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Reconstruction of the Auriculum
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Porecon® Implant and Fan Flap: A Concept for Reconstruction of the Auricle

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Total reconstruction of the auricle is performed for microtia and the much rarer condition of anotia as well as after traumatic loss or surgical removal of the auricle.

The most important indication for the operation is microtia, which occurs in 1:7000 to 1:8000 births.[1,2] In principle, it is possible to treat the defect with an epithesis, but the patient often has the wish "for an ear of flesh and blood."[3–5] The age at which children start school is the time often recommended for a microtia operation. This makes is possible to avoid psychic trauma[1] and also to determine the size of the new auricle according to the healthy side.[6,7] However, many patients only request surgery in adulthood.

A survey of various surgical techniques has been presented, for example, by Meyer and Sieber,[8] as well as by Davis.[9] Berghaus and Toplak[10,11] compiled the numerous frame materials for auricular reconstruction from the literature in a complete survey that had previously only been fragmentary.[12]

In contrast to *partial* reconstruction, *total* auricular reconstructions were considered to be impracticable until the end of the 19th century.[13–17] Julius von Szymanowski[18] did propose a procedure for total reconstruction of the auricle but never applied it himself.

As already stated by Zeis,[14] auricular reconstruction involves two fundamental difficulties: First, procuring suitable material for replacement of supporting auricular cartilage and, second, obtaining qualitatively and quantitatively adequate skin for coverage of this supporting frame.

The first reports on total auricular reconstructions in a narrow sense were presented by Kuhnt (Jena, Germany; cited after Schanz[19]), Randall[20] (Philadelphia, USA), who used a frame of fresh rabbit cartilage, and Hacker,[21] who unsuccessfully attempted to improve Szymanowski's[18] procedure by injecting petrolatum. Korte[3] used a "composite graft" from the healthy side to reconstruct the auricle. Autogenous costal cartilage, which later gained the most widespread acceptance as a supporting frame material, was likewise used very early[22] and is still by far the most commonly applied frame material for auricular reconstruction. Preference is usually given to the frame shape according to Tanzer[23] or Brent,[24] while the skin coverage is achieved in different ways.[8,24–35]

Though isolated attempts have repeatedly been made to operate without a supporting frame,[18,36–39] (v. Szymanowski 1870, Berger 1907 (cited after Nelaton and Ombredanne 1907), Beck 1925, de River 1927, Sarig *et al.* 1982), the possibilities of thus forming an appropriate relief are very limited.

Esser[40] demanded that the frame be "light, pliable, always sufficiently available, implantable in

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one piece, without rejection and with high tensile strength at minimal thickness." Among others, Peer[41] and Cronin[42] considered the choice of supporting frame to be very much more important than the type of skin coverage. According to Tanzer,[43] "the ideal supporting frame consists of non-organic material that can be preoperatively formed, then sterilized and applied."

Synthetic materials were introduced in auricular reconstructions, on the one hand, because of the demand for an uncomplicated supporting frame, and on the other, the aspiration not to purchase a plastic correction in the face by a possible deformation in another body region, which cannot always be ruled out when autogenous material is removed. Unfortunately, there are some unattractive examples of this in the literature. Particularly when the reconstructed ear contour shows postoperative thickening and spreading, the patient also tends to develop hypertrophic scars or keloids at the donor site on the costal arch.[44]

Among the alloplastic materials, those most commonly chosen apart from wire frames were synthetic materials. The silicone frame first introduced by Cronin[42] in 1966 gained the most widespread acceptance by far. After autogenous costal cartilage, these silicone frames have been the second most frequently applied materials in the last ten years. Synthetic materials meet the demand of Sanvenero-Rosselli,[45,46] to achieve "the best result within the shortest period of time with as few interventions as possible."

A further reason for switching over to alloplastic frame materials is the frequently observed resorption of biogenous materials. While the resorption of allogenous and xenogenous cartilage is generally accepted, it is apparently less well known that autogenous costal cartilage transplants can eventually be used up as well. Ten percent of the authors mentioned in our literature study[11] saw extensive resorptions of autogenous frames in the course of long-term follow-up examinations; 20% reported a spreading or shrinking of the reconstructed auricle, which likewise must in part be interpreted as resorption.

Skin necroses and protrusions of the cartilage were described by 29% of the authors and are thus by no means uncommon phenomena. A problem involved in obtaining the material is the occurrence of pleural ruptures (described by 10% of the authors); young patients can also develop growth disturbances and deformities of the thorax.

The predominant complication associated with silicone frames, on the other hand, is the very high incidence of implant rejection (observed by 80% of the surgeons). Skin perforations of silicone frames were mentioned by 60% of the authors and infections by 46%.

PROPOSED SURGICAL CONCEPT FOR AURICULAR RECONSTRUCTION

Supporting Frame

The considerable disadvantages of using autogenous materials and the problems with the previously known alloplastic materials have lent significance to the search for a suitable synthetic material as a supporting frame. Thus it was justifiable to apply a promising synthetic material like porous polyethylene in auricular reconstruction.

Porous high-density polyethylene (PHDPE) is a pure synthetic material without toxic additives (Porecon®). It has a pore size of 150 μm; the pore system is interconnectively open, thus permitting ingrowth of connective tissue and bone, which we were able to confirm by detailed experimental studies.[47] We have been using Porecon® implants for years to reconstruct bony facial defects and have achieved very successful results.[48] We did not observe any resorption. The material can easily be shaped with the scalpel. Delicate three-dimensional frames formed according to our suggestion are available for auricular reconstruction (Fig. 1).*

*Manufactured by Effner GmbH, Alt-Lankwitz 102, POB 46 02 20, D-1000 Berlin 46.

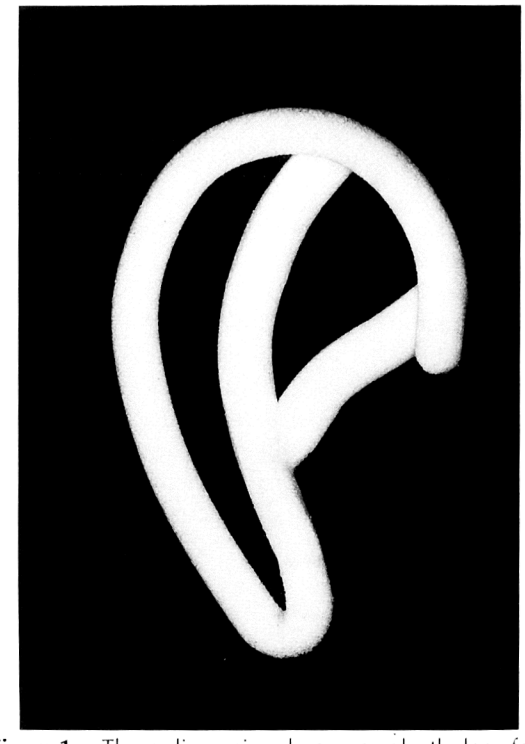


Figure 1. Three-dimensional porous polyethylene frame for auricular reconstruction.

Skin Coverage

In addition to compound and split-skin flaps, several special solutions have been suggested for skin coverage of these frames in cases of microtia.[49–51] Neumann[52] (1957, cited after O'Neal *et al.* 1984) suggested the "skin expander" to achieve an augmentation and thinning of the skin.

Our evaluation of the literature[11] shows that a markedly favorable influence on the long-term results in auricular reconstruction is exerted by the "fan-flap technique" reported by Fox and Edgerton[53] and previously described in principle by Edgerton and Bacchetta.[54] This procedure involves encasing the implant in fascia of the temporal muscle prior to coverage. The implant coating with periosteum ("perichondrization") described by Herrmann and Zühlke[55] can be regarded as a forerunner of the technique.

Surgical History

Five cases of microtia have been treated with the implants shown in Figure 1. One of these is a case of purulent perichondritis in which the necrotic cartilage was replaced by such a frame after the acute infection healed. The other cases involved microtia.

An encasement with temporal fascia ("fan flap") or a variation of this technique was applied in all cases. Skin coverage was achieved with thick split skin, full-thickness skin, or local skin flaps.

With the exception of isolated early postoperative complications that were easy to control (tapping of seromas, minor suture corrections), there has not as yet been any failure in an observation period of two to five years. There have been no rejections or infections.

Figure 2. Preoperative microtia on the right.

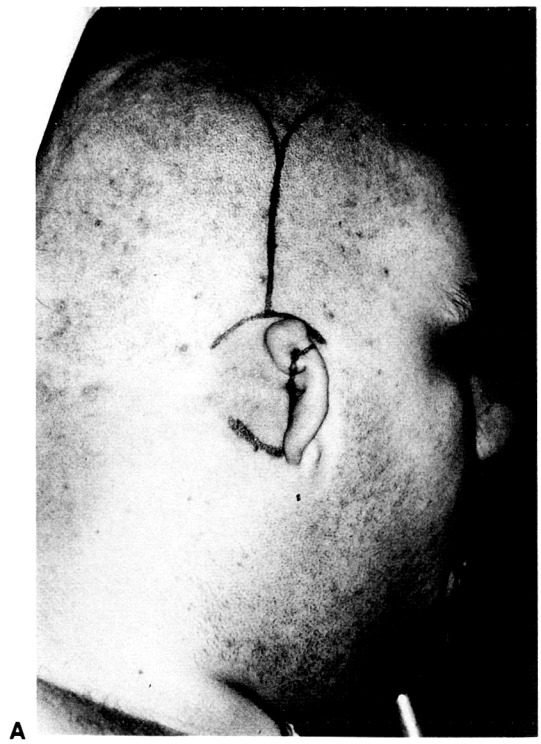
Case Example

Surgical treatment of microtia on the right in patient F.A. (Figs. 2–7). The patient had normal audition on the left and thus did not wish to have his hearing improved surgically. For an explanation of Figures 2–7, see legends.

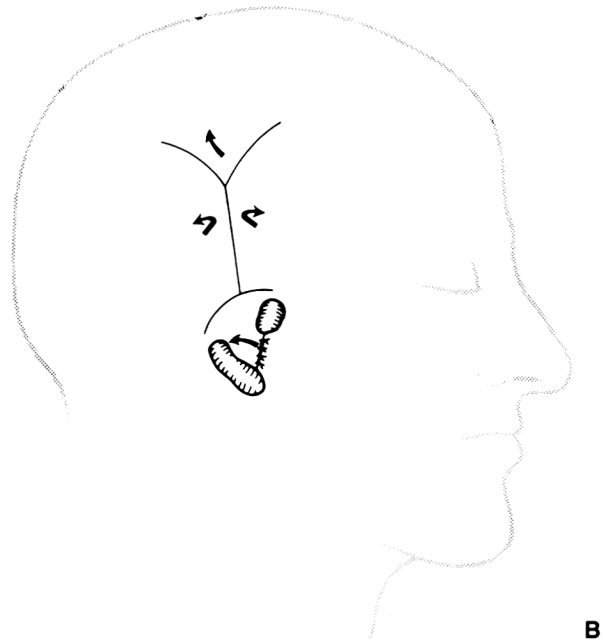
DISCUSSION

Porecon® is the first synthetic material to be examined for use in constructing supporting frames for auricular reconstruction since the introduction of silicone implants by Cronin.[42] The first clinical results can be assessed positively without reservations. Just as in reconstruction of the facial cranium, the porous polyethylene also displays its advantages here: good plasticity and stability, low weight, and good tolerance. Due to its porosity, anchorage by ingrowing connective tissue appears to be accompanied by particularly good nutrition of the covered skin in the rather risky implant bed, so that necroses and frame perforations occur less easily. Postoperative revisions of the synthetic frame were repeatedly required without leading to any healing disturbances.

Compared to biogenous materials, this synthetic frame material involves no resorption and does not necessitate a second intervention in the patient. There is less danger of infection than with silicone frames. The fan-flap technique has proven to be valuable and effective for the implantation.

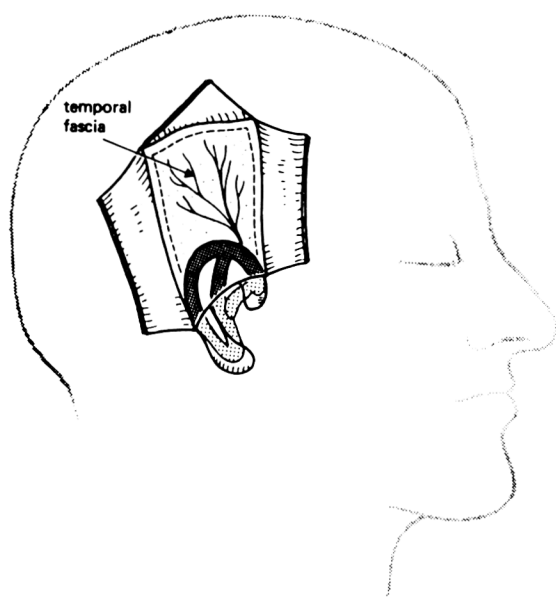


A



B

Figure 3. A, Incision for exposure of the fan flap and division of the auricular rudiment is marked. B, A Z-plasty was performed for displacement of the ear lobe.



A

B

Figure 4. A, The implant has been positioned and the temporal fascia flap exposed. B, The fan flap is raised.

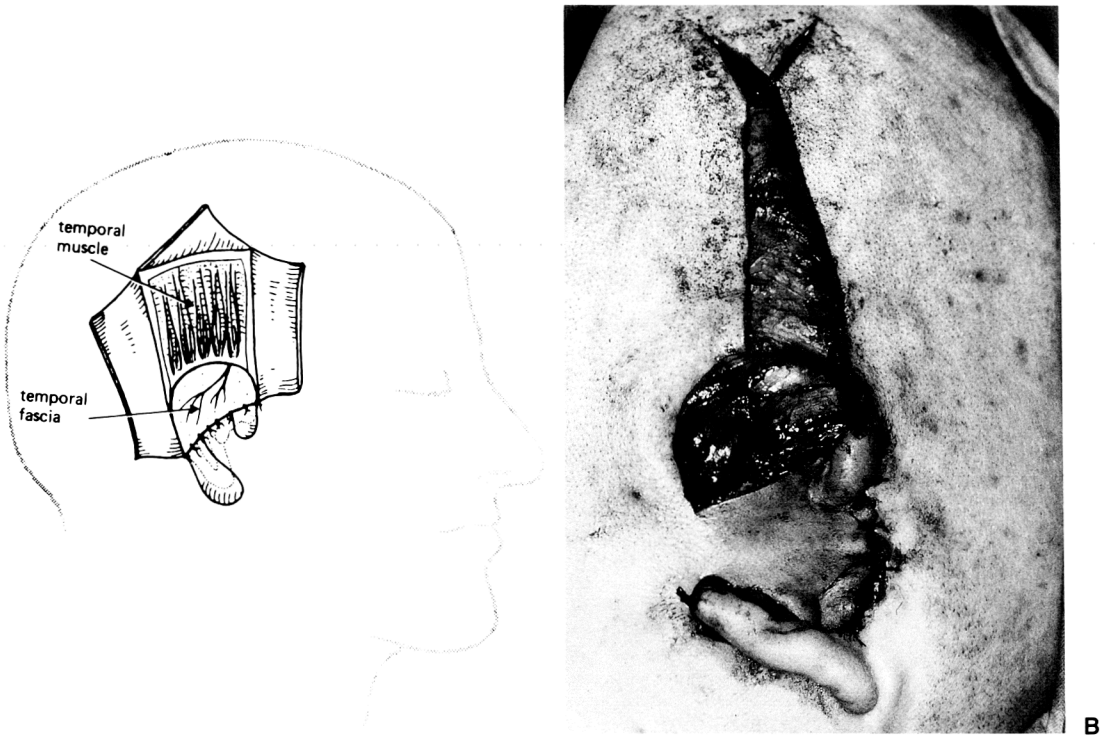


Figure 5. A, Encasement of the implant in the fan flap. B, Intraoperative situation with wrapped implant.

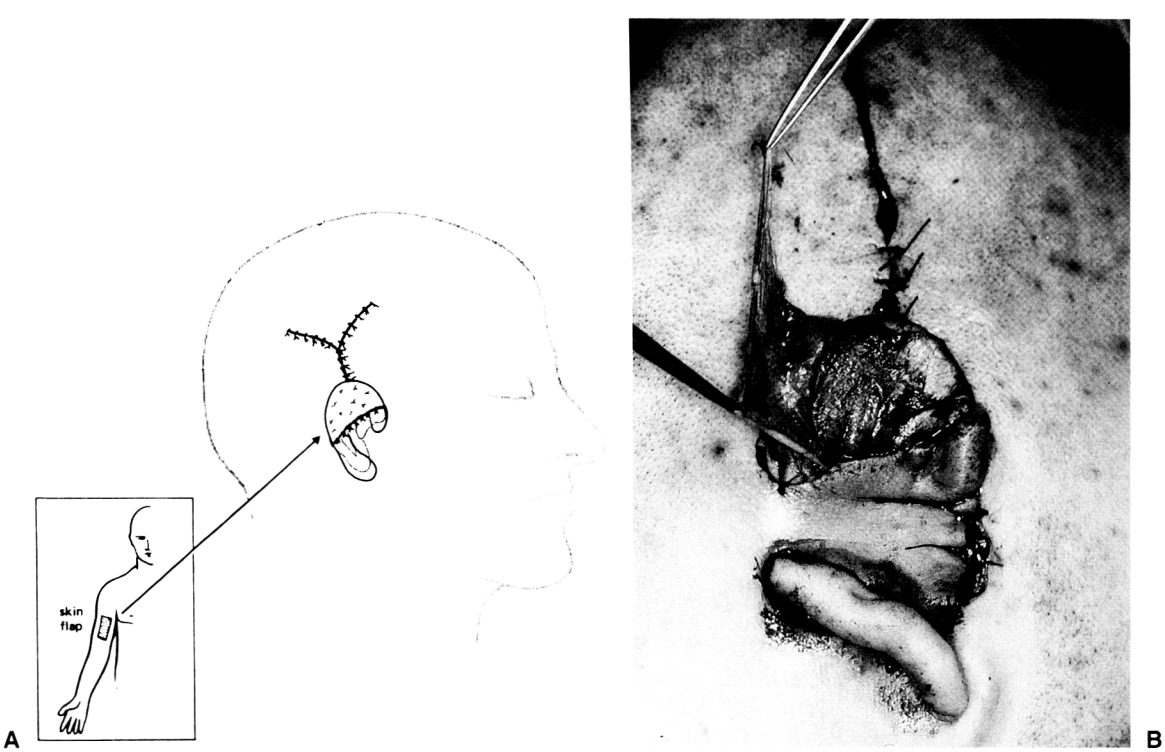


Figure 6. A, Coverage with free skin flap. B, Intraoperative situation with skin over fascia flap.

Figure 7. A, The same patient three years after surgery; in a second session, an intervention was performed to lift the auricle as well as to form a tragus and an opening to the auditory canal. B, Closer view of the reconstructed ear. For lifting of the auricle and creation of a postauricular sulcus, an "Esser inlay" was used as a composite graft with contralateral concha cartilage.

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