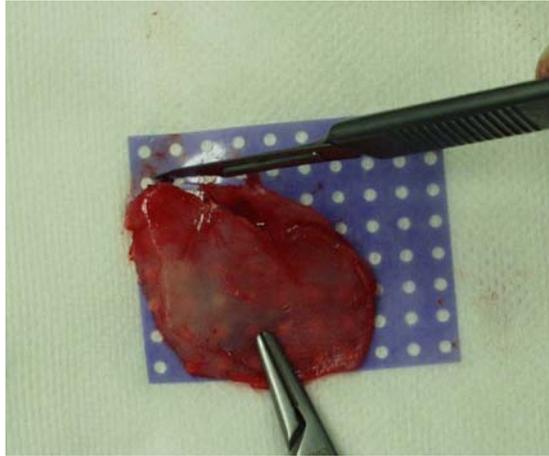
Starting from here the mucoperichondrium is dissected free on both sides.



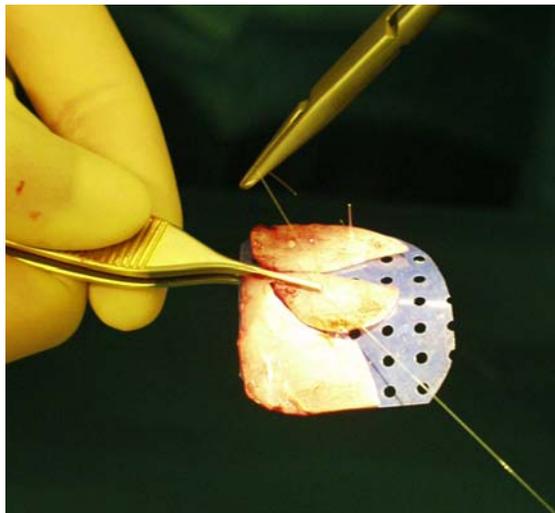
After a posterior chondrotomy the upper laterals are separated from the septum. After detaching the septal cartilage from the maxillary crest and the vomer the septal cartilage is completely free and can be removed in one piece.



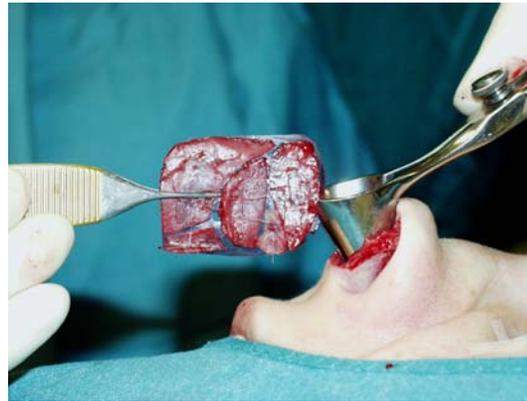
The removed cartilage is used as a template for cutting the foil. It is placed on the foil, the outlines of the removed cartilage are copied onto the PDS foil in order to determine the exact size of the septum to be reconstructed.



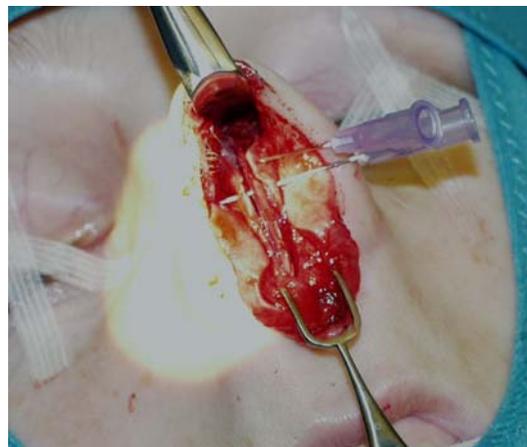
The foil is cut along marked lines, and the deviated cartilage can now be separated into straight pieces. These pieces are arranged upon the foil, and they are sutured to the foil with PDS suture material, usually 6/0.



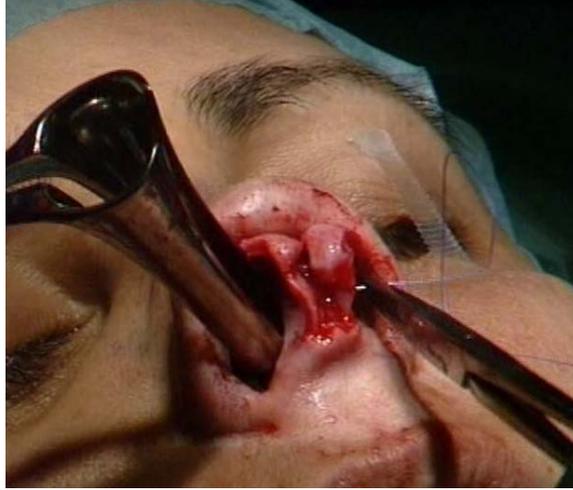
After correction of any possible deformities of the perpendicular plate and vomer, the reconstructed part of the septum, now combined with the PDS-foil,



is placed between the two layers of septal mucosa and adjusted to the correct position:.



In order to hold the graft in place, it is fixed with PDS sutures to the upper laterals, in the K- area, and to the periosteum of the anterior nasal spine. Afterward a series of continuous trans-septal through- and through sutures is positioned to fix the septal flaps, thereby closing all dead space and firmly stabilising the septal component.



This mattress suture also prevents septal haematoma, therefore endonasal packing is not required. Subsequently, the medial crura of the lower laterals are sutured over a columellar strut to maintain tip projection .



In addition depending on the deformity, all the other well known steps of rhinoplasty as trimming of the lower laterals, tip suturing or osteotomies are performed. However, this is not further explained because it is not the topic of this thesis,.

After meticulous closure of the skin incision with nylon 6/0 the nose is dressed from outside with a Denver splint .



The external fixation is removed on the 6th day together with the columella sutures.

As a matter of routine, patients receive antibiotic prophylaxis (e. g. with an amoxycillin) over a three day period. For local follow-up treatment, patients use a spray of saline solution.

Clinical experiences

The good results of the histological examination have been verified undoubtedly by the good clinical experiences. Up to now, we have used this technique in 397 cases. Starting from the original utilisation, the technique has been further developed, in using the PDS foil in combination with conchal ear cartilage. This turned out to be a great advantage, because only with this combination it is possible to create a stable cartilaginous septum with only with conchal cartilage. Therefore the harvesting of rib cartilage is not absolutely necessary.

We have never to date seen an acute or chronic complication as a consequence of the usage of PDS foil. We have never seen allergic reactions or rejection of the foil either. There was no local necrosis or infection. The compound graft proved to be stable enough to support the cartilaginous part of the nose. The only postoperative saddle nose did not occur due to the instability of the compound graft, but because of postoperative nasal trauma.

The cosmetic results happened to be convincing and stable, even years after surgery these remain satisfying.

The fundamental surgical goal, creating a straight nasal septum could be achieved in all of the cases. With regard to the improvement of nasal breathing the success rate was similar from a patient's viewpoint, also supported by rhinomanometry.

With further development of the technique and more routine we were able to decrease the inconveniences for the patients in postoperative time. Due to special suture techniques we could forgo any postoperative nasal packing. For three years 95 % of all cases have been operated in day care surgery without any negative consequences.

The utilisation of PDS foil during septal surgery seems to be an applicable method to facilitate external septal surgery, to correct several combined nasal deformities such as posttraumatic and iatrogenic irregularities and it helps to avoid postoperative saddle deformities with certainty, with no risk whatsoever for the patient.

Candidat's new findings

1. The PDS foil implanted in the nasal septum stays unchanged for ten weeks.
2. After 25 weeks the PDS foil will be completely resorbed.
3. Up to complete resorption no inflammatory or foreign body reactions occur. After elimination of the foil no remarkable scar tissue stays behind.
4. The foil represents a guideline for the cartilage regeneration and stabilises the cartilage fragments. It prevents overlapping and secondary deviations of the operated septum.
5. The PDS foil or its degradation products seem to have a conductive effect on cartilage regeneration and cartilaginous wound healing.
6. The utilisation of PDS foil makes the extracorporeal septal reconstruction technically easy and quick.
7. The implanted PDS foil gives a stable mechanical support for the nasal dorsum and prevents iatrogenic saddle deformity and columella retraction.
8. The connective tissue which is built up until the resorption procedure of the PDS foil begins, is stable enough to fix the cartilage fragments.
9. The utilisation in more than 350 surgeries did not cause any surgical complications, like inflammatory reaction or rejection of the foil.
10. The PDS foil with cartilage, the so-called Compound graft, seems to be a very successful method to correct the severe septal deformities, the "difficult septum".

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Impact factors:

4.144

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2. **Boenisch M.**, Septal reconstruction with polydioxanone plate (PDS), Summer Meeting European Academy of Facial Plastic Surgery, Bonn, Germany, June 12-14, 1998
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20. **Boenisch M.**, Upper lid Blepharoplasty. 6th European Congress of Oto-Rhino-Laryngology Head and Neck Surgery, Vienna, Austria, June 30th-July 4th ,2007