Aesthetics and Functionality in Ear Reconstruction
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Preface

The reconstruction of the auricle, due to dysplasia or sub/total auricle amputation, was seldom described before the beginning of the 20th century. The first techniques were described in 1845 by the famous German plastic surgeon Diefenbach, but he advised against reconstruction of total ear loss because of poor surgical results. In the early 1950s, more publications concerning the reconstruction of the external ear appeared, and it was during this period that the first modern methods for reconstructions, which use alloplastic materials or autogenous rib cartilage, were described. Over the last 25 years, these types of operations have become reliable methods that give satisfying aesthetic results.

Following the sage advice of Dr. McDowell in 1977 that you have to learn what others have done because you will not live long enough to make all these mistakes by yourself, we have summarized the past developments in ear reconstruction alongside a detailed presentation of future opportunities.

Hilko Weerda, one of the first German surgeons to focus on ear reconstructions, has given a historical overview of this field. In his article, the most important surgical techniques for ear reconstruction have been summarized. His excellent illustrations offer a clear impression of these techniques, including partial and total reconstructions, ear prostheses, the use of regional flaps, skin expansion and the use of autogenous rib cartilage for total reconstructions, and make it possible to apply these to the high diversity of patient problems.

Francoise Firmin, one of the most experienced surgeons in external ear reconstructions in the world – who was educated by the famous Burt Brent, has described state-of-the-art treatment in autologous ear reconstruction in cases of microtia. In her work, she has focused on the natural shape of the external ear, recreating the complex 3-dimensional architecture. The quality of her work is derived from two important considerations: firstly, precise preparation of the cartilage; secondly, making appropriate choices to correctly adapt the skin remnants to the cartilaginous framework. She describes her two-step procedure, in which the first step includes the insertion of the framework under the skin, and the second step comprises the elevation of the reconstructed ear (creating the retroauricular sulcus). This article, based on her personal experience of 1,520 cases, highlights the optimization of surgical techniques,
the avoidance of pitfalls encountered by both beginners and highly experienced surgeons, and offers many helpful hints and tips to bring about better results.

My heartfelt thanks go to Hilko Weerda and Francoise Firmin for sharing their personal experience and knowledge of this complex field.

Alexander Berghaus is well known for his use of alloplastic materials in the mechanical supports used for ear reconstruction. Over the last 15 years, he has focused upon porous polyethylene implants in particular. The big advantage of these techniques is the lack of donor site morbidity caused by the use of autogenous rib cartilage. He uses a 1-step procedure with porous polyethylene as the frame material, which is covered by the temporoparietal flap and a full-thickness skin graft. Using this technique, he has been able to achieve very convincing results over recent years.

An alternative method for restoring the external appearance of patients with ear malformation, the use of auricle prostheses, is described by Philipp Federspil. The breakthrough in auricle prostheses came with the introduction of modern silicones (which among other advantages can be made to have suitable coloring) and the more stable fixations resulting from bone anchoring. Since then, different solitary titanium implants have been introduced to attach the prostheses, with the focus on secure retention even in unfavorable anatomical conditions. The big advantages of prostheses are the suitability for elderly people, predictable cosmetic results, fast rehabilitation, no donor site morbidity and early detection of tumor recurrence. Depending on the individual case, this could be an alternative to plastic reconstructive surgery in ear malformation.

Classic microtia is combined with atresia of the external ear canal as well as considerable dysplasia of the middle ear, resulting in a functional impairment with a conductive hearing loss of around 50–60 dB. This reduced hearing ability is very important for the otorhinolaryngologist, particularly in patients with bilateral microtia.

Ralf Siegert established a technique of combined reconstruction of congenital auricle atresia and severe microtia. This 3-step procedure starts with the explantation of autogenous cartilage, the shaping of the auricle framework and implantation. In addition, the tympanic membrane and the external ear canal are prefabricated, and stored in a subcutaneous pocket. The second step includes elevation of the new cartilage framework in combination with the reconstruction of the ear canal by using the prefabricated tympanic membrane and external ear canal. In the third step, the cavum concha is deepened, and the external ear canal is opened and covered with a skin graft. Being an excellent surgeon, he achieved a final conductive hearing loss of 30 dB or less in more than 76% of his patients. Because of the complex reconstruction of the external ear canal, he observed no restenosis. This combination of plastic surgery of the auricle and functional surgery of the middle ear comes more under the focus of reconstruction.

Besides bone-anchored hearing aids, newly developed active middle ear implants have been used for the treatment of sensorineural hearing loss in the last 8 years. They provide acoustic amplification and transmission of sound energy by direct coupling of vibratory elements to the ossicular chain.
Jan Kiefer first described the use of the Vibrant Soundbridge for bilateral microtia in the international literature. This partially implanted device seems to be the most favorable implant in cases of severe ear malformations because of the high variety of coupling possibilities of the floating mass transducer to the ossicular chain or the oval/round window niche. Based on good results seen in bilateral cases, Kiefer and I also implanted unilateral ear malformations. It is possible to obtain an air-conductive threshold of 30 dB or less in more than 90% of patients; thus, the Soundbridge provides a valuable option for functional reconstruction of the malformed ear.

Future advances in this field will come from a variety of scientific disciplines. One of the leading ideas is to use tissue engineering to overcome donor site morbidity (from autogenous cartilage) and problems with the extrusion of alloplastic materials. We are looking at customized tissue engineering for ear reconstruction in our laboratory. Using computer-aided design/manufacturing systems, it seems to be quite possible to size and build individual scaffolds for autologous tissue engineering. The process starts with imaging data acquisition and 3D data processing. With the resulting STL file, it is possible to make customized scaffolds. After the isolation and amplification of cells from small biopsies, they can be used on individual scaffolds for tissue engineering of cartilage in order to produce an individually sized autologous implant.

Andreas Haisch, one of the pioneers in ENT tissue engineering for ear reconstruction, has provided a short overview of his recent work and some developments in the field, as well as the problems yet to be overcome. The expectations concerning tissue engineering are very high in reconstructive surgery; however, more experimental studies need to be conducted.

In this volume, several different aspects of reconstruction in severe ear malformation have been presented, with the aim of providing a complete, yet accessible, overview of the history, state-of-the-art techniques and future developments. Nowadays, many patients can get optimal aesthetic and functional solutions for ear malformations, but there is still room for improvement.

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