Reconstruction of post-traumatic full-thickness defects of the upper one-third of the auricle

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BACKGROUND: Reconstruction of partial ear defects represents a difficult challenge to the plastic surgeon due to the delicate and intricate architecture of the chondrocutaneous sandwich of the external ear.

METHODS: Fourteen patients with acute or previous traumatic subtotal loss of the upper one-third of the auricle were treated with autologous contralateral conchal cartilage graft and superficial temporoparietal fascia flaps.

RESULTS: The symmetry of the reconstructed ears was satisfactory and the cosmetic appearance was acceptable for 13 patients. Minor hematoma at the conchal cartilage graft donor site occurred in one (7.1%) patient and marginal loss of temporoparietal flap in another (7.1%). Revision surgery was required for widening of the scar and obscuring of the upper pole contour in one (7.1%) patient. No additional complications were encountered.

CONCLUSION: The authors recommend using this combined technique for reconstruction of full-thickness auricular defects.

Key Words: Auricular reconstruction; Ear defects; Temporoparietal fascia flap; Upper one-third auricular defects

Auricular defects pose one of the most difficult challenges in reconstructive surgery of the head and neck. The reason is the unique three-dimensional anatomical architecture of the auricle, with its multiple concavities and convolutions of the cartilage and the thin, delicate skin cover.

Acquired auricular deformities commonly result from traumatic injuries, burn trauma or tumour extirpation. These vary in severity from simple lacerations to complete auricular avulsions (1). The goal of reconstruction is the precise duplication of the missing anatomical part with regard to size, orientation and anatomical landmarks (2). The methods of reconstruction range from healing by secondary intention to complete replacement with auricular prosthesis.

The present study aimed to evaluate the reconstruction of upper one-third auricular defects using autologous conchal cartilage graft and temporoparietal fascia flap covered by split-thickness skin graft.

METHODS

The present study was conducted between January 2010 and December 2011 in the Plastic Surgery Department of Ain Shams University (Cairo, Egypt). Fourteen patients presenting with either acute or previous traumatic subtotal defects (range 15% to 50%) of the upper one-third of the auricle were included. Their mean ($\pm$ SD) age was 27.07 ± 5.48 years (range 19 to 41 years) and all were male.

Informed written consent was obtained from each patient according to the regulations of the local research ethics committee. The patients were examined periodically in the follow-up period, which ranged from three and nine months (mean 4.50 ± 1.79 months).

In all cases, operations were performed under general anesthesia. In acute traumatic cases, debridement of the wound was performed and skin margins were excised. In older cases, the marginal scar was excised then, when possible, a posteriorly based flap was elevated from the available skin.

La reconstruction d'anomalies de toute l'épaisseur du tiers supérieur du pavillon de l'oreille après un traumatisme

HISTORIQUE : La reconstruction d'anomalies partielles de l'oreille pose un défi particulier au chirurgien plasticien en raison de l'architecture délicate et complexe du bourgeonnement chondrocutané de l'oreille externe.

MÉTHODOLOGIE : Quatorze patients ayant subi une perte traumatique subtotale aiguë ou antérieure du tiers supérieur de l'oreille se sont fait traiter par une greffe du cartilage de la conque contralatérale autologue et des lambeaux superficiels de fascia temporopariétal.

RÉSULTATS : Treize patients ont trouvé la symétrie de l'oreille reconstruite satisfaisante et leur aspect esthétique acceptable. Un patient (7,1 %) a présenté un hématome mineur au foyer de la greffe de cartilage de la conque et un autre (7,1 %), une perte marginale du lambeau temporopariétal. Un patient (7,1 %) a dû subir une opération de reprise pour élargir la cicatrice et occulter le contour du pôle supérieur. Aucune autre complication ne s'est produite.

CONCLUSION : Les auteurs recommandent cette technique combinée pour la reconstruction des anomalies de toute l'épaisseur de l'oreille.

Figure 1) An intraoperative view showing harvesting of the conchal cartilage graft from the contralateral auricle

First, a conchal cartilage graft was harvested from the contralateral auricle according to the technique described by Ortiz-Monasterio and Molina (3). Its dimensions were determined according to a template representing the dimensions of the contralateral normal auricle (ranging from $2 \text{ cm} \times 2 \text{ cm}$ to $2.5 \text{ cm} \times 3 \text{ cm}$) (mean $2.04 \pm 0.72 \text{ cm}^2$). The graft was sutured to the remaining cartilaginous framework using 4/0 prolene (Figures 1A and 1B).

Second, a temporoparietal fascial flap was elevated through a temporal incision extending from the anterior limit of the auricular defect according to the technique described by Antonyshyn et al (4). If there was adequate remaining skin to cover the posterior aspect of the cartilage grafts, the flap was applied as an onlay cover to the conchal cartilage graft; otherwise, the fascial flap was wrapped around the cartilage graft to cover both sides. The skin graft was applied to the fascial flap either primarily, or after five days if the vascularity of the flap needed further monitoring.

Documentation was performed using medical digital photography before treatment and at the follow-up visits. Patients were asked to subjectively evaluate their final results (size, shape and contour of the

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Figure 2) A Acute posttraumatic loss of the upper part of the right auricle with exposed cartilage. B An intra-operative view after inset of the temporoparietal fascia flap

Figure 3) A An intraoperative view of post-traumatic loss of the upper part of the left auricle with exposed cartilage with after elevation of the temporoparietal fascia flap. B An intraoperative view after inset of the temporoparietal fascia flap. C Postoperative view after three weeks with stable coverage

reconstructed ear relative to the contralateral ear) using a four-point numerical rating scale, where 0 indicated no improvement and 3 indicated highly satisfied. In addition, patients were objectively evaluated by two plastic surgeons who were not involved in the treatment. These surgeons compared pre- and postoperative (one month and six months) photographs with regard to shape, size, symmetry and contour. Any complications were also noted. Their evaluation was recorded as percentage of improvement of the cosmetic appearance on a quartile grading scale: <25%: mild improvement; 25% to 50%: moderate improvement; 51% to 75%: good improvement; and 76% to 100%: excellent improvement.

RESULTS

The present prospective study involved 14 men who experienced post-traumatic subtotal loss of the upper one-third of the auricle. In all cases, reconstruction was performed using a conchal cartilage graft from the contralateral auricle, which was covered by a temporoparietal fascial flap and split-thickness skin graft (Figures 2 and 3).

Complications included minor hematoma at the conchal cartilage graft donor site in one patient (7.1%), marginal loss of the temporoparietal flap in one patient (7.1%) (Figure 4) and widening of the donor site scar in one patient (7.1%). Otherwise, all temporoparietal flaps were completely viable and supported excellent skin graft take.

Subjective evaluation revealed an overall high degree of satisfaction in 13 of 14 patients. One patient reported moderate satisfaction (Figure 5 and Table 1). The objective aesthetic outcome was rated as 'excellent' in 13 of 14 patients (93%). One patient's outcome was rated as 'good' because the contour at the upper pole of the auricle was obscured (Figure 6 and Table 2).

DISCUSSION

Auricular defects represent a difficult challenge to the reconstructive surgeon because of the unique three-dimensional anatomical architecture of the auricular cartilage. The three-dimensional topography of the external ear reflects the shape of its underlying elastic cartilage framework (1).

Figure 4) A case of post-traumatic loss of the upper part of the left auricle. View four days postoperatively showing marginal loss of the temporoparietal flap

Figure 5) A A preoperative view of old post-traumatic loss of the upper part of the left auricle. B An intraoperative view after inset of the cartilage graft. C Postoperative view after two months showing restoration of the length and contour of the left auricle compared with the normal right side

Auricular defects may result from traumatic avulsion, burns, trauma or tumour extirpation (5). In burns, damage of the auricle may result from direct thermal injury or resorption and removal of a part of the cartilage in the course of management of chronic suppurative perichondritis (6). In our study, all patients experienced traumatic etiology and none experienced previous thermal burn.

Anthropometric studies have revealed that the average length of an adult ear is 5.5 cm to 6.5 cm, with the width equivalent to 60% of its length (7). The age of the patient is an important variable in auricular reconstruction. Auricular growth is fairly rapid in the early life, attaining nearly 87% to 97% of the final height and width by five years of age. Development is fully completed by early adolescence. The cartilaginous framework remains stable in the latter stages of life while the lobule undergoes elongation, narrowing and becomes ptotic (8). In the present study, gross asymmetry in the size of the reconstructed auricle was not encountered because all patients were >19 years of age.

The major structural components of the auricle include the peripherally located helix and antihelix, central conchal complex and an inferiorly placed lobule. Several classification methods have been proposed for auricular defects. According to Orticochea (9), the auricle consists of two aesthetic parts: the central concave concha and the peripheral section, which includes the helix, antihelix and lobule. Loss limited to the concha does not require reconstruction while peripheral loss requires reconstruction to restore the external appearance of the auricle.

TABLE 1

Patient satisfaction* with outcome of reconstruction of post-traumatic full-thickness defects of the upper one-third of the auricle

Satisfaction	n (%)	Valid, %	Cumulative, %
Moderate	1 (7.1)	7.1	7.1
High	13 (92.9)	92.9	100.0
Total	14 (100.0)	100.0	

*Subjective rating based on 0 to 3 numerical rating scale, where 0 = no improvement and 3 = highly satisfied

Figure 6 **A** A case of post-traumatic loss of the upper part of the left auricle showing widening of the donor site scar with obscuring of the contour at the upper pole of the auricle. **B** An intraoperative view after revision of the scar and restoration of the upper pole contour

Wang (2) divided auricular defects into central, peripheral, and large central and peripheral defects. Peripheral defects were further subdivided into upper one-third, middle one-third and lower one-third defects. We adhered to this classification in our patient selection.

The choice of repair ultimately depends on the amount of tissue loss and the location of the auricular defect. The classical method of wedge excision of the auricle often leads to distortion of the remainder of the ear and the formation of cup ear-like deformities in spite of various refinement procedures. Clean loss involving the helix and part of the scapha may be treated by suturing the wound edge to postauricular skin as a first stage of repair, postponing cartilage grafting to a second stage (10). Traumatic radial loss involving <15% of the upper one-third of the auricle may be closed primarily in a wedge-shaped manner or star-shape resection of parts of the scapha (11). Alternatively, initial skin approximation to cover exposed cartilage and delayed reconstruction has been proposed (6).

The use of local flaps for providing helical contour has been attempted. These include the anterosuperiorly based cephaloauricular flap (12), the retroauricular flap based anteriorly on the remnants of the auricle (6) and the posteriorly based mastoid flap, which may be expanded to include the medial auricular skin (13). However, long-term results without incorporation of a cartilaginous strut have been unsatisfactory (5). Geary and Davis (14) reported that the stability of helical defects cannot be accomplished by cutaneous flap alone and advocated chondrocutaneous flaps.

Sclafani and Mashkevich (1) classified post-traumatic defects as partial-thickness injuries involving the skin only or the skin and the underlying cartilage, or full-thickness defects that span all tissue layers of the auricle. All of our cases were full-thickness defects that required multilayered reconstruction with replacement of the cartilage framework and a vascularized soft tissue cover. Several reconstructive techniques were described for reconstruction of full-thickness auricular defects. According to Davis (15), the best material for ear reconstruction is the auricular tissue.

Chondrocutaneous flaps of various designs have been used in reconstruction of auricular defects (16,17). Although the aesthetic

TABLE 2

Surgeon satisfaction* with outcome of reconstruction of post-traumatic full-thickness defects of the upper one-third of the auricle

Evaluation	n (%)	Valid, %	Cumulative, %
Good	1 (7.1)	7.1	7.1
Excellent	13 (92.9)	92.9	100.0
Total	14 (100.0)	100.0	

*Objective ratings by two plastic surgeons who were not involved in treatment of the study group. Their evaluation was recorded as percentage of improvement of the cosmetic appearance on a quartile grading scale: <25% mild; 25% to 50% moderate; 51% to 75% good; and 76% to 100% excellent improvement

outcome is considered to be good, the size of the reconstructed auricle is smaller and the contour is rounded when compared with the contralateral side (18).

A composite conchal flap including the conchal fibrocartilage and its anterior and postauricular skin based posteriorly on a pedicle 1 cm wide (9) or based on the anterior helix (19) provides good blood supply to reconstruct upper one-third auricular defects. The reconstructed external ear appears smaller and shorter than normal, with a localized helical deformity at the site of the pedicle that requires further correction. Normal anatomy of the antihelix and triangular fossa is not recreated by this technique but patients have reported satisfaction with the outcome (20).

An alternative approach for reconstruction of full-thickness defects in the upper one-third of the auricle is cartilage grafting and soft tissue cover. Autologous cartilage sources for grafting include the contralateral concha, nasal septum or costal cartilage. Salvage of the cartilage in the avulsed segment, when available, may be attempted by retroauricular implantation of a dermabraded segment (21) or fenestration of the cartilage with or without preservation of the retroauricular skin (22). According to Brent (5,23), both ipsilateral and contralateral conchal cartilage grafts are preferred for reconstruction of partial auricular defects because of its delicate flexible structure.

Orthotopic placement of thin, elastic, flexible conchal cartilage makes the graft more resistant to trauma and resorption. Costal cartilage, although frequently used for total auricular reconstruction (24), is thicker and requires precise cutting, and is not suitable for one-stage grafting (20). It is rarely used for reconstruction of partial auricular defects (24).

The use of a contralateral conchal cartilage graft does not result in any donor site morbidity in the normal auricle because the integrity of the auricle is maintained if the antihelical fold, the edge of the navicular fossa and the root of the helix are left during graft harvesting (3).

Vascularized soft tissue is provided by the periauricular skin or the temporoparietal fascia and skin graft. The periauricular skin provides good texture and colour match for soft tissue reconstruction but flap harvest may result in visible scarring, thus precluding its use (1). The temporoparietal fascia is an alternative to periauricular skin. It is a thin layer of moderately dense connective tissue that lies immediately deep to the hair follicles and subdermal fibrofatty tissue. It has excellent blood supply from the superficial temporal artery (25). It has been used mostly for reconstruction of auricular defects, for which it provides a protective cover for the auricular framework without obscuring the contour details (4).

Reports regarding reconstruction of post-traumatic auricular defects are scarce in the recent literature. Osorno (26) presented his 20-year experience in reconstruction of auricular deformities in 291 cases. Most of these were congenital and post-traumatic cases represented only 5.2% of the total. In another series (27), functional outcome was assessed according to the ability of the patient to wear eyeglasses.

All patients involved in the present study were post-traumatic cases. Aesthetic outcome was very good in 93% of patients without any functional problem because of the adequate ear projection and

maintenance of the postauricular sulcus. A few minor complications were encountered in our patients including hematoma in the conchal cartilage graft donor site in one (7.1%) patient and widening of the scar in another (7.1%). Marginal flap loss that occurred in one patient did not jeopardize the procedure because the flap was advanced at the time of skin grafting. We did not encounter any case of infection, skin loss, hypertrophic scarring or cartilage resorption.

CONCLUSION

The use of contralateral conchal cartilage graft and coverage by temporoparietal fascia and skin graft is our reconstructive method of choice for segmental full-thickness defects in the upper one-third of the auricle. The integrity of the contralateral auricle is maintained by preserving critical structures that maintain its shape. The fascia covered by skin avoids the use of scarred inelastic periauricular or scalp hair-bearing skin that requires further hair removal.

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