ABSTRACT

The ear is usually damaged during thermal injury, burns of the upper body occur frequently, burn of the face and the neck represents 30% of all burn injuries.

Four features in various combinations characterize deformity in the burned ear: (i) The presence of scarred skin at the site of and surrounding the ear, with dramatic loss of skin elasticity; (ii) The presence of longitudinal scars of the pinna due to previous drainage of the perichondritis as an initial trial for saving the ear; (iii) Absence of different components of the framework of the ear, mostly the helix/antihelix complex (the cartilage-containing part) with or without the ear lobe; (iv) Scarred chest wall due to associated burns of the skin of the upper body.

Reconstruction of the severely deformed burned ear is usually a difficult task.

The aims of the technique were the following: (i) Removal of the remaining cartilage of the burned ear, part or the whole of it in severe cases, because it may be a source of infection; (ii) Wide exposure of the cartilage of the ribs through sufficient chest wall incision to overcome the severe fibrosis of the burned chest wall skin; (iii) Creation of delicate smooth cartilage framework, free of sharp edges; and (iv) Creation of a skin pocket of sufficient size to adapt the newly reconstructed auricle.

Patients and Methods: Twenty-three patients with a unilateral or bilateral deformity of the ear following burns were operated upon during the period from May 2006 to December 2014, with a median age of 26.71 years.

Results and Conclusion: There was a good colour match between the reconstructed auricle and the surrounding skin. Patient satisfaction was high and the results were well accepted.

INTRODUCTION

Reconstruction of the severely deformed burned ear is often a difficult task due to lack of healthy local skin and subcutaneous tissue.

The ear is usually damaged during thermal injury, burn of the upper body occurs frequently, burn of the face and the neck represents 30% of all burn injuries [1].

From an anatomical point of view the ear has no subcutaneous tissue to protect the cartilaginous framework. This cartilaginous framework, once exposed or injured, is particularly susceptible to infection.

Auricle deformities can be a result of both direct thermal injuries and subsequent chondritis, which is a severe complication of ear burns that can destroy even unburned cartilage if not recognized early [2].

Chondritis can occur in both full thickness as well as deep partial thickness burn injuries [3]. The onset of symptoms of chondritis is often insidious and typically presents 2-5 weeks after injury, the usual presentation being a dull pain followed by swelling, erythema, and tenderness on palpation of the affected auricle [4].

K'ung et al. [5] classified burned ear deformities into three main types: (i) The mild type in which there is loss of the helix and the upper part of the auricle without extensive scarring, (ii) The moderate type in which the concha is normal, although it may be adherent to the side of the head; the upper half of the ear has sloughed off with loss of the anti-helix altogether with its anterior and posterior crura, and (iii) The severe type with only a remnant of the concha and marked scarring of the local soft tissue; the external auditory meatus is normal or it may be stenosed.

Four features, manifested in various combinations, characterize the deformity in the burned ear: (i) The presence of scarred skin at the site and surroundings of the ear, with dramatic loss of skin elasticity (Fig. 1), (ii) The presence of longitudinal scars of the pinna due to previous drainage of the perichondritis, as an initial trial for saving the ear (Fig. 2), (iii) absence of different components of the framework of the ear, mostly the helix/antihelix...
complex (the cartilage-containing part) with or without the ear lobule (Fig. 3) and (iv) scarred chest wall due to an associated burn of the skin of the chest (Fig. 4).

There are three problems associated with the treatment of burn injured auricle defect: (i) Adequate blood supply, (ii) Create a framework that is delicate, yet enough to resist injury and (iii) Paucity and poor quality of skin available in the auricular area.

Techniques [6] used in reconstruction of the deformity of the burned ear are many: Excision of the damaged portion with direct closure, cervical tube pedicle flap [7], Conchal graft with local flap coverage [8], autogenous ear reconstruction using rib cartilage graft [9,10-13], silastic prosthesis insertion [14] and the use of an external ear prosthesis.

PATIENTS AND RESULTS

Twenty-three patients with unilateral or bilateral deformity of the ear following burns injuries, who could be considered grade II or III according to the Weerda classification [15] of the congenital microtia, were operated on during the period from May 2006 till December 2014. Sixteen were males and 7 were females ranging in age from 8 to 44 years with a median age of 26.71 years. Local infection of the burned ear or its surrounding was excluded by operating only patients who were totally free of any infection for at least 6 months after burn healing. Also all the patients did not show any signs of active scarring of the skin. ENT consultation for exclusion of any sign of external otitis externa was done. Clinically the cases were classified into 2 mild cases of ear deformity, 4 cases were moderate and 17 cases were considered severe; three cases were bilateral and presented with an anotia-like deformity.

Surgical technique:

The technique was done into 2 stages following Nagata

Stage 1:

Wide exposure of the cartilage of the ribs was done, through sufficient chest wall incision to overcome the severe fibrosis if the chest wall was burned.

The synchondrotic portions of the sixth, seventh and the eighth ribs were taken; the plane of dissection was subperichondrial plane. With the help of a template, cartilage fabrication was carried out to create delicate smooth cartilage framework free of sharp edges (Fig. 5).

Skin pocket:

After operating 7 cases, I made the incision for removal the remnants of the old cartilage of the ear and creating the skin pocket standard for the rest of the cases as shown in Fig. (6).

Two incisions were done; a small incision at the posterior margin in the middle of the planned pocket, and another vertical incision superior to the upper limit of the planned pocket.

The framework was introduced after securing good haemostasis. Skin was coapted to the framework with the help of two suction drains, one above and one below the framework. No bolster sutures were used in any of our patients for fear of skin necrosis. In mild cases we used the pocket principle technique described by Mladick [16]. The construct was placed into a subcutaneous pocket through a transverse incision at the level of the amputated cartilage (Fig. 7).

Stage 2:

Creation of the post-auricular sulcus Separation was usually performed after 6 months.

1- Marking of a super-thin skin flap at the periphery of the palpable edge of the construct (Fig. 8).
2- Creation of a super-thin skin flap (Fig. 9).
3- Deepening of the dissection deep to the capsule covering the framework (Fig. 10).
4- Elevation of the framework by a cartilage strut and covering it with a mastoid fascial flap [17] or advancement the periostium from posterior to cover the cartilage strut (Fig. 11).
5- Covering of the flap with a full-thickness skin graft (Fig. 12).

The follow-up period ranged from 6 months to 9 years with average period of 6 years post-operatively.

Minor surgical revisions (which in most cases were laser hair epilation) were carried out under local anesthesia to improve the final aesthetic outcome.

There was a good color match between the reconstructed auricle and the surrounding skin. Patient satisfaction was high and the results were well accepted.

Minor complications were encountered; one case of partial skin necrosis of the skin cover which healed spontaneously with secondary intention, one case of seroma formation of the chest wall.
which was drained under local anesthesia at bed side and two cases of failure of the graft take in the second stage, both patients were re-grafted after formation of healthy granulation tissue.

Figures (14-21) represent some clinical cases (pre- and postoperative photos).

Figures (14,15): 34 years old female patients presented with right near total ear loss because of thermal injury following flame burn.

Figures (16,17): 42 years old male patient presented with medium degree left ear loss following several attempts of draining chondritis complicated facial flame burn.

Figures (18,19): 29 years old male patient with medium degree left ear loss following several attempts of draining chondritis complicated facial flash burn.

Figures (19-21): 26 years old male with severe degree ear loss following several attempts of draining chondritis complicated facial flame burn.

Fig. (1): The presence of scarred skin at the site and surroundings of the ear, with dramatic loss of skin elasticity.

Fig. (2): The presence of longitudinal scars of the pinna due to previous drainage of the perichondritis, as an initial trial for saving the ear.

Fig. (3): Absence of different components of the framework of the ear, mostly the helix/antihelix complex (the cartilage-containing part) with or without the ear lobule.

Fig. (4): Scarred chest wall due to an associated burn of the skin of the chest.

Fig. (5): Framework fabrication: Creation of delicate smooth cartilage framework free of sharp edges.
Fig. (6): Creating the skin pocket for the cartilage framework.

Fig. (7): In mild cases, creating the pocket following technique described by Mladick.

Fig. (8): Marking of a super-thin skin flap at the periphery of the palpable edge of the construct.

Fig. (9): Creation of a super-thin skin flap.

Fig. (10): Deepening of the dissection deep to the capsule covering the framework.

Fig. (11): Elevation of the framework by a cartilage strut.
Fig. (12): Covering the cartilage strut with a mastoid fascial flap.

Fig. (13): Covering the fascial flap with a full-thickness skin graft.

Fig. (14): Pre-operative lateral view of 42 years old female patient with severe post-burn deformity of the right ear.

Fig. (15): Post-operative lateral view of the same patient 14 months after total ear reconstruction.

Fig. (16): Pre-operative lateral view of 44 years old male patient with moderate post-burn deformity of the left ear.

Fig. (17): Post-operative lateral view of the same patient 8 months after reconstruction of the upper half of the left ear.
BHANDARI stated that approximately 90% of patients with cervicofacial burns will have burns of the ear, and up to 30% of all auricular burns will develop the serious complication of auricular chondritis. The best treatment of this complication is prevention through the following guidelines: The avoidance of both pressure to the burned ear and bulky dressings is critical, aggressive debridement of eschar and crusts should be minimized, and all hair that could potentially come into contact with the ear should be trimmed in order to limit bacterial contamination. Gentle washing with antibacterial soap and water and twice-daily application of local antibiotic should be performed. 

In the case of development of a post-burn deformity of the ear we have to find a solution to the paucity and poor quality of skin available in the auricular area.

Over the past 50 years, the available methods for auricle reconstruction following burn deformity have changed. In 1974, Tanzer [19] grafted the scarred auricular skin from the supraclavicular area for its reconstruction, 6 months later transplanted a cartilage framework, unsatisfactory outcome was the end result due to lack of elasticity of the grafted skin.

In 1974, Edgerton and Bacchetta [20] were the first to describe a fan flap composed of temporal muscle, fascia and epicranium to cover a silicone ear implant, but silastic implants resulted in an extrusion rate of more than 65%, which necessitated additional operations, further compromising the local tissue [21].
In 1976, Fox and Edgerton [22] used a fan flap to salvage the auricular cartilage of acute burn patients. In 1977, Tegtmeyer and Godding [23] performed a one-stage primary auricular reconstruction using an anteriorly located virgin skin flap to cover a silicone frame and a large fascial flap. In the same year, Avelar [24] performed a similar one-stage procedure using costal cartilage. Wellsisz [25] used a temporoparietal fascial flap with a MEDPOR pivoting helix framework for ear reconstruction in burned ear patients with excellent results.

Many surgeons [26-29] have used tissue expanders for creation of a skin pocket during ear reconstruction, even in the presence of scarred skin.

In 1985, Brent and Byrd [9] were the first to advocate excising the entire scar of the burned ear, sculpting autogenous rib cartilage graft and covering the latter with a temporoparietal fascia flap. This technique can be used to solve the paucity and scarring of the postauricular skin in a burned ear.

Nagata further refined Brent's technique by doing the following: (1) Excision of the entire scar tissue without elasticity. (2) Excision of the anatomically abnormal ear cartilage. (3) Placing a precise 3D cartilage framework based on normal anatomy. (4) Covering the 3D frame with temporoparietal fascial flap or deep temporal flap. (5) Covering the fascial flap with a split-thickness skin graft from the scalp. (6) Creating a conchal cavity with framework and skin flap [30].

In this study, the problem of the paucity and scarring of the skin was solved by performing the ear reconstruction in a staged procedure based on the principles of the Nagata technique of staged ear reconstruction, popularised by Weerda. [15] Firmin [30] and excellently modified by Siegert, [32] in which a roomy skin pocket was created in the planned area (the remaining skin of the auricle and the postauricular skin) for reconstruction of the ear, fabricate the cartilage framework from the cartilage of the sixth to the ninth ribs, insert the framework in the pocket and bank the rest of the cartilage for firm elevation of the ear in a subsequent stage.

Brent and Byrd [3] were the first to advocate aggressive principle for treating secondary ear reconstruction: Excising the entire auricular scar area, immediately placing a sculpted autogenous rib cartilage graft and covering the latter with a temporoparietal fascia flap. This principle can be also applied to the burned auricle to solve these the problem. But I believe it is wiser to keep the superficial temporal artery flap as lifeboat in case of failure of the reconstruction using the local available tissue.

In conclusion, autogenous auricular reconstruction in a post-burn deformity is possible if you follow the proper surgical principles using the scarred skin of the auricular region if soft and supple alone or in combination with other local skin or facial flaps.

The temporoparietal fascial flap is a very versatile flap which can be used as a pedicled or a free flap to provide cover to the framework in those cases where local skin is not available or in cases of complication of the skin cover, so not to waste it as a first line of treatment in ear reconstruction.

REFERENCES
13- Nagata S.: Secondary reconstruction for unfavorable


