

# Reconstruction of partially amputated external ear with costal cartilage graft: case report

## Ricostruzione del padiglione auricolare parzialmente amputato mediante innesto di cartilagine costale: descrizione di un caso

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### Key words

External ear • Traumatic lesion • Surgical reconstruction

### Parole chiave

Orecchio esterno • Lesioni traumatiche • Ricostruzione chirurgica

### Summary

Many causes are responsible for secondary anomalies of the outer ear, such as: car accidents, sport- or work-related accidents, assaults, bites from animals or humans, benign or malignant tumours, burns and the effects of surgical interventions of the ear (plastic surgery on the ear or attempts at correction of primary malformations of the ear). The anatomical complexity of the ear makes its reconstruction particularly complicated with post-operative results that are often disappointing. The Authors describe their experience in the reconstruction of a partially amputated outer ear following a dog bite. The therapeutic protocol required various surgical stages. Initially, a cutaneous expander was applied at the level of the mastoid in order to ensure a sufficient quantity of local skin. The second stage was to remove cartilage from the ribs, followed by construction of a cartilaginous model of the ear and its insertion into the subcutaneous mastoid region after removal of the cutaneous expander and any residual ear cartilage. The last stage was to separate the neo-formed outer ear from the mastoid skin with the insertion of a cartilage graft to the posterior region of the reconstructed ear. This graft was covered by the occipital fascia rotated at 180° and by a skin graft removed from the pubis. The post-operative result was satisfactory with recuperation of a good aesthetic appearance of the ear. Aim of the present report is to describe the surgical technique employed in the reconstruction of secondary anomalies of the ear and to highlight errors committed during this procedure. These considerations have allowed us to stress some fundamental elements in the reconstruction of the ear. In particular, the watershed was the awareness that we had to create a cartilaginous model that respected, as far as possible, the anatomy of the outer ear with all its ridges, trenches and cavities. This as well as ensuring a sufficient quantity of local skin in order to cover the cartilaginous graft and, therefore, reduce the risk of exposing the cartilage and subsequent infection, to guarantee an optimal end result.

### Riassunto

Molteplici sono le cause responsabili delle anomalie secondarie del padiglione auricolare, quali incidenti stradali, sportivi, sul lavoro, aggressioni, morsi di essere umano o di animali, neoplasie benigne o maligne, ustioni ed esiti di interventi sull'orecchio (otoplastiche o tentativi di correzione delle malformazioni auricolari primarie). La complessità anatomica dell'orecchio rende la sua ricostruzione particolarmente complicata con risultati postoperatori spesso deludenti. Gli Autori riportano la loro esperienza nella ricostruzione di un padiglione auricolare parzialmente amputato in seguito al morso di un cane. Il protocollo terapeutico applicato ha previsto numerosi tempi chirurgici. Inizialmente è stato applicato un espansore cutaneo a livello mastoideo per assicurare una sufficiente quantità di cute locale. Nel secondo intervento è stato effettuato un prelievo di cartilagine costale, seguito dalla costruzione del modello cartilagineo dell'orecchio e del suo inserimento sottocutaneo in sede mastoidea previa rimozione dell'espansore cutaneo e della cartilagine auricolare residua. L'ultimo intervento ha previsto lo scollamento del padiglione auricolare neoformato dalla cute mastoidea mediante l'inserimento di un innesto cartilagineo in corrispondenza della regione posteriore dell'orecchio ricostruito. Tale innesto è stato ricoperto dalla fascia occipitale ruotata di 180° e da un innesto di cute totale prelevato a livello inguinale. Il risultato postoperatorio è stato soddisfacente con un buon recupero dell'estetica auricolare. Lo scopo di questo lavoro consiste nell'espone la tecnica chirurgica utilizzata nella ricostruzione di anomalie auricolari secondarie e nell'evidenziare gli errori commessi nella realizzazione di questa procedura. Tali considerazioni hanno permesso di sottolineare alcuni elementi fondamentali della ricostruzione dell'orecchio. In particolare, la chiave di volta è stata la consapevolezza di dover creare un modello cartilagineo che rispettasse, per quanto possibile, l'anatomia del padiglione auricolare con tutti i suoi rilievi, solchi e cavità. Inoltre assicurare una quantità di cute locale sufficiente a ricoprire l'innesto cartilagineo riduce i rischi di esposizione della cartilagine e di successiva infezione garantendo il raggiungimento di un risultato finale ottimale.

## Introduction

Secondary anomalies of the outer ear may be due to various causes. Amongst these are traumas from car accidents, sport- and work-related injuries, assault, bites from humans or animals, benign or malignant tumours of the outer ear, results of plastic surgery to the ear or results of surgery to correct primary ear malformations and burns.

Reconstruction of the outer ear has always caused several problems as far as faithful reproduction of the missing region is concerned.

The ear is constituted by numerous ridges and trenches distributed on the three levels of the area and it projects from the exterior of the cranium at an angle of about 30°<sup>1</sup>.

These are the reasons why the surgical technique to reconstruct primary and secondary anomalies of the outer ear are particularly complicated. The first attempt at reconstruction of an outer ear dates back to 1597 when Tagliacozzi<sup>2</sup> proposed the use of flaps from behind the ear in order to repair malformations of the lower and upper regions of the outer ear. In 1845, Dieffenbach<sup>3</sup> devised the use of an advanced posterior flap to correct deficits in the central regions of the ear. At the beginning of the 20th Century, scientific research dealt not only with secondary ear anomalies but also with primary anomalies such as microtia, which had been given little attention until then. In 1920, Gillies<sup>4</sup> positioned a roughly sculpted cartilaginous graft, in the subcutaneous mastoid region, that was subsequently separated from the cranium by a retroauricular cutaneous flap.

Numerous Authors have attempted to improve the surgical technique in order to obtain better aesthetic results, and the use of alloplastic materials such as silicone, medpore, Teflon, etc. have been proposed<sup>5-7</sup>.

Nevertheless, it should not be forgotten that the decisive contribution was given by Tanzer<sup>8-10</sup>, followed by Fukuda<sup>11,12</sup>, Brent<sup>13-16</sup> and, in these last few years, Nagata<sup>17-21</sup> and Firmin<sup>22-24</sup>.

Aim of the present case report is to describe the surgical technique used to reconstruct an outer ear that was partially amputated following a dog bite.

## Case report

The patient MF, a 30-year-old male, came to our attention suffering from partial amputation of the outer ear following a dog bite.

Upon clinical observation, we found the skin to be of satisfactory quality with no retroauricular scars. The region of amputated cartilage was more than a quarter of the length of the helix and spanned 2 levels. The upper half of the helix, of the triangular dimple



Fig. 1. Preoperative view of patient showing partial ear amputation due to dog bite.

and the upper branch of the antihelix were found to be missing (Fig. 1).

Echodoppler showed that the superficial temporal artery was free of obstructions.

Pre-operative surgery required 3 different surgical timings.

The insertion of a subcutaneous expander behind the amputated outer ear, using the auricular scar, present along the posterior margin of the partially amputated ear, as an entrance way.

We created a retro-auricular pocket into which we inserted the cutaneous expander (Figs. 2-4).

Reconstruction of the amputated region was performed with the use of a cartilaginous graft removed from the costal region, refashioned and positioned in the auricular region (Figs. 5, 6). The costal cartilage was obtained through a vertical cutaneous incision of the right paracostal line allowing exposure of the 5th-6th-7th-8th costal cartilages after incision of the external oblique and rectal muscles of the abdomen. We then removed the 6th-7th-8th costal cartilages, that were refashioned. The various fragments were held in place by means of metal strings 5.0 placed on double straight needles. We saved a small piece of cartilage (3 cm x 2 cm) in the subcutaneous region of the costal removal. Once we had fashioned the auricular model, we removed the expander and corrected the scar resulting from the first stage along the posterior margin of the amputated ear. We removed any residual cartilage of the ear while preserving the region of the conch, of the tragus and the antitragus. The last step consisted in positioning the fashioned ear, subcutaneously, and covering it with the flap of expanded skin in the posterior region and with the auricular skin free of cartilage in the anterior region. Good adhesion of the skin and the cartilaginous graft was ensured by the application of compressive tampons



**Fig. 2.** First surgical step: the cutaneous way to apply cutaneous expander.



**Fig. 3.** First surgical step: expander has been applied in a retroauricular pocket.

(Fig. 6) and 2 ronds, removed on the fourth post-operative day.

The creation of a retro-auricular trench according to the Brent technique with positioning of a costal cartilaginous graft corresponding to the posterior face of the neo-formed ear, covered by a flap of occipital fascia and a skin graft (Figs. 7-9). The cartilaginous graft had been maintained, at the end of the previous operation, in the area of costal removal, at subcutaneous level. A simple plastic surgery procedure of the paracostal scar allowed us to find the fragment that we fashioned and positioned on the posterior face of the neo-formed ear through an incision along the posterior margin of the helix. A second mastoid incision, octagonal with respect to the former, at the level of the 3rd middle helix, was necessary in order to allow the flow of the skin flaps under the ear. The cartilaginous flap was kept in place with Vycril 3.0 in the mastoid region and covered with a flap from the occipital fascia, rotated at 180° and covered with a skin graft obtained from the pubis.

The post-operative period was uneventful and out-

come was satisfactory with good recuperation of autonomy of the outer ear and ear projection with respect to the contralateral ear (Figs. 10-13).

## Discussion

In order to establish a correct therapeutic protocol in patients suffering from amputation of the outer ear, evaluation of the skin and the degree of the amputation is of fundamental importance during the clinical assessment of the patient. If, locally, the skin is of good quality (satisfactory elasticity, absence of scars), we can programme immediate reconstruction of the outer ear; if, on the other hand, the local skin does not permit the insertion of the cartilaginous model sub-cutaneously, it will be necessary to take into consideration an additional surgical timing in order to insert a skin expander.

For partial amputations, if the amount of amputated cartilage is less than a quarter of the length of the helix and spans 1 or 2 levels, reconstruction of the



**Fig. 4.** First surgical step – post-operative result: suffering of cutaneous flap and scarred area is evident.



**Fig. 5.** Second surgical step: reconstruction of amputated region with use of cartilaginous graft removed from costal region.



**Fig. 6.** Second surgical step: positioning of fashioned ear subcutaneously using the flap of expanded skin in posterior region.

missing region can be carried out with the aid of the contralateral conchal cartilage (if available). Otherwise, if the amount of missing cartilage exceeds a quarter of the length of the helix and/or is spread over more than 2 area levels, the only possibility for satisfactory reconstruction is to obtain costal cartilage, to be refashioned in respect of the missing auricular region. This reconstructive method is the only alternative in the presence of total amputations and autologous materials are being used<sup>23-25</sup>.

In the case described in the present study, critical postoperative evaluation showed that errors were committed during the programming and performance of the operations.

Notably, the skin, locally, was sufficient to ensure good coverage of the cartilaginous graft and, therefore, insertion of a skin expander would not have been necessary. In addition, the entrance approach, represented by the scar left following the bite, was not a good choice, as this was located in correspondence to the posterior margin of the partially amputated ear (residual upper helix, triangular dimple,

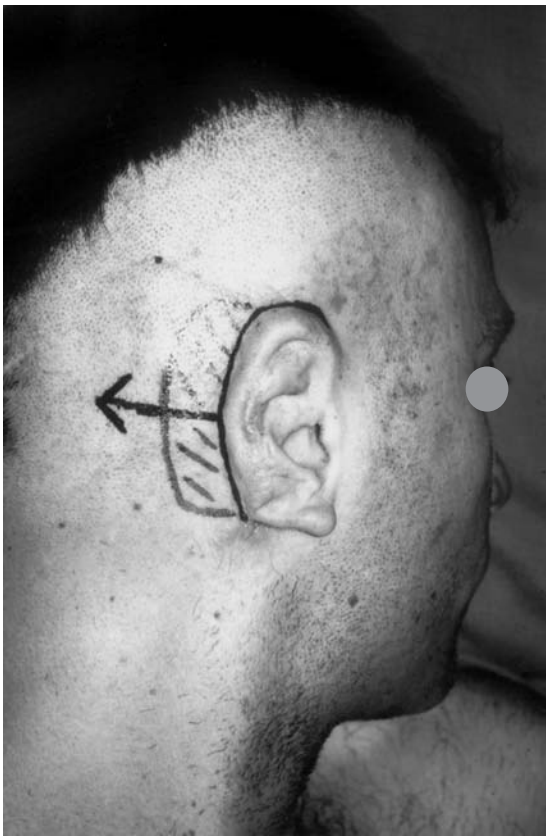


Fig. 7. Third surgical step: skin ways using to creation of the retroauricular trench according to the Brent technique.



Fig. 9. Third surgical step: result at end of operation.



Fig. 8. Third surgical step: a costal cartilaginous graft has been positioned to posterior face of neo-formed ear.

posterior region of the antihelix, all the way to the upper-posterior portion of the auricular lobe). This decision led to suffering of the cutaneous flap and the



Fig. 10. Post-operative lateral view of patient showing ear reconstruction.



Fig. 11. Lateral view of normal ear: a comparison made between the ears can be done.



Fig. 12. Fronto-lateral view of fashioned ear.

scarred area in the post-operative period (Figs. 2-4). In those cases in which the use of a skin expander is deemed necessary, this can be positioned in corre-



Fig. 13. Fronto-lateral view of normal ear in order to make a comparison between the ears.

spondence to the mastoid region through a marginal entrance approach, with respect to the area involved, in order to reduce the tension on the scar to a minimum. A second possibility for this positioning is represented by the temporo-parieto-occipital region, and, therefore, in the areas that define the auricular region in order to obtain expansion of the skin bordering onto the mastoid area. In the latter case, there are generally two approaches, in the temporal and occipital regions.

In the second operation, which consisted of sculpting the cartilaginous graft and positioning it in the auricular region, the complete removal of residual auricular cartilage, except for the regions of the tragus and antitragus, was fundamental. This implied removal of the helix, of the antihelix and the conch. The latter was not removed in toto. Consequently, counter-clockwise rotation of the cartilaginous graft occurred with an increase in the vertical dimensions of the reconstructed ear as opposed to the opposite one.

## Conclusions

Reconstruction of the outer ear can be considered one of the most complex techniques in the field of reconstructive surgery since it requires a certain percentage of "fancy" on the part of the surgeon. Perhaps this is the reason why the surgical techniques used, in the past, have undergone, over the last few decades, important improvements with results that are increasingly satisfactory. The watershed was the awareness of the need to create a cartilaginous model that respected, as far as possible, the anatomy of the outer ear with all its ridges, trenches and cavities. Assurance of a cutaneous coverage of the cartilaginous graft guarantees an optimal end result. First choice

material is of an autologous nature and consists of cartilage removed from the costal region<sup>8-10 13-24</sup>. This, notwithstanding, some Authors<sup>5-7</sup> have preferred to use alloplastic materials such as medpore or silicone with poor results as far as concerns aesthetics and resistance to trauma due to infections, not only in the post-operative period but even some time after surgery<sup>16</sup>.

There are, however, cases in which it is not possible, or not advisable, to reconstruct the outer ear according to the technique described here. It, therefore, seems evident that, today, the only alternative treatment to the use of cartilaginous grafts is the use of prostheses.

## References

- 1 Balboni CG, Motta P, et al. *Anatomia umana*. Ed. Ermes 1987, Vol. 3. p. 635-40.
- 2 Tagliacozzi G. *De curtorum chirurgia per insitionem*. Ed. Bindoni 1845.
- 3 Dieffenbach JF. *Die operative Chirurgie*. Leipzig, F.A. Brockhaus 1845.
- 4 Gillies H. *Plastic surgery of the face*. London: H. Frowde, Hodder Stoughton; 1920.
- 5 Bresnick SD, Reinsh RF. *Reconstruction technique for salvage of the medpore ear reconstruction*. Presented at Ear Reconstruction 1998: Choices for the future, Chateau Lake Louise, Canada, March 5 1998.
- 6 Wellisz T. *Reconstruction of the burned external ear with a medpore porous polyethylene pivoting helix framework*. *Plast Reconstr Surg* 1993;91:811-8.
- 7 Williams JD, Romo T III, et al. *Porous high-density polyethylene implants in auricular reconstruction*. *Arch Otolaryngol Head Neck Surg* 1997;123:578-83.
- 8 Tanzer RC. *Total reconstruction of the external auricle*. *Arch Otolaryngol* 1961;73: 64-8.
- 9 Tanzer RC. *An analysis of ear reconstruction*. *Plast Reconstr Surg* 1962;30:236-46.
- 10 Tanzer RC. *Total reconstruction of the auricle. The evolution of a plan of treatment*. *Plast Reconstr Surg* 1971;47:523-33.
- 11 Fukuda O. *The microtic ear: survey of 180 cases in 10 years*. *Plast Reconstr Surg* 1974;53:458-63.
- 12 Fukuda O, Yamada A. *Reconstruction of the microtic ear with autogenous cartilage*. *Clin Plast Surg* 1978;5:351-66.
- 13 Brent B. *The correction of microtia with autogenous cartilage grafts: I. The classic deformity*. *Plast Reconstr Surg* 1980;66:1-12.
- 14 Brent B. *The correction of microtia with autogenous cartilage grafts: II. Atypical and complex deformities*. *Plast Reconstr Surg* 1980;66:13-21.
- 15 Brent B. *Total auricular reconstruction with sculpted costal cartilage*. In: Brent B, editor. *The artistry of reconstructive surgery*. St Louis, C.V. Mosby Company 1987. p. 113-27.
- 16 Brent B. *Technical advances in ear reconstruction with autogenous rib cartilage grafts: personal experience with 1200 cases*. *Plast Reconstr Surg* 1999;104:319-34.
- 17 Nagata S. *A new method of total reconstruction of the auricle for microtia*. *Plast Reconstr Surg* 1994;93:221-30.
- 18 Nagata S. *Modification of the stages in total reconstruction of the auricle: Part I. Grafting the three-dimensional costal cartilage framework for lobule-type microtia*. *Plast Reconstr Surg* 1994;93:221-30.
- 19 Nagata S. *Modification of the stages in total reconstruction of the auricle: Part II. Grafting the three-dimensional costal cartilage framework for concha-type microtia*. *Plast Reconstr Surg* 1994;93:231-42.
- 20 Nagata S. *Modification of the stages in total reconstruction of the auricle: Part III. Grafting the three-dimensional costal cartilage framework for small concha-type microtia*. *Plast Reconstr Surg* 1994;93:243-53.
- 21 Nagata S. *Modification of the stages in total reconstruction of the auricle: Part IV. Ear elevation for the constructed ear*. *Plast Reconstr Surg* 1994;93:254-66.
- 22 Firmin F. *Microtie: Reconstruction par la technique de Brent*. *Ann Chir Plast Esthet* 1992;37:119-31.
- 23 Firmin F. *Reconstruction totale du pavillon de l'oreille*. In: Banzet P, Servant JM, editors. *Chirurgie plastique reconstructive et esthetique*. Tolon Flammarion 1994. p. 366-73.
- 24 Firmin F. *Ear reconstruction in cases of typical microtia. Personal experience based on 352 microtic ear corrections*. *Scand J Plast Reconstr Hand Surg* 1998;32:35-47.
- 25 Texier S, et al. *Reconstruction partielle de l'oreille*. In: Banzet P, Servant JM, editors. *Chirurgie plastique reconstructive et esthetique*. Tolon: Flammarion 1994. p. 357-66.

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