Otoplasty – techniques, characteristics and risks

Abstract

The protruding ear as a minor ear abnormality is found in approx. 5% of the German population and may give rise to serious emotional problems in children and also in adults. In general, the procedure used for the surgical correction of protruding ears (otoplasty) is a combination of incision, scoring and suture techniques. The choice of the surgical procedure is based on the severity of the ear abnormality and the individual characteristics of the auricular cartilage. In children up to the age of ten years, a soft, elastic or easily pliable auricular cartilage is often still present. In this situation, gentle suture techniques, such as a suturing technique described by Mustardé, are frequently enough to achieve a cosmetically good and lasting result. In adults, the auricular cartilage has already become stiff. Therefore, a combination of incision, scoring and suture techniques is usually required. Apart from reducing the cephaloauricular angle to 15-20°, emphasis on the antihelical fold and a smooth rim of the helix without interruption of the contour are desirable outcomes of this operation. Occasionally, surgical fixation (lobulopexy) may be required to treat protruding lobules or, in rare cases, an additional conchal reduction may become necessary in cases of conchal hyperplasia. Since postoperative complications can often result in severe auricular deformities, as a matter of principle, each ear should be analysed individually regarding its problem areas, and the surgical approach that causes the least injury to the cartilage should be used.

Keywords: otoplasty, combination of incision, scoring and suture technique, cartilage characteristics, risks

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1 Anatomy of the auricle

1.1 Basic anatomy

The auricle (pinna) and the external auditory canal are part of the external ear. The fine contour of the ear is determined by the form and shaping of the elastic auricular cartilage, which is covered by a skin with fine pores. The lobule itself does not contain any cartilage, but is mainly composed of adipose and connective tissue. The funnel formed by the auricle extends into the slightly curved external auditory canal, which consist of a lateral cartilaginous portion and a medial bony portion [1]. The complex shape of the auricle is determined by the individual form of the helix, the antihelix, the antihelical scapha, the antihelical crura, the tragus, the antitragus, the cavum conchae, the cymba conchae, and the lobule (Figure 1). As early as in week 4 of gestation, the auricle, the auditory canal and the middle ear form from an ectodermal protuberance of the first two branchial arches. The auricle develops from hillocks of the second branchial arch with the formation of the lobule, the antihelix, and the dorsocaudal portion of the helix. In contrast, the cartilage of the tragus is formed from the first branchial arch [2]. Therefore, in case of an incomplete fusion of the aggregations of the branchial arches, malformations of the external ear and the middle ear can already develop during the embryonic stage.
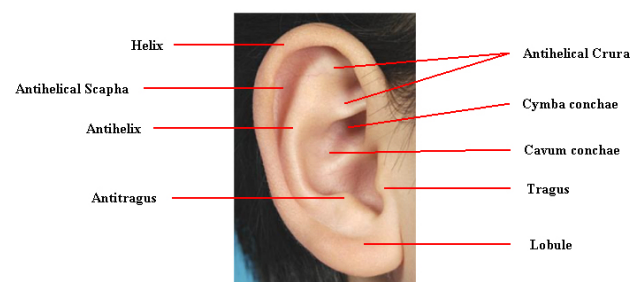

Figure 1: Anatomy of the auricle

1.2 Auricular growth

So far, no conclusive evidence is available with regards to the age at which the growth of human auricle is completed. There are numerous anthropometric studies showing that up to 90% of the auricular growth is already completed at an age of 11 to 12 years [3], [4], [5], [6]. Kalcioglu et al. compared the growth ratios of the auricle in 1552 persons from birth until age 18 years, measuring the longitudinal diameter (upper rim of the helix-lobule), the external transverse diameter (lateral rim of the helix-tragus), the internal transverse diameter (outer rim of the antihelix-tragus), as well as conchal depth (Figure 2) [7].

The development of the auricle regarding the transverse growth and the growth of the conchal depth was fully completed by the age of six years, independent of gender. Only the growth in auricular length took until the age of 11 to 12 years, before it was almost completed. Even so, the length of the auricle increases during the natural aging process because of the natural skin and soft tissue elasticity. Ito et al. evaluated 1958 persons aged 5 to 85 years regarding their growth in auricular length and revealed by histomorphological studies based on auricular cartilage samples that the increased replacement of elastic auricular cartilage fibres by collagen-like fibres is responsible for the growth in auricular length at an advanced age [8]. Despite these results, otoplasty in paediatric patients has no significant influence on later auricular growth [9].
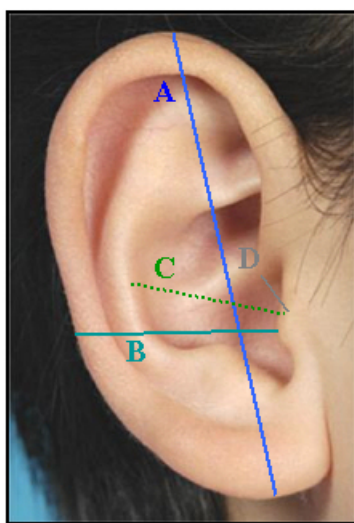

Figure 2: Auricular growth (modified according to Kalcioglu et al. 2003 [7])
A = upper rim of the helix-lobule, B = helix-tragus, C = antihelix-tragus, D = conchal depth

1.3 Classification of auricular deformities

With an incidence of 1:2,000-1:20,000 births per year in Germany, auricular deformities of various severity are not rare. Despite of numerous classification systems for auricular deformities, the classification according to Weerda, in line with the consensus report of the German Society of Otorhinolaryngology, Head and Neck Surgery of 1998, has been proven to be very feasible and sensible [10], [11], [12], [13]. It differentiates between three degrees of severity in auricular deformities (Figure 3). Grade I includes mild deformities of the auricle in which the anatomical structures of the auricular basic architecture are almost completely preserved. Examples include protruding ears, cryptotias, macrotias, colobomas, as well as mild cup ear deformities. In moderate grade auricular deformities, malformations of the basic architecture of the cartilage are already apparent. Moderate auricular deformities include severe cup ear deformities and the

mini-ear. In severe auricular deformities, only isolated remains of the cartilage or appendages without signs of normal auricular shape are apparent. Subject to the severity, a conchal type can be differentiated from a lobular type; they often occur combined with agenesis of the external auditory canal and the middle ear [14]. The most extreme form of a severe auricular deformity is anotia, in which the auricle or the presence of an auricular basic architecture is completely missing. These deformities are mostly unilateral and are more frequently found among male patients.
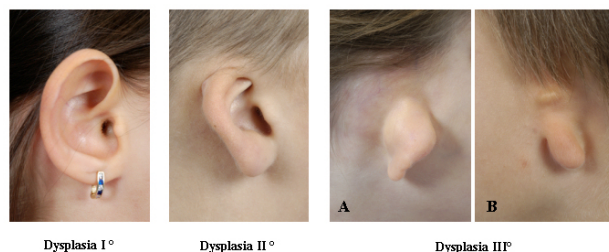

Dysplasia I °   Dysplasia II °   Dysplasia III°

Figure 3: Classification of congenital deformities of the auricle (according to Weerda)
A = conchal type, B = lobule type

2 Definition of the protruding ears

2.1 Anthropometric data

Protruding ears (apostasis otis) is one of the most common grade I abnormalities according to Weerda. The pathogenetic factors discussed in protruding ears include genetic factors, point mutations, but also environmental influences during pregnancy, such as exposure to X-rays, hypoxia, as well as the intake of certain drugs, such as thalidomide [15].

Frequently, it is difficult to establish the difference between a grade I abnormality of the auricle and an imperfect shape of the auricle; therefore, an accurate preoperative problem analysis is crucial.

To this end, numerous anthropometric studies were carried out to measure the distance or to calculate the angle between the ear and the head (cephaloauricular angle). According to Wodak, the average distance between the helical rim and the head is approximately 6 to 20 mm in adults, measured at the upper and middle measuring point, and at the level of the tail of the helix [16]. The angle between the mastoid and the helix of a normally shaped auricle should not exceed 30 degrees [17], [18], [19]. Numerous further criteria for a properly shaped auricle have been suggested by various authors: a) the axis of the ear should be almost parallel to the bridge of the nose; b) the position of the auricle should be approx. one auricular length behind the lateral orbital margin (55-70 mm); c) the width of the auricle should be 50-60% of the auricular length (width: 30-45 mm, length 55-70 mm); d) the anterolateral angle should be 21-30 degree; and e) the lobule should be positioned parallel to the antihelical fold in the same plane [20], [21], [22], [23].

In protruding ears, deviations from the normal shape are especially apparent at the antihelix, the concha, the mastoid-helix angle, and the lobule. The enlargement of the helix-mastoid angle is enough to cause a protrusion of the entire auricle, especially in the mid portion (Figure 4a). This situation is sometimes referred to as pseudo-conchal hyperplasia. In contrast, hyperplasia of the cavum with a significantly enlarged and lifted cavum conchae may also result in protruding ears, despite a normal helix-mastoid angle. Very frequently, hypoplasia of the antihelix associated with an incomplete or unformed antihelical fold is found in combination with an increased helix-mastoid angle (Figure 4b). This results in a flattening of the scapha and the fossa triangularis, as well as in a ventral protrusion of the helix in the upper and/or middle region.
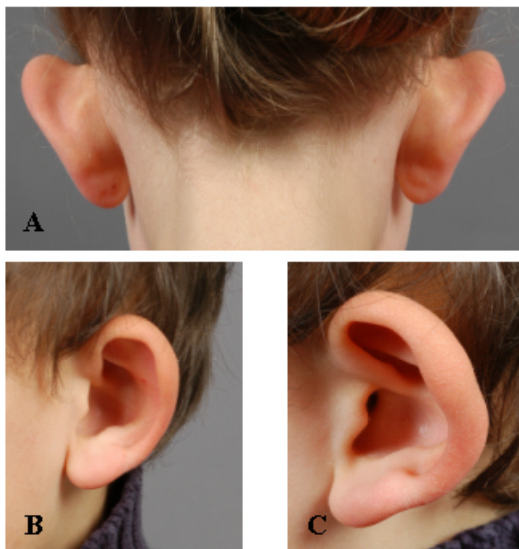

Figure 4: Problem analysis in protruding ears
A = increased helix-mastoid angle, B = antihelical hypoplasia,
C = cavum hyperplasia and protruding lobule

It is not uncommon that in addition the lobule is positioned more or less ventrally and emphasises – especially in the lower region – the appearance of a prominent ear (Figure 4c). Apart from the criteria discussed above, the width of the auricle as seen from an anterolateral perspective is an important aspect of the evaluation of the auricle [18].

2.2 Psychosocial aspects

Children with protruding ears are often exposed to substantial psychological pressure, such as being teased at school or in kindergarten. Approximately 5% of the adult population in Germany suffer to some extent from the stigma of having prominent ears. Low self-esteem, general lack of self-confidence, and social isolation are amongst the reasons why parents of affected children or affected adults decide for otoplasty. Schwentner et al. interviewed patients before and after otoplasty regarding their pre- and postoperative emotional state, using a standardised questionnaire [24]. The results of this retrospective study showed a significantly improved attitude towards life, increased courage to face life, and better self-confidence among the patients, with no difference between male and female subjects. Especially in children suffering from protruding ears, an increased tendency towards depression, lower achievements in school, lower self-esteem, and socio-communicative problems in school and at home were observed [25]. In the light of these problems, it is recommended to perform otoplasty in children suffering from protruding ears when they are between 5-6 years of age, prior to the start of schooling. However, despite of the convincing arguments in favour of otoplasty, it should be kept in mind at the time of assessment that protruding ears not necessarily result in the affected patients experiencing psychosocial problems . It has to be considered that children aged 5- 6 years can already provide information about their psychological strain or possible problems with other children associated with their protruding ears. So it is not surprising that often the parents of the affected children wish otoplasty to be performed, while the children themselves deny having problems because of their ear deformities [26]. Consequently, the indication for otoplasty should always be discussed together with the parents and the child to avoid later problems or misunderstandings at an early stage.

3 Preoperative preparations

3.1 Medical history

The value of the doctor-patient discussion prior to an aesthetic surgery procedure, such as otoplasty, is an important precondition for the pre- and postoperative compliance. Apart from the patient's past history in general, the question of previous ear surgery or otoplasty should always be addressed. Previous otoplasties are frequently associated with some degree of scarring, which may influence the further surgical planning and the postoperative outcome.
Prior to the otoplasty, the patients or the parents of the child are informed about the different surgical techniques and potential risks and complications, including haematoma and infections of skin or cartilage, and also regarding the possibility of an unsatisfactory cosmetic result.

3.2 Problem analysis

Following a detailed medical history, a thorough ENT examination is performed to exclude other potential causes of protruding ears, such as retroauricular space-occupying lesions or traumatic cartilage deformities [27], [28]. An accurate problem analysis of the antihelix fold, helix-mastoid angle, helix-head distance, position of the lobule and of the cavum conchae is crucial. Another aspect with significant impact on procedure planning is the analysis of the cartilage consistency and here, in particular, the stiffness and thickness of the cartilage. The consistency

of the cartilage is typically evaluated by palpitation and cautious, controlled bending. Additional ear abnormalities, such as auricular appendages, Darwin tubercle etc., can also be excluded in many cases simply by an inspection-based diagnosis.

Occasionally, threshold audiometry with impedance testing may be required to exclude possible conductive or perceptive hearing losses. Apart from an ENT examination, a pre- and postoperative photographic documentation in frontal, lateral, oblique, and dorsal views is prepared (Figure 5). The purpose of the photographic documentation is to document the preoperative situation, and it can also be used to sketch problem areas or steps of the procedure. Taking postoperative photos at intervals of 6 and 12 months helps to monitor postoperative success and is also recommended for medicolegal reasons [29], [30].

Figure 5: Photographic documentation

3.3 Time of otoplasty

The appropriate time for the correction of prominent ears depends on factors such as auricular growth, cartilage consistency, psychological strain, and the patient's wishes. At an age of six years, the ear has completed most of its growth; therefore, an otoplasty at this time does usually not affect auricular growth to any significant extent. The softer the auricular cartilage, the easier it is to shape the cartilage or auricle into the appropriate form and pin it back, using gentle surgical techniques [31]. Over the past years, the nonsurgical correction of auricular deformities has increasingly been discussed; by using appropriate auricular moulding devices already in newborns presenting with suitable auricular deformities, good to very good results were partly achieved [32]. The background is the relatively good plasticity of the auricular cartilage during the first months of life. Other authors provided evidence that surgical otoplasty performed during the first for years of life did not result in any signi-

ficant disturbance of auricular growth [33]. Nevertheless, most authors typically recommend the surgical correction of protruding ears in general anaesthesia between the age of 5 to 6 years, prior to the start of schooling [34]. In older children, starting from age 11-12, or adults with adequate compliance, the procedure can be performed under local anaesthesia.

4 Techniques of otoplasty

4.1 Historical overview

Not earlier than in the end of the 19th century, reports on surgical techniques used to pin down protruding ears for cosmetic reasons were published. Dieffenbach was among the first when, in 1845, he described his technique of otoplasty to correct a posttraumatic prominent auricle in a patient. He excised retroauricular skin and used a conchomastoidal suture for the fixation of the ear [35]. Following his approach, Ely described in 1881 a continuous, crescentic resection of a strip of cartilage in combination with a conchomastoidal fixation suture. To correct bilateral prominent ears, Ely performed the otoplasty as a two-step procedure [36]. In 1890, Keen spared the preauricular skin in such a procedure [37]. Different skin excisions behind the ear were performed by Hauck (1884) und Joseph (1896). Various forms of skin sling plasty were described by Stetter (1884) and Payr (1906). Gersuny observed in 1903 that, because of the elastic resetting force of the cartilage and the natural elasticity of the skin, a skin excision alone is not enough to achieve lasting results from otoplasty [38]. In 1910, Luckett combined a skin-cartilage excision along the antihelical fold with horizontal mattress sutures to achieve a better formation of the scapha [39]. In contrast, Becker made only an incision along the antihelical rim and was able to achieve, in combination with posterior mattress sutures, satisfactory shaping of the antihelical fold in1952 [40]. Gibson and Davis could finally show that cartilage incised on one side has the ability to warp to the opposite side [41]. This knowledge of this phenomenon became ultimately the starting point for numerous modifications of incision-scoring techniques in the area of antihelix, which were described by Converse (1955), Converse and Wood-Smith (1963), Chongchet (1963), and Stenström (1963) [42], [43], [44], [45]. Converse performed incomplete cartilage incisions from posterior in combination with fixation sutures, Chongchet and Crikelair scored the anterior cartilage of the lateral scapha with a scalpel to form the antihelix using a posterior access, while Stenström used a rasp to shape the anterior cartilage via a small posterior access [44], [45], [46]. In contrast to the incision-scoring techniques portrayed above, Mustardé described in 1963 and 1967 a technique to create a new antihelical fold that was only based on sutures made of nonabsorbable suture material [47], [48]. He used a posterior access to place several individual cartilage mattress sutures to bring the antihelix into the desired.

Apart from the cavum rotation technique, Furnas (1968) and Spira (1969) described a concha-mastoid fixation suture technique intended to reduce the helix-mastoid distance, which was used in combination with an antihelix plasty [49], [50].

Numerous techniques have been described over the past years for the correction of the protruding lobule. Spira et al. performed a wedge excision in the area of the lobule in 1969, and shifted the lobule into the correct position using a deep skin-skull periosteum suture [50]. Wood-Smith suggested a "fish tail-like" retrolobular skin excision with a subsequent V-Y plasty [51]. Unfortunately, due to the natural elasticity of the skin, all these procedures ultimately were followed by a return of the lobule into its original position. In contrast, lobulopexy, as described by Siegert, has been proven to be very effective in moving the lobule posteriorly to the required extent, using a mattress suture [52].

A review published by Weerda, comprising 94 articles on otoplasty techniques, makes it clear that the decision on the appropriate surgical procedure for the correction of prominent ears can only be made on an individual basis, since the variability associated with prominent ears has to be accounted for [53].

Eventually, of the many different surgical techniques and their modifications, three methods, alone or in combination, have proven their effectiveness in the correction of prominent ears: the incision-suture technique described by Converse, the incision technique described by Stenström, and the suture technique described by Mustardé [42], [45], [47]. In addition, various techniques for the fixation of the lobule, as well as for cavum reduction and cavum rotation are used. Since in procedure planning for each patient should be based on the results of the problem analysis, the various methods of otoplasty will be matched to the various problem areas and presented in the following.

4.2 "Anthelix"

4.2.1 Suture technique by Mustardé

In 1963, Mustardé described an otoplastic technique which is suitable for folding an antihelical fold in children with soft or thin cartilage [47]. Prior to the start and at the end of the operation, the ear-head distance according to Wodak is measured to achieve the best possible symmetry of the corrected ears. For this end, the values of the upper and middle helix-head distance as well as of the lobule-head distance are measured (Figure 6). The retroauricular skin incision is performed 8-10 mm below and parallel to the helical rim (Figure 7). The skin above the cartilage is mobilised caudally up to the mastoid and cranially to the helical rim. In order to prevent postoperative skin distortions, the mobilisation should not be extended beyond the helical rim. The perichondrium, which ensures adequate nutrition of the cartilage, and the auricular cartilage itself remain intact. The new antihelical fold is punctured with needles from ventrally and is

marked using methylene blue solution from retroauricularly, if necessary. Subsequently, the mattress sutures made of nonabsorbable, transparent or white material, such as e.g. Goretex 4.0, are placed at the corresponding markings, using a retroauricular access through the auricular cartilage and the perichondrium, without penetrating the ventral skin (Figure 7). The knots of the mattress sutures can be everted towards the inside to prevent later extrusion of the sutures. This technique can be combined with a lobulopexy and/or cavum rotation. A crescentic excision of the excessive skin can be made; however, an increased tension should be avoided to prevent postoperative keloid formation [54].
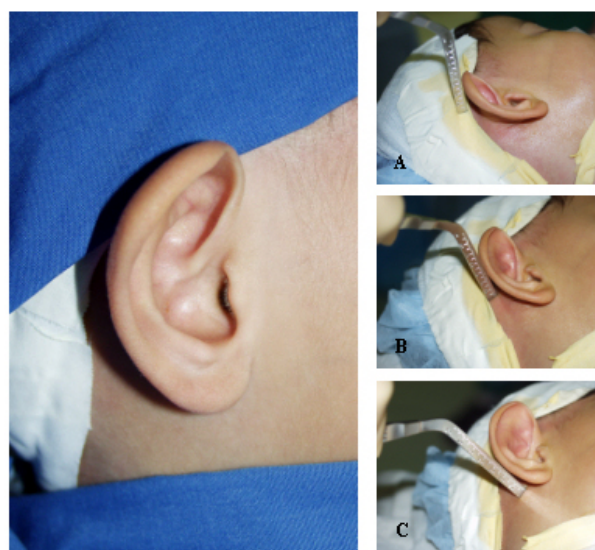

Figure 6: Measurement of helix-head-distances according to Wodak
A = Upper helix-head distance, B = middle helix-head distance, C = lobule-head distance are measured.
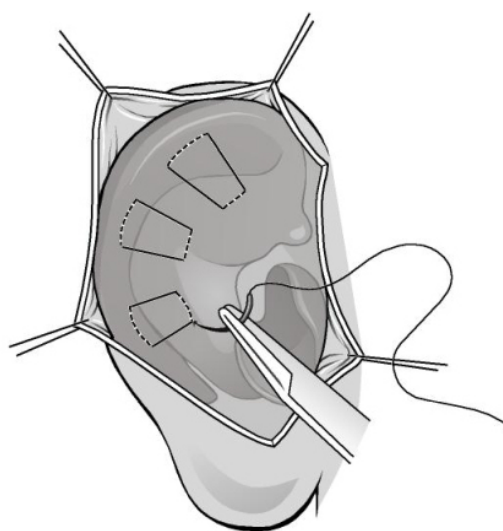

Figure 7: Suture technique according to Mustardé

A significant advantage offered by this technique is that it spares the auricular cartilage, especially since there

are no sharp, aesthetically undesirable edges at the anterior side of the antihelix. In addition, the risk of a postoperative haematoma formation is low for perichondrium-sparing methods. Despite its advantages, Mustardé's technique is primarily suitable for soft and thin cartilage, which is generally present in children up to the age of 10 years. However, if the cartilage is firmer, there is an increased risk that the it may show a tendency to return to its original shape with the associated possibility of mattress sutures tear-out. Additionally, the use of absorbable suture material for the mattress sutures may lead to an early recurrence of the original deformity. The risk of a suture granuloma associated with the use of nonabsorbable suture material is up to 4% [55], [56].

4.2.2 Incision-suture technique by Converse

The shaping of the antihelix using Converse's technique is achieved by a combination of incision technique and suture technique (Figure 8). The technique described by Converse is frequently used for the correction of protruding ears, especially in patients with stiff cartilage [57]. The cartilage incisions are placed parallel to the helical rim and the base of the antihelix, including the superior crus, using a retroauricular approach.
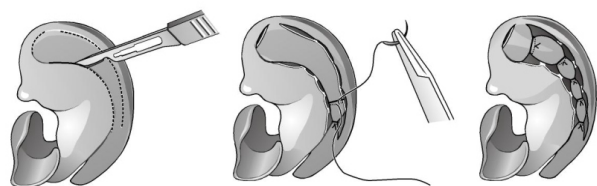

Figure 8: Incision-suture technique according to Converse

In contrast to Converse, who completely transected the auricular cartilage, it is sensible to leave the ventral perichondrium intact in order to minimise the risk of aesthetically undesirable, sharp edges. The antihelix may additionally be scored using a scalpel or Adson-Brown forceps to support the retrograde warping of the cartilage. The fixation of the newly formed antihelical fold is finally achieved with nonabsorbable mattress sutures. Lobuloplasty, cavum rotation as well as cavum fixation according to Furnas can subsequently be performed [49].

In contrast to Mustardé's technique, thick or stiff auricular cartilage can generally be shaped effectively using Converse's technique so that an aesthetically superior and lasting result can usually be achieved. A frequently discussed problem associated with this technique is the creation of sharp and undesirable edges in antihelical area [56]. The formation of edges is mostly seen with the classical technique described by Converse, which involves the transection of the auricular cartilage and the ventral perichondrium. In addition, inappropriate placement and excessive pulling of the mattress sutures may cause the so-called "hidden helix" or narrowing of the ear. With intact ventral perichondrium, the risk of edge formation is significantly reduced [58].

4.2.3 Incision-scoring techniques (Stenström, Crikelair, Chongchet)

The studies of Gibson and Davis (1958) showed that unilaterally scored or incised cartilage with a concave bending warps towards the side of scoring [41]. Stenström, Chongchet and Crikelair utilised this knowledge, preparing the anterior cartilage in different ways to achieve the formation of a new antihelix (Figure 9). Cartilage is incised parallel to the scapha, and the anterior skin-perichondrium layer at the anterior surface of the antihelical cartilage is exposed. The anterior antihelical cartilage is prepared to the extent required, and finally, e.g. with an Adson-Brown forceps, cautiously and evenly scored to achieve a convex warp of the antihelix. Stenström incises the cartilage from the tail of the helix to the scapha and, in contrast to Crikelair and Chongchet, uses are rasp more or less blindly to score the anterior cartilage surface after lifting the perichondrium. Additionally, Stenström's and also Chongchet's techniques involve retroauricular spindle-shaped skin excisions [45].
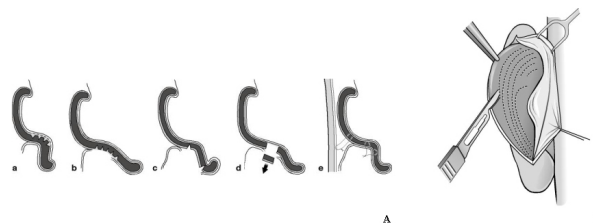

Figure 9: Incision-scoring techniques
A = a: anterior scoring technique, b: posterior scoring technique, c, d: posterior concha resection e: concha suture technique; B = Crikelair.

Because of the cartilage's tendency to warp, the incision-scoring techniques are a safe method to shape the antihelix in cases of stiff and thick auricular cartilage. Nevertheless, excessively deep incision or scoring of the auricular cartilage may result in aesthetically undesirable edges in the region of the antihelix. Injuries to the ventral perichondrium may cause chondronecrotic lesions with associated major deformities. Here again, the skin excision should only be performed very cautiously to reduce the risk of keloid formation.

4.2.4 Cartilage thinning by Weerda

The otoplasty technique described by Weerda can be a suitable method to shape thick auricular cartilage with low elasticity [59]. With a diamond drill, the auricular cartilage is weakened immediately above and below the intended new antihelical fold and the antihelical crus, using a retroauricular access (Figure 10). Continuous rinsing during drilling is important to prevent heat-induced chondronecrosis. In addition, full-thickness mattress sutures of slowly absorbable suture material are placed at the positions with the corresponding markings to fix the antihelix in the intended position.
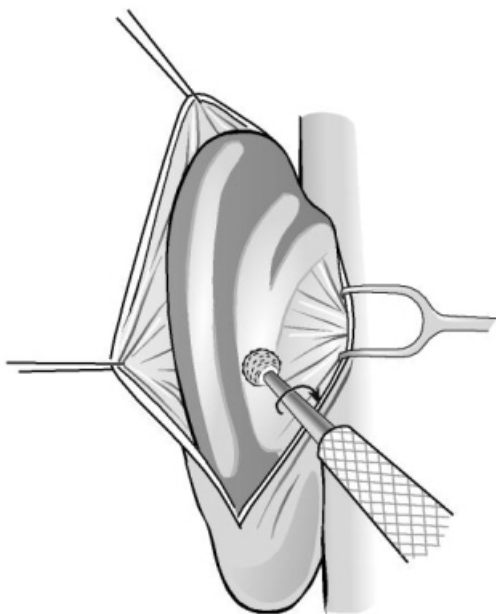
Figure 10: Cartilage thinning according to Weerda

This comparatively simple and practicable method is also suitable for the antihelix plasty in patients with stiff or thick cartilage. However, there is still a risk of chondronecrosis associated with inappropriate manipulation of the cartilage. Following complete absorption of the absorbable suture material and after inadequate preparation of the auricular cartilage with the drill, a partial or complete recurrence of the original auricular deformity may occur. By using nonabsorbable instead of absorbable suture material, similar as in the Mustardé suture technique, the recurrence rate can be minimised.

4.2.5 Otoplasty by Walter

The otoplasty described by Walter is an incision technique with cartilage excisions [60]. When bringing back a prominent ear in the mid portion, the most intense tension zones are found at the helical ligament and the intertragal notch; in addition, the shape and thickness of the cauda helicis may create another area of tension. According to Walter, his technique is based on the following principle: "Ease tension where it occurs and shape " [61]. Following retroauricular skin incision and preparation of the dorsal aspect of the auricular cartilage to approximately 5 mm in front of the mastoid plane, a cartilage incision is placed 5 mm along the helical rim and to the front, around the auricle and to the inferior crus or its region (Figure 11). Below the inferior crus, the incision is directed towards the concha and extends below the intended antihelix, which has to be newly created or is only partially formed, up to the intertragal notch. The anterior perichondrium is spared. In addition, the cauda helicis is severed and, if necessary, partially excised. As a result, the lobule is freely movable too. If necessary, concha reductions by crescentic cartilage excision can also be performed from here. Subsequently, the helical ligament is severed,

carefully paying attention to the course of the temporal artery and vein. At the base of the inferior crus and in the intertragal region, cartilage excisions are performed to the necessary extent to effectuate anterograde rotation as well as reduction of tensions in these areas. Modelling of the antihelix is either achieved by scale-like cartilage resections or e.g. by weakening of the cartilage using a diamond drill. Additionally, excessive skin is excised. Then, temporary percutaneous mattress sutures, which shape the antihelix and the crura and are made of nonabsorbable suture material, keep the newly formed auricle in the correct position.
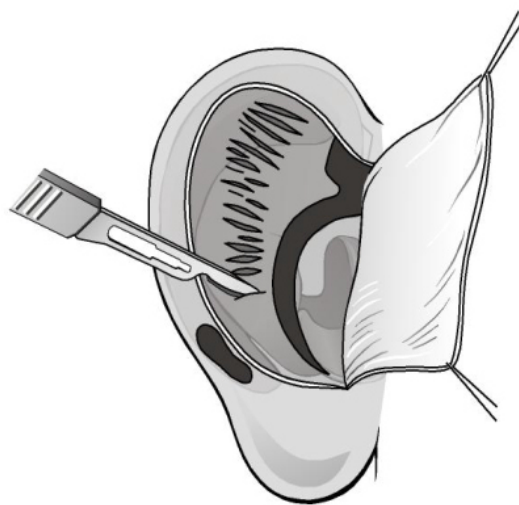

Figure 11: Technique according to Walter

Walter's otoplasty is suitable for all types of protruding ears and revision procedures. The author states a very low recurrence rate for this technique. Because no mattress sutures remain, suture complications are not to be expected. However, the surgeon will need sufficient experience to perform otoplasty using this complex technique, as well as in-depth knowledge of the anatomy of the auricular cartilage architecture to prevent complications or undesirable outcomes, such as visible cartilage edges and distortions associated with excessive cartilage excisions or injury to the superficial temporal artery or vein. Since this techniques involves extensive manipulation of the auricular cartilage, the correction of recurrences in the presence of increased scar formation may be difficult.

4.2.6 Cartilage island flap technique by Pitanguy

The method described by Pitanguy is based on an incision-suture technique, in which an excised cartilage island defines the new antihelical prominence [62], [63]. Following anterior colour marking of the position of the new antihelix, a retroauricular skin incision is placed, and the posterior aspect of the auricular cartilage is exposed up to the mastoid plane. The retroauricular cartilage island

is marked in the region of the antihelix, using ventrally introduced needles and methylene blue solution. Finally, a crescentic incision is placed around the cartilage island so that the anterior perichondrium is undermined, but not excised, at the anterior aspect of the cartilage island (Figure 12). Subsequently, the edges of the cartilage incisions are stitched again in the shape using absorbable suture material so that the prepared cartilage island, in the correct position, defines a new antihelix by an overlay technique. Additionally, lobuloplasty, cavum rotation, as well as cavum fixation according to Furnas can be performed.
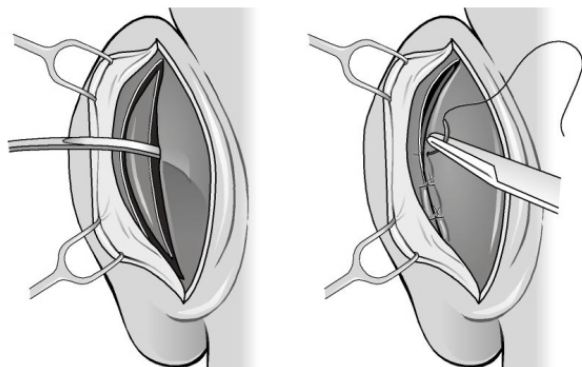

Figure 12: Cartilage island flap technique according to Pitanguy

Although the technique described by Pitanguy creates a satisfactory antihelix, this method is associated with various postoperative risks. It is not uncommon to see sharp edges in the area of the new antihelix; the risk of haematoma formation and suture dehiscence is increased. In addition, undesirable cosmetic outcomes with asymmetrical antihelices may develop as the result of asymmetrical cartilage islands. Although the author himself reports symmetrical antihelices in almost 100% of his patients over a follow-up period of 25 years, this technique may be regarded as an alternative to the previously described techniques only if performed by a very experienced surgeon.

4.3 "Concha"

4.3.1 Conchal cartilage excisions

To achieve a reduction in height and/or size of the concha or the cavum conchae, procedures such as cartilage excisions, cartilage-weakening scoring-incision techniques, and suture techniques are available.
Theses excisions of the concha can be performed, using an anterior access, with a combined skin-cartilage excision, or, using a retroauricular access, in a skin-sparing manner. To date, no conclusive evidence is available regarding the advantages and disadvantages of the anterior and posterior method, respectively. Converse described in 1955 an excision technique via a retroauricular access, favouring a spindle-shaped excision of a cartilage strip for the reduction of the concha, sparing the anterior perichondrium [42]. Stenström chose an anterior access

to expose and score the antihelical cartilage, performing a simultaneous concha reduction using a spindle-shaped anterior excision [45]. Beasley and Jones excised the lower conchal bowl segment via a posterior access to primarily reduced the height of the antitragus [64]. In contrast, Bauer and Elliott propose an anterior conchal excision, additionally excising an anterior skin strip from the concha area. The skin excision is intended to prevent a cosmetically undesirable skin fold formation in the area of the anterior concha [65], [66], [67].

4.3.2 Cavum rotation and fixation according to Furnas

The angle between the mastoid and the helical rim should be between 20-30 degrees according to Vargas [16]. In protruding ears, this angle can be up to 90 degrees, due to hyperplasia of conchal bowl. Apart from the techniques for antihelix formation already described, a reduction of the cavum-mastoid angle is often required to bring back the ear to the cranial bone. For this end, initially a retroauricular incision along and parallel to the helical rim is placed, and the preparation of the posterior aspect of the cartilage in a caudal direction up to the mastoid plane is performed. The excessive retroauricular connective, fatty, and muscular tissue is excised, completely sparing the temporal fascia (Figure 13 a, b). Subsequently, the auricle is rotated dorsally and fixed between the conchal cartilage and the dorsal mastoid periosteum, using mattress sutures (Figure 13 c) [49].
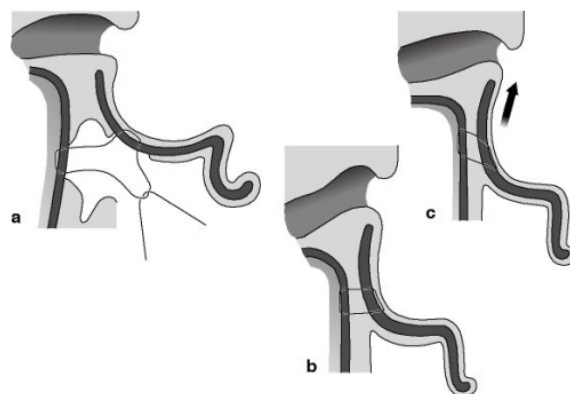

Figure 13: Cavum rotation technique
a: retroauricular resection of adipose/connective tissue, b: preparation of the temporal fascia, c: cavum rotation and fixation

With this comparatively simple and effective suture technique, other cartilage excisions are generally not required for a satisfactory reduction of the cavum-mastoid angle. By combining this technique with an antihelix plasty and lobuloplasty, good to very good cosmetic results can be achieved. Attention should be paid to an adequate dorsal preparation of the retroauricular skin and the connective tissue to prevent narrowing of the external auditory canal by mattress sutures placed too far ventrally.

4.3.3 Concha cartilage weakening

Based on the studies of Gibson and Davis, as well as those of Stenström and Chongchet, numerous methods and their modifications have been presented over the last years which achieve the desired shape of the conchal cartilage with scoring, incisions, grinding down with diamond drills, rasps, needles, or Adson-Brown forceps [41], [43], [45], [68], [69], [70], [71], [72], [73], [74]. These procedures are frequently performed in combination with mattress sutures of absorbable or non-absorbable suture material to keep the weakened cartilage in the desired position. If the cartilage is soft, conchal reduction, especially in the region of the cavum conchae, can be achieved by a suture technique alone, using nonabsorbable suture material and properly positioned mattress sutures.

4.4 "Lobule"

The initial problem analysis prior to otoplasty frequently shows a marked anterolateral projection of the lobule. Following antihelix plasty, the lobule often appears to protrude even further. For aesthetic reasons, the lobule should be positioned parallel to plane of the upper third of the ear. Numerous retrolobular skin incisions or excisions have been described that are intended to permanently reposition the protruding lobule.

The retroauricular skin incision can easily be extended to the middle of the lobule, and subsequently skin excisions can be performed to the extent required (Figure 14 a). Many types of skin excisions, e.g. in the shape of a fish tail, a Z-plasty or an ellipse, in combination with fat resection in the area of the lobule have been suggested [47], [51], [75], [76].
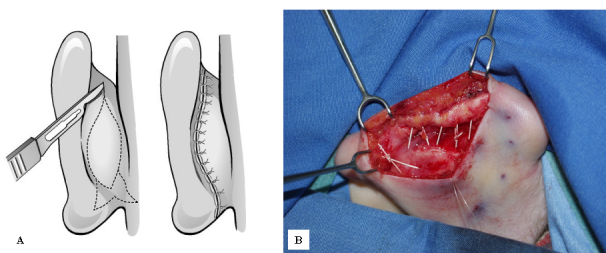

Figure 14: Lobuloplasty
A = skin excisions, B = lobuloplasty according to Siegert

Because the lobule is immediately adjacent to the cauda helicis, a caudal abnormality is also discussed as possible cause of protruding ears. Based on their studies on cadaver specimens, Goulain and Conway divide the helical and conchal cartilage into two separate entities and suggest for the reposition of the lobule a suture between the cauda helicis and the concha along with an intact anterior cartilage surface [77]. In contrast, Webster recommends a combination of a cartilage excision in the area of the cauda helicis and an elliptic retrolobular skin resection [78]. While Spira favours a single skin-mastoid suture for the reposition of the lobule, Gosain and Recinos suggest a combination of a retrolobular skin excision and

a full-thickness skin-mastoid suture [31], [79]. Despite numerous reports about successful repositions of the lobule, the skin-suture techniques alone cannot guarantee a successful long-term result due to the natural elasticity of the skin.

In contrast, Siegert described a suture technique in which the connective tissue is dissected towards the lobule at the caudal end of the incision [52]. The ventral and dorsal skin in the region of the lobule are separated and then an absorbable mattress suture is placed through the edge of the lobule and of the cavum conchae (Figure 14 b). In this way, the lobule can be drawn to the cavum in a controlled manner and satisfactory reposition is achieved without additional skin resection. However, it has to be kept in mind that if this generally simple technique is improperly performed, using excessive pull or placing the suture incorrectly, aesthetically undesirable retraction may occur [58].

5 Modifications of the otoplasties

5.1 Minimal invasive otoplasty

Over the past years, there have been increasing calls for minimally invasive methods of otoplasty. The reasons behind this development are the quest for methods to minimise invasive surgical techniques and, on the other hand, the reduction of postoperative risks, including haematoma and increased scarring. Fritsch describes a suture-only technique, creating a new antihelical fold with percutaneously placed and subcutaneously laid horizontal mattress sutures [80]. A modification of this technique is described by Peled as "incision-free otoplasty", combing a suture technique similar to that of Fritsch with blind scoring of the anterior antihelix via a small skin incision in the area of the anterior cauda helicis [81]. An additional minimally invasive endoscopic assisted otoplasty has been suggested by Graham and Gault et al. [82]. To this end, a small skin incision in the upper hairline above the auricle is made to introduce the endoscope. The cartilage in the area of the new antihelix is scored blindly from a retroauricular approach. Additionally, a scapha-mastoid suture of nonabsorbable suture material is placed via small, retroauricular incisions. New techniques for a gentle weakening of the antihelical and conchal cartilage have been described by Raunig H.; for this purpose, a special diamond rasp was developed that is inserted via small skin incisions at the inner side of the upper helical rim and at the caudal antihelix [83]. Recently, Benedict and Pirwitz also described a minimally invasive otoplasty, combining subcutaneously placed cartilage-penetrating nonabsorbable mattress sutures and blind scoring of the anterior antihelix cartilage with a scoring instrument according to Benedict [73]. Although the authors report favourable results, long-term data are not yet available.

5.2 Nonsurgical methods for the correction of protruding ears

Few studies have been published on nonsurgical methods for the correction of protruding ears. Nevertheless, it has been repeatedly reported that a neonate's auricular cartilage is mouldable without surgical or pharmacological interventions. Tan et al. reported about newborns with protruding ear in whom auricular moulds were used in the first 3 postnatal days to form a normally shaped ear [84], [85]. When the initiation of treatment was delayed beyond three days after birth, less favourable results were achieved due to a reduced malleability of the auricular cartilage. Tan et al. and Matsuo et al. attributed this to a measurable drop in circulating maternal oestrogens, which peak during the first three postpartum days and arrive at normal levels by the time of 6th postpartum week [84], [86]. In later studies, Matsuo et al. observed that the percentage of protruding ears increased from 0.4 percent at birth to 5.5 percent at the age of one year, and concluded that most cases might actually represent "acquired " prominent ears as a consequence of a wrong position of the infant's head, leading to folding of the auricle during sleep at night [87].

6 Complications of otoplasty

In principle, it can be differentiated between early and late complications of otoplasty [23], [53], [56], [57], [66]. Early complications include haematomas, wound infections, which may be associated with perichondritis, pain, postoperative bleeding, allergic reactions, and, most devastatingly, cartilage-skin necroses. In contrast, hypertrophic scars, keloids, suture material rejection with fistula formation, hypaesthesia or paraesthesia, auricular deformities or a recurrence occur as late complications (Table 1). For the early detection of complications, regular follow-up examinations and care are strongly recommended and should be performed by the surgeon. Haematomas are more frequently associated with cartilage weakening methods of antihelix plasty, such as incision and/or scoring techniques. Each otoplastic intervention carries the risk of perichondritis which, in extreme cases, may result in cartilage-skin necrosis with cosmetically unsatisfactory auricular deformity. Pain during the first postoperative days may herald complications and require immediate attention, including examination and change of dressing. Significant local pruritus at the ear may indicate an allergic reaction to the suture material or the dressing material, and further clarification should be attempted. Since late complications, such as hypertrophic scars or keloids, may occur even months after otoplasty, follow-up examinations at longer intervals up to one year are recommended. If the patient has a history of hypertrophic scars or keloids, he or she should be informed about the associated increased risk and the potential at a second surgical intervention may be required. In addition, these patients should apply a scar ointment, which

inhibits excessive collagen synthesis in the region of the scar. Fistula formation may indicate rejection of the suture material or the presence of knots too superficially placed underneath the retroauricular skin, and requires surgical revision with fistelectomy and removal of the originally used suture material. Even if the surgical technique is correctly performed, a recurrence with renew protrusion of the ears may occur. Therefore, already during the first appointment or, at the latest, during the informed consent discussion, the patient or the parents of the child should be comprehensively informed about the associated risks and possible complications and be asked about their expectations regarding the outcome of the intervention. In-depth knowledge of suitable surgical techniques and the correct performance of the otoplasty procedures are crucial for a good cosmetic result.

Table 1: Complications after otoplasty

Early complications	Late complications
pain	hypertrophic scars, keloids
haematoma, postoperative haemorrhage	fistulas, granulomas
wound infection, perichondritis	hyp- and paraesthesia
cartilage-skin-necroses	recurrence
allergic reaction	auricular cartilage deformities

7 Algorithm of otoplasty

See Figure 15. During the evaluation of the ear and the planning of the otoplasty, attention should be paid to the following parameters:

- Helix-mastoid angle (>30°)
- Helix-mastoid distance: a) cranial helical rim; b) helical rim at the level of the cavum conchae; c) lobule (>18-20 mm)
- Hypoplastic antihelix, anthelical folding
- Conchal hyperplasia, cavum conchae
- Position of the lobule
- Isolated changes at the ear: coloboma, Darwin tubercle, auricular appendage
- Cartilage consistency:
  a) soft, easily pliable cartilage
  b) thick, stiff, poorly pliable cartilage
- First intervention or revision
- Tendency to develop keloids
- Age of the patient

Otoplasties are generally performed in children of 5-6 years of age under general anaesthesia. Although some authors recommend to already perform an otoplasty in children younger than four years of age under general anaesthesia, the necessary compliance and the auricular growth should also be taken into consideration when
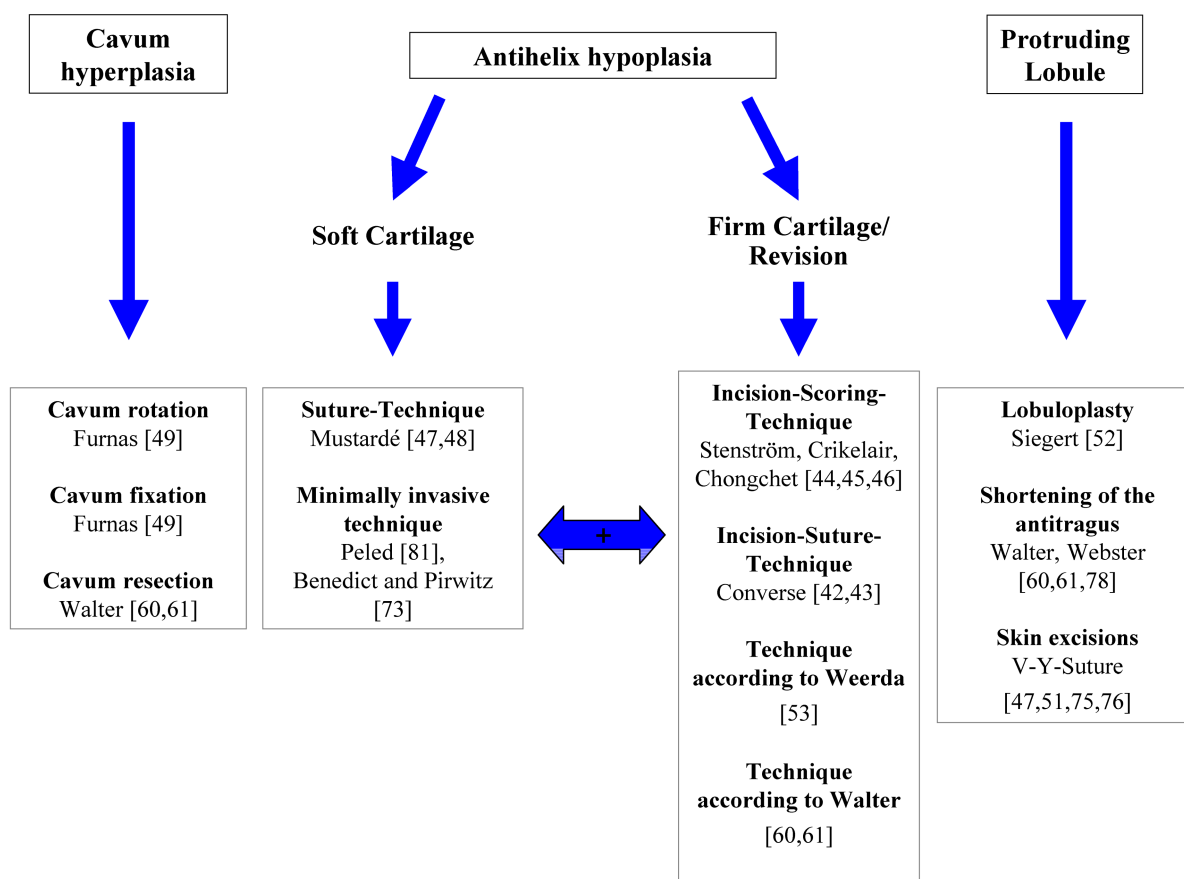
Figure 15: Algorithm of otoplasty

planning the time of the operation [33]. In children or adolescents aged 10 years and above, as well as in adults, otoplasty can be performed under local anaesthesia without problem. Nevertheless, the compliance of the patient or the child should generally be taken into consideration when selecting the appropriate surgical technique and anaesthetic method.

It is not unusual that the choice of the surgical technique is made based on the interventional experience of the surgeon. Despite individual preferences regarding certain techniques, every surgeon performing an otoplasty should have theoretical knowledge of and practical experiences with the various standard techniques, as a matter of principle. The standard methods include the suture technique according to Mustardé, the incision-suture technique according to Converse, and the incision-scoring technique according to Stenström, Chongchet and Crikelair. Despite numerous modifications, almost all protruding ears can be corrected with good to very good cosmetic results using these standard techniques [42], [44], [45], [46], [47].

In most patients with protruding ears, an antihelical hypoplasia or a complete agenesis of the antihelical fold is found. If the cartilage is very thin and soft, the gentle suture technique described by Mustardé is very promising regarding the shaping of a new antihelix; here, the use of nonabsorbable suture material is recommended. In contrast, the use of incision-scoring techniques or incision-suture techniques is generally required in cases

of thick or stiff auricular cartilage or for revision procedures to achieve sufficient weakening of the cartilage and shaping of the antihelix.

Alternatively, if the cartilage is thick, posterior cartilage weakening by means of a diamond drill, as described by Weerda, can be used [59].

In case of hyperplasia of the cavum conchae, cartilage-sparing procedures, such as cavum rotation, cavum fixation according to Furnas, or, in severe cases, cavum cartilage resection is performed [42], [45], [49], [64], [65]. Modifications of the techniques described, incorporating cartilage incisions or scoring, can suffice to weaken the cartilage of the cavum conchae in selected cases [73], [74].

It is not uncommon that after completion of the antihelix plasty and the cavum rotation a protruding lobule is seen. Although retrolobular skin excisions are recommended by various authors for the correction of the lobule, the risk of recurrence due to the natural skin elasticity must not be underestimated [51], [75]. Some authors recommend cartilage resections in addition to the skin resections in the area of the cauda helicis to achieve repositioning of the lobule [78]. Siegert developed a suture technique by which the lobule can be pulled with a suture to the cavum conchae and satisfactory reposition is achieved without additional skin resection [52]. This technique is easy to perform and can be easily combined with other techniques of otoplasty.

At the end of the operation, excessive retroauricular skin can be excised sparingly, ensuring tension-free suture to prevent the formation of postoperative keloids [88].

8 Follow-up care

For postoperative care after otoplasty, packing with cotton or straps soaked with an antibiotic-containing preparation or disinfecting agent have proven to be effective. With these measures, the contour of the newly formed auricle is stabilised and an infection is prevented (Figure 16). The first dressing change is usually performed on the 1st-2nd postoperative day to ensure that a possible haematoma is recognised early and drained, if necessary. During the first 7-8 days, the dressing is changed twice. In addition, peri- and postoperative antibiotic prophylaxis over 7 days with a cartilage-penetrating agent may be used in cases of extensive cartilage-weakening surgery. At the 7th-8th postoperative day, the sutures are removed and the dressing is replaced by a headband. The headband should be worn for another 4-6 weeks, at least at night, to prevent accidental kinking of the auricle. At 6 and 12 months after the operation, a further photographic documentation is recommended.
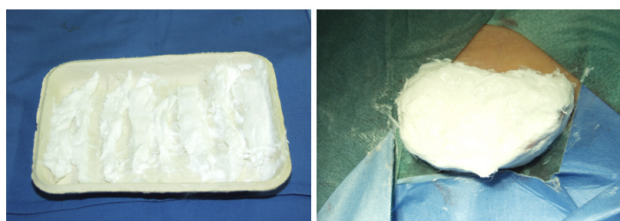

Figure 16: Ear dressing

Concluding, a real patient is portrayed as an example. A 6-year-old girl underwent otoplasty under general anaesthesia. Because of her markedly prominent ears, the child had often been teased. The preoperative examination showed significantly protruding ears with an ear-head distance according to Wodak of 34-35 mm in the region of the upper and mid auricle. In addition, marked antihelical hypoplasia and cavum hyperplasia was present.

The auricular cartilage was soft and elastic. Based on the findings during assessment, an antihelix plasty using Mustard's suture technique, a retroauricular adipose tissue reduction with subsequent rotation and fixation of the cavum according to Furnas, as well as a moderate lobuloplasty according to Siegert were performed. The postoperative result 6 months after the intervention showed a symmetrical ear-head distance of 16-17 mm, a newly formed antihelical fold, a smaller cavum conchae, as well as a lobule set back in the auricular plane (Figure 17).
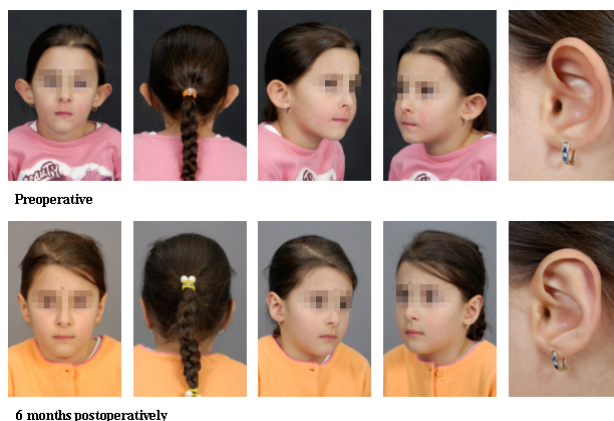

Preoperative

6 months postoperatively

Figure 17: Surgical results after otoplasty

References

1. Frick H, Leonhardt H, Starck D. Allgemeine Anatomie - Spezielle Anatomie I. Bd. 1. Stuttgart: Thieme; 1987. p. 673.

2. Siegert R, Weerda H, Remmert S. Embryology and surgical anatomy of the auricle. Facial Plast Surg. 1994;10:232-43.

3. Adamson JE, Horton CE, Crawford HH. The growth pattern of the external ear. Plast Reconstr Surg. 1965;36:466-8.

4. Pelz L, Stein B. Clinical assessment of ear size in children and adolescents. Padiatr Grenzgeb. 1990;29:229-35.

5. Farkas LG, PosnickJC, Hreczko TM. Anthropometric growth study of the ear. Cleft Palate Craniofac J. 1992;29:324-9.

6. Kalcioglu MT, Toplu Y, Ozturan O, Yakinci C. Anthropometric growth study of auricle of healthy preterm and term newborns. Int J Pediatr Otorhinolaryngol. 2006;70:121-7.

7. Kalcioglu MT, Miman MC, Toplu Y, Yakinci C, Ozturan O. Anthropometric growth study of normal human auricle. Int J Pediatr Otorhinolaryngol. 2003;67:1169-77.

8. Ito I, Imada M, Ikeda M, Sueno K, Arikuni T, Kida A. A morphological study of age changes in adult human auricular cartilage with special emphasis on elastic fibers. Laryngoscope. 2001;111:881-6.

9. Balogh B, Millesi H. Are growth alterations a consequence of surgery for prominent ears? Plast Reconstr Surg. 1992;90(2):192-9.

10. Rogers B. Microtic, lop, cup and protruding ears: four directly inheritable deformities? Plast Reconstr Surg. 1968;41:208-31.

11. Tanzer R. Congenital deformities. In: Converse J, ed. Reconstructive Plastic Surgery. Philadelphia: Saunders; 1977. p. 1671.

12. Weerda H. Classification of congenital deformities of the auricle. Facial Plast Surg. 1998;5:385-8.

13. Ganzer U. Konsensusbericht der Deutschen Gesellschaft für Hals-Nasen-Ohren-Heilkunde, Kopf- und Hals-Chirurgie: Plastisch-rekonstruktive und ästhetische Operationen in der Hals-Nasen-Ohren-Heilkunde, Kopf-Hals-Chirurgie. HNO Mitt. 1998;48:186-90.

14. Siegert R. Neue Wege bei der chirurgischen Behandlung der kongenitalen Gehörgangsastresie. HNO. 2004;2:275-86.

15. Takemori S, Tanaka Y, Suzuki JI. Thalidomide anomalies of the ear. Arch Otolaryngol. 1976;102(7):425-7.

16. Wodak E. On the position and shape of the human auricle. Arch Klin Exp Ohren Nasen Kehlkopfheilkd. 1967;188:331-5.

17. Farkas LG. Anthropometry of the normal and defective ear. Clin Plast Surg. 1990;17:213-8.

18. Siegert R, Krappen S, Kaesemann L, Weerda H. Computer assisted anthropometry of the auricle. Face. 1998;6:1-6.

19. Farkas LG. Anthropometry of normal and anomalous ears. Clin Plast Surg. 1978;5:401-14.

20. Tolleth H. Artistic anatomy, dimensions, and proportions of the external ear. Clin Plast Surg. 1978;5:337-41.

21. Tolleth H. A hierarchy of values in the design and construction of the ear. Clin Plast Surg. 1990;17:193-9.

22. Bozkir MG, Karakas P, Yavuz M, Dere F. Morphometry of the external ear in our adult population. Aesthetic Plast Surg. 2006;30:81-5.

23. Janis JE, Rohrich RJ, Gutowski KA. Otoplasty. Plast Reconstr Surg. 2005;115(4):60e-72e.

24. Schwentner I, SchmutzhardJ, Deibl M, Sprinzl GM. Health-related quality of life outcome of adult patients after otoplasty. J Craniofac Surg. 2006;17:629-35.

25. Sheerin D, MacLeod M, Kusumakar V. Psychosocial adjustment in children with port-wine stains and prominent ears. J Am Acad Child Adolesc Psychiatry. 1995;34:1637-47.

26. Wolfe SA. Timing of otoplasty for prominent ears. Plast Reconstr Surg. 2006;117(2):681.

27. Payasli C, Babuccu O, Kargi E, Hosnuter M, Tekerekoglu B. Traumatic prominent ear secondary to cartilage fracture without skin laceration or hematoma. Plast Reconstr Surg. 2006;117(3):1052-3.

28. Meagher PJ, Morrison WA. An unusual presentation of bilateral prominent ears. Br J Plast Surg. 2001;54(4):366-7.

29. Spira M. Otoplasty: What I do now - a 30-year perspective. Plast Reconstr Surg. 1999;104(3):834-41.

30. Becker W, Deutsch E, Knappen FJ, Nussgens K. Panel discussion: problems of the specialist's duty to inform the patient. HNO. 1976;24(6):181-96.

31. Gosain AK, Recinos RF. Otoplasty in children less than four years of age: surgical technique. J Craniofac Surg. 2002;13(4):505-9.

32. Ullmann Y, Blazer S, Ramon Y, Blumenfeld I, Peled IJ. Early nonsurgical correction of congenital auricular deformities. Plast Reconstr Surg. 2002;109(3):907-15.

33. Gosain AK, Kumar A, Huang G. Prominent ears in children younger than 4 years of age: what is the appropriate timing for otoplasty. Plast Reconstr Surg. 2004;114(5):1042-54.

34. Ganzer U. Konsensusbericht der Deutschen Gesellschaft für Hals-Nasen-Ohren-Heilkunde, Kopf- und Hals-Chirurgie: Plastisch-rekonstruktive und ästhetische Operationen in der Hals-Nasen-Ohren-Heilkunde, Kopf-Hals-Chirurgie. In: Leitlinien "Ohrplastik" online; 2003.

35. Dieffenbach JE. Die operative Chirurgie. Leipzig: F. A. Brockhaus; 1845.

36. Ely ET. An operation for prominent auricles. Arch Otolaryngol. 1881;10:97. reprinted in Plast Reconstr Surg. 1968;42:582.

37. Keen WW. New method of operating for relief of deformity of prominent ears. Ann Surg. 1890;11:49.

38. Gersuny R. Über einige kosmetische Operationen. Wien Med Wochenschr. 1903;53:2253.

39. Luckett WH. A new operation for prominent ears based on the anatomy of the deformity. Surg Gynecol Obstet. 1910;10:635.

40. Becker OJ. Correction of protruding deformed ear. Br J Plast Surg. 1952;5:187.

41. Gibson T, Davis W. The distortion of autogenous cartilage grafts: Its cause and prevention. Br J Plast Surg. 1958;10:257.

42. Converse JM, Nigro A, Wilson FA, Johnson N. A technique for surgical correction of lop ears. Plast Reconstr Surg. 1955;15:411.

43. Converse JM, Wood-Smith D. Technical details in the surgical correction of the lop ear deformity. Plast Reconstr Surg. 1963;31:118.

44. Chongchet V. A method of antihelix reconstruction. Br J Plast Surg. 1963;16:268.

45. Stenström SJ. A "natural" technique for correction of congenitally prominent ears. Plast Reconstr Surg. 1963;32:509.

46. Crikelair GF. Another solution for the problem of the prominent ear. Ann Surg. 1964;160:314-24.

47. Mustardé JC. The correction of prominent ears using simple mattress sutures. Br J Plast Surg. 1963;16:170.

48. Mustardé JC. The treatment of prominent ears by buried mattress sutures: A ten-year survey. Plast Reconstr Surg. 1967;39:382.

49. Furnas DW. Correction of prominent ears by conchamastoid sutures. Plast Reconstr Surg. 1968;42:189.

50. Spira M, McCrea R, Gerow FJ, Hardy SB. Correction of the principal deformities causing protruding ears. Plast Reconstr Surg. 1969;44:150.

51. Wood-Smith D. Otoplasty. In: Rees T, ed. Aesthetic Plastic Surgery. Philadelphia: Saunders; 1980. p. 833.

52. Siegert R. Correction of the lobule. Facial Plast Surg. 2004;20:293-8.

53. Weerda H. Chirurgie der Ohrmuschel. Bd. 1 Stuttgart: Thieme; 2004.

54. Buchwald C, Nielsen LH, Rosborg J. Keloids of the external ear. ORL J Otorhinolaryngol Relat Spec. 1992;54(2):108-12.

55. Rigg BM. Suture materials in otoplasty. Plast Reconstr Surg. 1979;63(3):409-10.

56. Staindl O. Failures and complications following otoplasty. Laryngol Rhinol Otol. 1986;65(11):646-51.

57. Heppt W, Trautmann Y. Otoplastic techniques for the correction of protrudingears. HNO 1999;47(8):688-94.

58. Mattheis S, Siegert R. Techniques in otoplasty. HNO. 2006;54(8):643-56.

59. Weerda H. Remarks about otoplasty and avulsion of the auricle. Laryngo-Rhino-Otol. 1979;58(3):242-51.

60. Walter C. Correction of the auricle. HNO. 1983;31(11):381-6.

61. Walter C. Plastic surgery of protruding ears. HNO. 1998;46(3):193-4.

62. Pitanguy I, Muller P, Piccolo N, Ramalho E, Solinas R. The treatment of prominent ears: a 25-year survey of the island technique. Aesthetic Plast Surg. 1987;11(2):87-93.

63. Pitanguy I, Fiazza G, Calixto CA, Muller PM, Caldeira AM, Alexandrino A. Prominent ears - Pitanguy's island technique: long-term results. Head NeckSurg. 1985;7(5):418-26.

64. Beasley NJ, Jones NS. Otoplasty: the problem of the deep conchalbowl. J Laryngol Otol. 1996;110(9):864-8.

65. Bauer BS, Song DH, Aitken ME. Combined otoplasty technique: chondrocutaneous conchal resection as the cornerstone to correction of the prominent ear. Plast Reconstr Surg. 2002;15;110(4):1033-41.

66. Elliott RA Jr. Complications in the treatment of prominent ears. Clin Plast Surg. 1978;5(3):479-90.

67. Elliott RA Jr. Otoplasty: a combined approach. Clin Plast Surg. 1990;17(2):373-81.

68. Nordzell B. Open otoplasty. Plast Reconstr Surg. 2000;106(7):1466-72.

69. Yugueros P, Friedland JA. Otoplasty: the experience of 100 consecutive patients. Plast Reconstr Surg. 2001;108(4):1045-53.

70. Bulstrode NW, HuangS, Martin DL. Otoplasty by percutaneous anterior scoring. Another twist to the story: a long-term study of 114 patients. Br J Plast Surg. 2003;56(2):145-9.

71. Peker F, Celikoz B. Otoplasty: anterior scoring and posterior rolling technique in adults. Aesthetic Plast Surg. 2002;26(4):267-73.

72. Hoehn JG, Ashruf S. Otoplasty: sequencing the operation for improved results. Plast Reconstr Surg. 2005;115(1):5-16.

73. Benedict M, Pirwitz KU. Minimally invasive otoplasty. HNO. 2005;53(3):230-7.

74. Keramidas EG. The use of Adson-Brown forceps to score the cartilage in otoplasty. Plast Reconstr Surg. 2006;118(1):263.

75. Kelley P, Hollier L, Stal S. Otoplasty: evaluation, technique, and review. J Craniofac Surg. 2003;14(5):643-53.

76. Lavy J, Stearns M. Otoplasty: techniques, results and complications - a review. Clin Otolaryngol Allied Sci. 1997;22(5):390-3.

77. Goulian D, Conway H. Prevention of persistent deformity of the tragus and lobule by modification of the Luckett technique of otoplasty. Plast Reconstr Surg. 1960;26:399.

78. Webster GV. The tail of the helix as a key to otoplasty. Plast Reconstr Surg. 1969;44:455.

79. Spira M. Reduction otoplasty. In: Goldwyn RM, ed. The Unfavorable Result in Plastic Surgery. Boston: Little, Brown; 1984. p. 307-23.

80. Fritsch MH. Incisionless otoplasty. Laryngoscope. 1995;105 (Suppl 70):1-11.

81. Peled IJ. Knifeless otoplasty: how simple can it be? Aesthetic Plast Surg. 1995;19(3):253-5.

82. Graham KE, Gault DT. Endoscopic assisted otoplasty: a preliminary report. Br J Plast Surg. 1997;50(1):47-57.

83. Raunig H. Anthelix plasty without modelling sutures. Arch Facial Plast Surg. 2005;7:334-1.

84. Tan ST, Abramson DL, MacDonald DM, Mulliken JB. Molding therapy for infants with deformational auricular anomalies. Ann Plast Surg. 1997;38(3):263-8.

85. Tan ST, Shibu M, Gault DT. A splint for correction of congenital ear deformities. Br J Plast Surg. 1994;47(8):575-8.

86. Matsuo K, Hirose T, Tomono T, Iwasawa M, Katohda S, Takahashi N, Koh B. Nonsurgical correction of congenital auricular deformities in the early neonate: a preliminary report. Plast Reconstr Surg. 1984;73(1):38-51.

87. Matsuo K, Hayashi R, Kiyono M, Hirose T, Netsu Y. Nonsurgical correction of congenital auricular deformities. Clin Plast Surg. 1990;17(2):383-95.

88. Bloching M, Kippenhahn K, Knipping S, Berghaus A. Die Ohrmuschelanlegeplastik. Medithek of the Deutsche Gesellschaft für Hals-Nasen-Ohrenheilkunde, Kopf- und Halschirurgie; 2000.

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