Longterm Results after Implantation of Different Lyophilized Bones & Cartilage for Reconstruction in Craniofacial Surgery

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INTRODUCTION

Since craniofacial surgery has existed autologous bones like ribs or iliac crest have been used for all purposes of reconstruction. Calvarial bone usually split by an oscillating saw was later used and is still considered the material of choice for this kind of work. Homologous tissues of bone or cartilage have not been used to our knowledge in craniofacial surgery during the last 10 years.

Having used homologous lyophilized cartilage (lyocartilage) in maxillofacial surgery since 1960 in the Department of Maxillofacial Surgery of the University of Zurich with excellent results (Sailer 1983) we have introduced the material in 1980 also for craniofacial reconstruction as well as also lyophilized bones (lyobones) of different sources according to our own method. The results achieved are presented in this publication.

OUR METHOD:

1. Lyophilization

The method is based on our experiments performed at the Royal College of Surgeons of England where different homologous and heterologous cartilage preparations were examined in animal studies with monkeys (Sailer 1983). The experiments showed that cartilage prepared according to our procedure trasforms into bone after a transitional period of calcification.

During rehydration of the material usually an antibiotic solution of Streptomycin and Penicillin is used; the antibiotics are absorbed by the material which acts as an antibiotic deposit after grafting.

The material is very resistant against infection and can also be implanted into an infected area: In craniofacial fractures with infected frontal sinuses and further development of chronic epidural abscess formation it can directly be grafted into the revised sinus for obliteration and onto the dura for calvarial reconstruction (Sailer and Grätz, 1991); it is also possible to use an antibiotic solution of choice for rehydration according to a preoperative antibiogramme.

Whereas lyophilized cartilage has been used by us for more than 10 years for craniofacial reconstruction, lyophilized bone has been produced and used according to the same method since 1987.

2. Sterilization

Lyophilisation is a method of desantigenisation but not of sterilization. Therefore the lyophilized tissues have to be sterilized. We use ethylenoxide. After sterilisation a degassing process for ethylenoxide gas elimination follows. Gas sterilisation preserves the physical properties of the biological materials in contrast to irradiation.

3. Donor selection

We use exclusively material of young donors not older than 30 years of age. They are usually victims of traffic accidents. Donors with infectious diseases such as HIV, hepatitis and others are excluded in spite of the fact that gas sterilisation and the whole processing of the material eliminates these viruses as well as bacteria. The young donor age on one hand and a careful family history on the other should also exclude slow virus diseases, for instance Creutzfeldt-Jakob. Possible donors who have shown neurological symptoms in lifetime have therefore to be excluded.

4. Donor regions

Principally all parts of the skeleton may be used as donor materials. On a routine base we take calvarium, ribs, sternum, iliac bone, femur, all rib cartilage and if possible mandibular bone.

RESULTS

Lyocartilage

In the period between 1972-1990 lyophilized cartilage was grafted more than 4000 times into 2666 localisations of the cranio-maxillo-facial area. The overall infection rate was less than 1%. In the cranial area, i.e. cranial base, orbits, cranial vault, zygomatic and temporal area we have never seen an infection, even then when the material was grafted into a massively infected frontal sinus (Sailer and Grätz, 1991); in the maxillo-facial area the infection rate is slightly higher, caused by pressure ulcers in the oral cavity.

Lyocartilage is transformed into autologous bone; this process is usually visible in the x-ray depending on the projection. In infants and young children calcification occurs faster (Fig. 1) than in adults (Fig. 2).

The material is ideal not only as a filling substance but also as an onlay graft (Fig. 3)

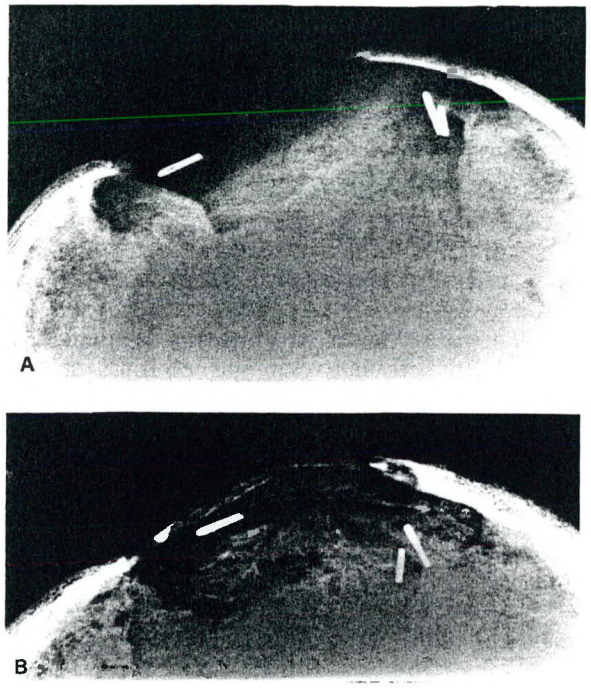


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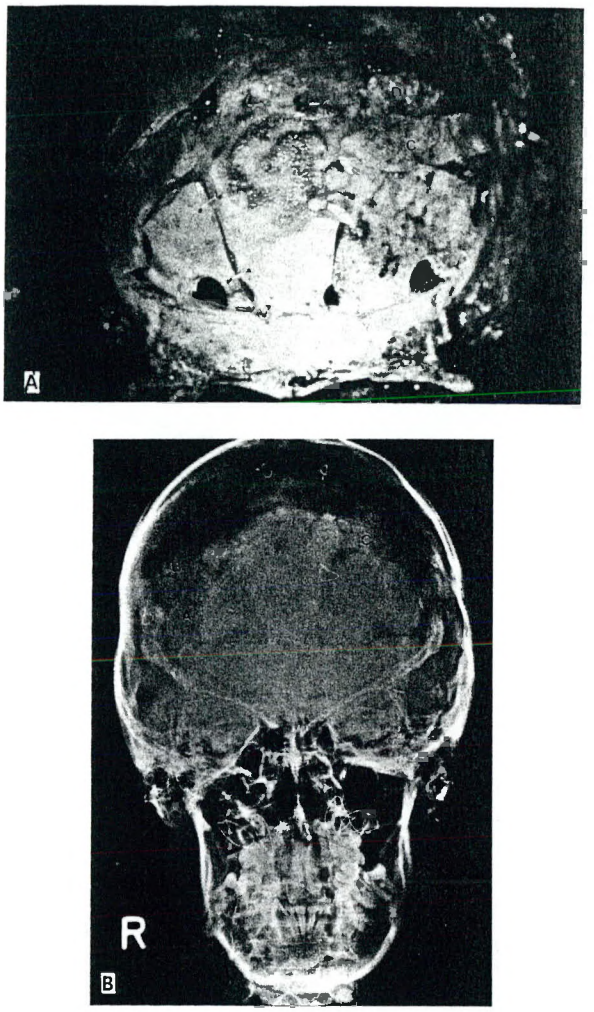


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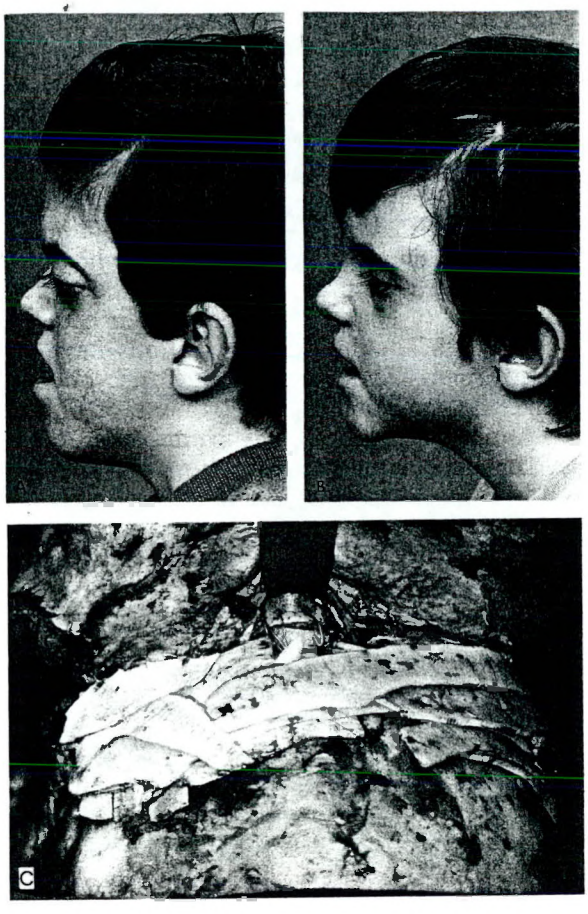


Fig. 3 A,B,C: Case of Crouzon's disease where a Le Fort III - Osteotomy without craniotomy was performed: The preoperative profile shows the typical signs of the syndrome **(A)**, the postoperative profile **(B)**, the normal appearance of the eye region, the midface and the supraorbital and forehead region; this result would not have been possible without frontal advancement but is was achieved by massive onlay grafting of lyocartilage **(C)** to the forehead area.

because of its very small resorption rate.

It is highly superior to autologous bone in this respect which usually resorbes between 70 and 100%.

Overcorrection of lyophilized cartilage reconstructions is thus not necessary. Calcification and ossification occurs also in the soft tissue bed, f.i. in the nose (Fig. 4).

Lyobone

From 1987 on we have used lyophilized bone in craniofacial surgery for reasons of stabilization in the frontonasal, zygomatic, calvarial area and in the lateral orbital wall region.

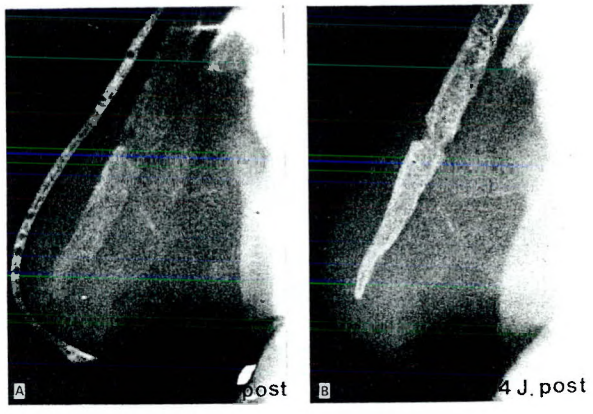


Fig. 4 A,B: Lyocartilage in the soft tissue bed of the nasal dorsum in a cleft palate patient: The lateral x-ray of the nose **(A)** demonstrates calcification/ossification of a lyocartilage strut 2 years after insertion and a further x-ray **(B)** taken 4 years after grafting shows a kind of corticalization of the same strut.

We do not use lyobone for nasal reconstruction. Lyophilized bones are only used when lyocartilage could not fulfil the same purpose. Lyobone was grafted into 221 localisations. The origin of the material was sternum in 40%, iliac crest in 20%, rib in 15%, calvarium in 11.5%, mandibular bone in 7.5%, mentum in 5% and femur in 1% of the operations.

The overall infection rate is less than 2%. Lyobone is transformed into autologous bone by creeping substitution; the transformation process lasts much longer than that of autologous bones; this helps to prevent relapses of the midface in important areas like the zygomatic arch, the lateral orbital walls, the frontonasal and the pterygoid region.

DISCUSSION

The use of homologous lyophilized materials has many advantages in comparison with autologous material: There is no surgical site which may be a source of pain, infection and other complications; the time of surgery can be reduced (Sailer and Landolt, 1991). Lyophilized cartilage is far superior to any autologous graft material as far as the infection rate

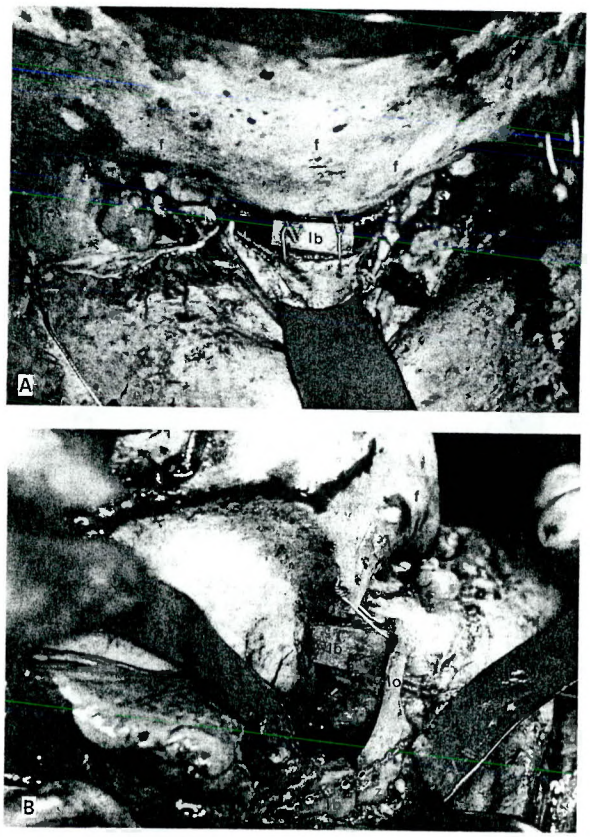


Fig. 5 A,B: Same patient of Crouzon's disease as described in Fig. 3: Condition after midface advancement and interpositioning of lyobone (1B) into the frontonasal osteotomy line **(A)** and depicted in Fig. 5B into the gap within the lateral orbital wall and the zygomatic area where the lyobone (1B) graft is fixed by a microplate (lo = lateral orbital rim; z = zygomatic bone; f = forehead corrected by lyocartilage onlay grafts depicted in Fig. 3C).

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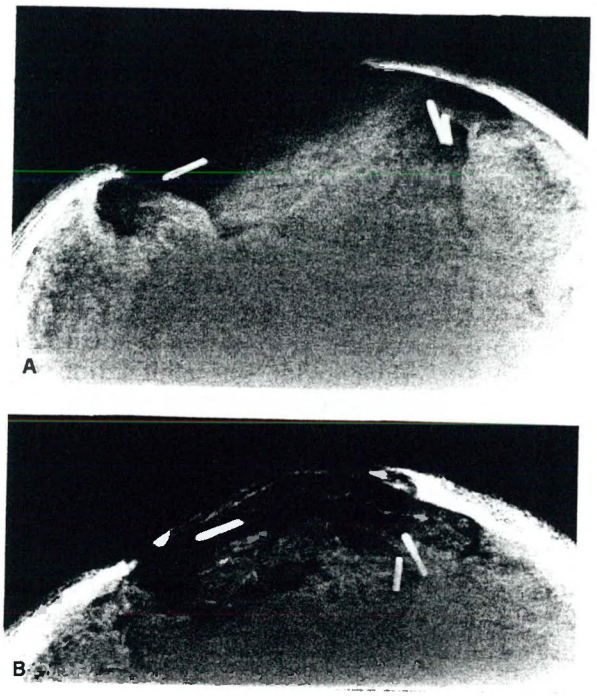


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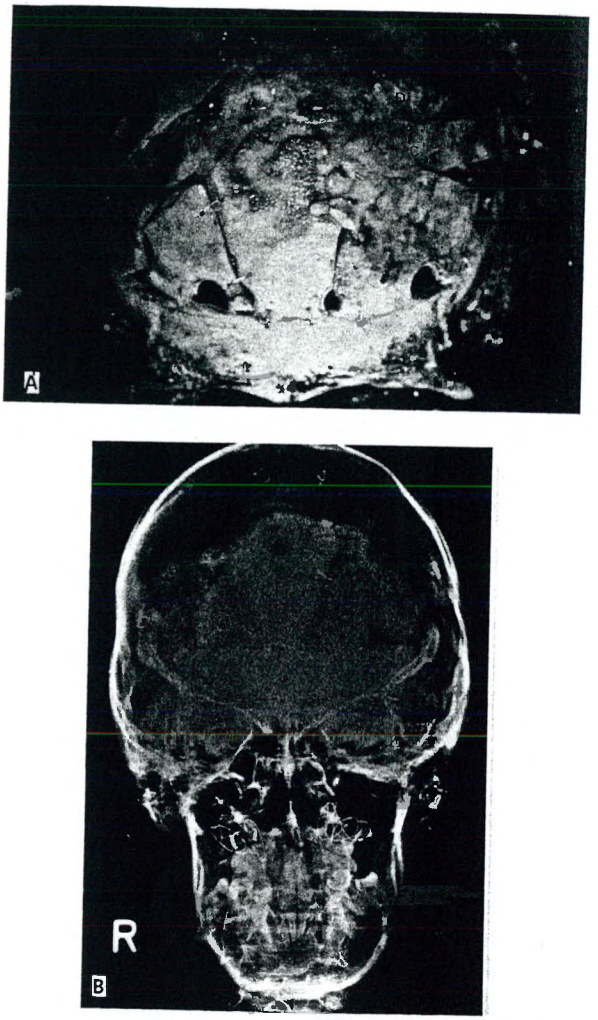


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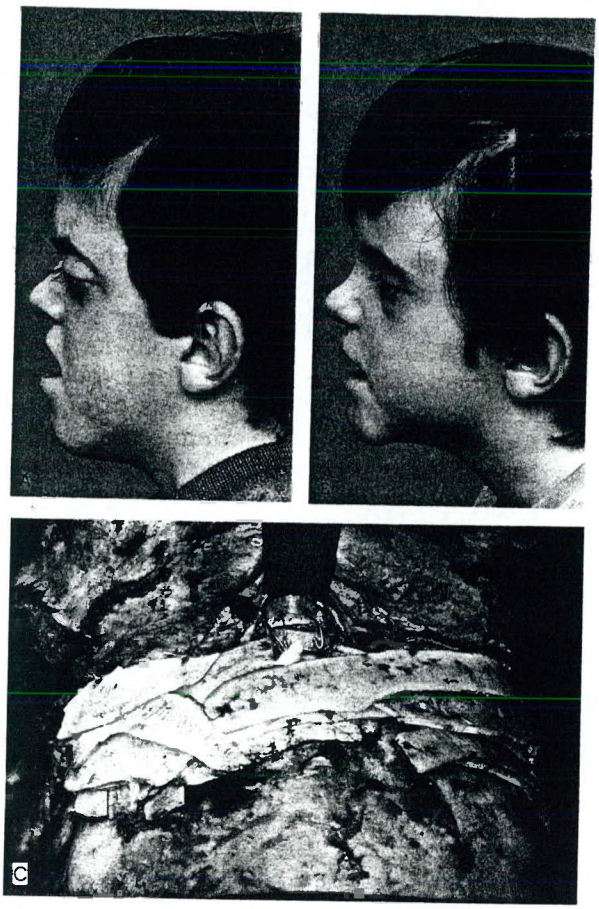


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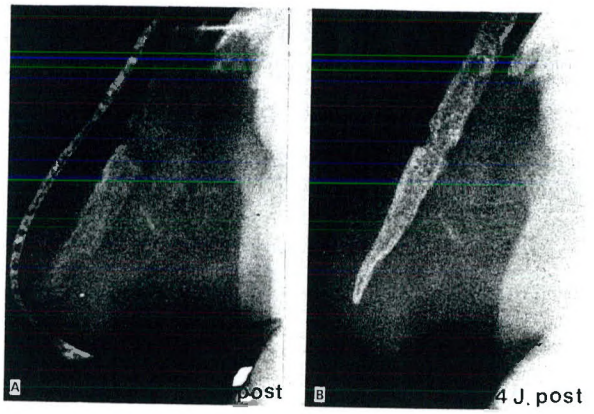


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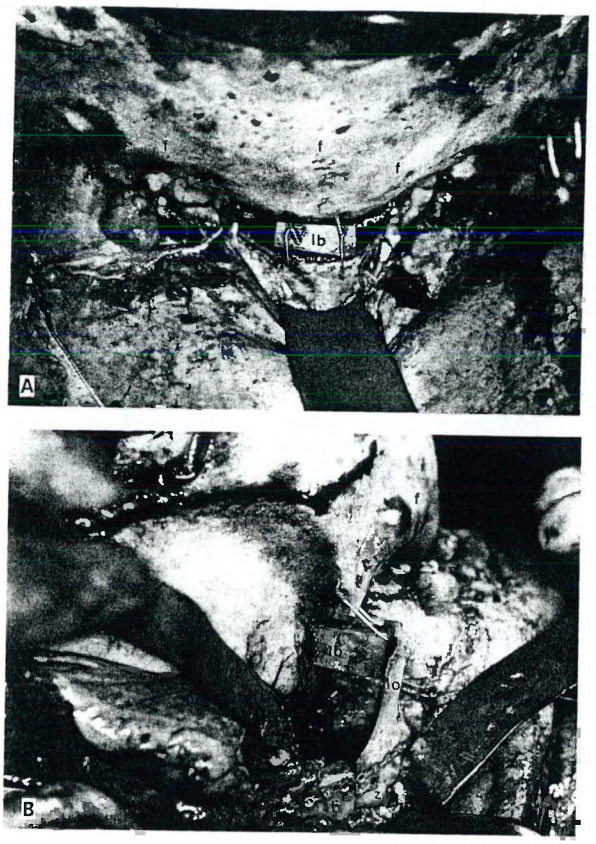


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