Split calvarial bone graft for chemical burn-associated nasal augmentation

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Abstract

The nose is the central part of the face, and constitutes the most prominent projection in facial geometry. This report presents five cases that sustained a chemical burn injury with associated facial mutilation resulting from contact with strong acids. The chemical burn affected the nasal architecture after inflicting a burn injury to the face. Applying bone deriving from a split skull procedure for the nasal projection restoration and the augmentation of the dorsal nose is a feasible undertaking, and the overall result appears satisfactory.

A retrospective survey of cases admitted to our clinic from January 1999 to December 2001, inclusively was undertaken and is described below. Split calvarial bone graft procedure for the nasal tip projection reconstruction was performed for five patients, all of whom had sustained chemical burns following assault by strong acid. The disfiguration of the nasal anatomical structure was due to healing from deep burn wounds. The tip became blunt and less protruberant following the arising of cicatricial tightness of the surrounding tissue. Strength and resistance to scar contraction are the first considerations for such implantation when attempting to correct the nasal tip projection. The five female patients sustained a severe chemical burn which involved a surface area ranging from 25 to 60% of total body surface area. The facial mutilation was noted simultaneously with the determination of the extent of the burning injury. A severe burn scar is the typical sequel following a deep chemical burn. Nasal tip projection was restored and a nasal dorsum augmentation procedure with a split calvarial bone graft under an “open” method was used. This particular surgical procedure was able to be used in order to improve the nasal tip projection and resist surrounding scar contracture. The three-dimensional surface structure of the face became more prominent subsequent to the administration of this procedure.

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1. Introduction

The split calvarial bone technique was popularized by Tessier [1] in 1932, and applied first in nasal bone reconstruction by Jackson et al. [2] in 1983, the advantage of the procedure being that it could assist with the restoration of nasal contour defects resulting from a previous injury. Progressively thereafter, the procedure was ever more frequently used to treat cases of acute trauma, post-traumatic deformity, and secondary rhinoplasty and midface hypoplasia, post-hypertelorism correction, telecanthus, and nasal hypoplasia, and even postcancer nasal reconstruction. In 1991, Parsa [3] suggested the use of autogenous calvarial graft for nasal augmentation for oriental patients for the replacement of alloplastic materials to solve the deformity-associated complications and to correct the deformity.

To the best of our knowledge, for patients suffering burns, there appears to be very little available data pertaining to nasal augmentation associated with a facial scar. In the Far East and Japan [4], the use of alloplastic materials for reconstructive nasal surgery appears to be very popular, although for scarred tissue in the nasal region, we need to seek a simple and low morbidity procedure in order to achieve aesthetically-pleasing nasal augmentation. The harvesting of a split calvarial graft could be used to combine the treatment of burn-associated alopecia by simultaneous staging excision and bone graft cropping. We offer a good alternative for nasal augmentation in reconstruction surgery in order to achieve pleasing dimensional change for facial mutilation patients.

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2. Materials and methods

From January 1999 to December 2001, inclusively, we enrolled five chemical burn mutilation patients featuring full thickness burns with the insulted area including the face. The facial involvement varied from one third of the patient’s face to the entire face area. The age of patients ranged from 30 to 48 years of age (Table 1). These patients underwent an “open” rhinoplasty method for nasal reconstruction following maturation of scar tissue for more than 6 months subsequent to a severe chemical burn.

A limited longitudinal incision in the parietal region is used to reveal the donor site. The bone grafts were harvested from the parietal area parallel to the middle sagittal line and about 5 cm distant from the line. The periosteum was incised and reflected. We marked long 5.5 cm and wide 1.0 cm on the outer table of the skull. It was not necessary for any hair to be shaved using this procedure, with the wound margin being located along the direction of hair pattern. The split calvarial graft was cropped using a cutting burr with a tip diameter of 1.5 mm in order to outline the marked area by creating a groove about 1.0 mm in breadth, and a little slope over the outer edge. Following this, we shifted the oval head cutting burr down to the diploic layer of the skull. The oozing of blood from the excision site revealed penetration to the appropriate anatomical level of the skull. The final step was to use a 4 mm to 1 cm curved osteotome in order to free the intended bone graft from the donor site, avoiding sourcing any material from the inner table of the skull.

Bleeding from the diploic layer of the skull was controlled with bone wax combined with geloform (Pharmacia & Upjohn, Michigan, USA) soaked with 1:50,000 epiéphrine solution and bone dust. The scalp wound was closed in one layer using a series of skin staples. Following this, 1–0 nylon was applied to form a bolster mattress of sutures in order to achieve some level of wound compression, they then being removed 3 days subsequently. The need for such an open rhinoplasty method was determined by whether the nasal reconstruction warranted the need for some cartilage restoration. After sculpturing the intended bone graft in order to outline the marked area, the burn involving the face, neck, chest wall, and bilateral upper extremities. The face was resurfaced with sheet split-thickness skin graft, harvested from the patient’s scalp. The contractile scar over the nasal region was associated with destruction of the right lateral cartilage of the nose. The nasal reconstruction was scheduled after the burn wound had healed. The split calvarial bone graft technique was used for dorsal augmentation (Fig. 1), and some

Table 1: Demography of study-included burns patients.

<table>
<thead>
<tr>
<th>No.</th>
<th>Sex</th>
<th>Age</th>
<th>Causative agent</th>
<th>Degree</th>
<th>TBSA (%)</th>
<th>Rhinoplasty conducted</th>
<th>Area insulted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>59</td>
<td>HCl</td>
<td>3rd</td>
<td>20</td>
<td>September 2001</td>
<td>Face, trunk</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>33</td>
<td>H₂SO₄</td>
<td>3rd</td>
<td>15</td>
<td>October 2001</td>
<td>Face, trunk</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>44</td>
<td>H₂SO₄</td>
<td>3rd</td>
<td>25</td>
<td>September 2001</td>
<td>Face, extremities</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>30</td>
<td>HCl</td>
<td>3rd</td>
<td>25</td>
<td>November 2000</td>
<td>Face, chest wall, extremities</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>48</td>
<td>HCl</td>
<td>3rd</td>
<td>40</td>
<td>June 2001</td>
<td>Face, chest wall, extremities</td>
</tr>
</tbody>
</table>

TBSA: total body surface area involved.
cartilage from the patient’s ear was used for lateral cartilage restoration, and the apparent soft tissue defect was filled with a seagull flap. The postoperative follow-up at 6 months revealed a satisfactory result (Figs. 2 and 3).

3.2. Case 2

This patient suffered from an attack with sulfuric acid involving injury to the entire face, with the nose being reconstructed with a sea-gull flap. The redundant soft tissue was trimmed off to an appropriate size (Fig. 4); and the dorsal nasal augmentation was completed using a split calvarial bone graft (Fig. 5). The postoperative follow-up was photographed 1 year after the procedure completed. Satisfactory projection was regained (Fig. 6).
3.3. Case 3

The patient sustained chemical burn with hydrochloric acid with full thickness burn over face, trunk, and upper extremities. Post-burn alopecia and facial burn scar were noted after treatment (Fig. 7). She underwent calvarial bone graft for nasal augmentation. A good nasal tip was obtained, and the patient was followed for more than 6 months. A blanching condition was noted over nasal tip for which the

Fig. 5. The split calvarial bone graft from parietal portion of skull.

Fig. 6. The lateral view of nose after calvarial bone graft for nasal dorsal augmentation.

Fig. 7. Post facial burn with scar contracture surrounding the nasal region.

Fig. 8. After nasal dorsal augmentation with split calvarial bone graft.
4. Discussion

Chemical assault has been reported in many countries. The reported facial lesions varying in dimension from 34 to 76% of body surface area, and the severity depended to some extent, upon different cultures and causes [5-11]. In our burn center, we have admitted 59 patients who had sustained some form of chemical burn in the period from 1995 to 2002, inclusively. The patients could be divided into two groups according to the modality of their injury, these being either assault 12 (20%; 11 female and 1 male), or a work-related injury 47 (80%, 35 male and 12 female). All members of the first group revealed injuries sustained to the facial region, of whom five patients asked for a further reconstruction procedure to be conducted in order to improve their overall facial contour. Initially, the facial chemical burns for these victims did not induce any anatomical distortion. The “crush” formation of skin tissue was treated as a series of superficial burns, and eschar formation was treated as deep or full-thickness burns. Corrosive chemical contact with skin will typically lead to tissue damage with the severity of the skin damage depending upon the chemical’s strength, quantity applied, duration of contact, degree of skin penetration, and the chemical’s mechanism of action. Following chemical attack, if a strong acid had been used, it usually tended to react with the tissue with which it came into contact by protein coagulation change and penetration to the deep soft tissue base of the skin [12]. The recommended first-aid procedure is to attempt to preserve soft tissue as much as is possible and especially to avoid desiccation by continuous irrigation of the wound site with clean water or normal saline for a period of more than 2 h from the time of attack or first-aid being delivered. At our burn center, meticulous wound care using silver sulfadiazine or other antibiotic ointment is mandatory for all burn cases. Further surgical intervention for burn patients is typically delayed until it is clear that the patient’s vital signs have stabilized, or for at least 10-14 days subsequent to the injury. Too aggressive debridement of tissue post-injury could result in the excessive sacrifice of some precious soft tissue [13].

According to the strategy for treating the severely disfigured face of a burns victim as proposed by Rose [14] in 1995, there exists a need to consider the functional result of restorative surgical intervention apart from merely considering the enhancement of aesthetic appearance. There are several criteria for the evaluation of facial reconstruction: (1) a relatively normal looking face viewed at a conservative distance, (2) overall facial balance and symmetry, (3) distinct aesthetically acceptable units with attempts made to camouflage damage and feature, as best as is possible, an inconspicuous scar, (4) skin texture suitable for corrective makeup, and (5) the ability to demonstrate dynamic facial expression. As for the nasal structure, it is composed of three important elements. The first is skin for external coverage; the second is the nose’s inner lining, and the final element is the skeletal portion of the nose [15]. Subsequent to improvements to medical practice having significantly lowered mortality rates for burns patients, the functional and aesthetic results achieved after post-burn restorative surgery have tended to become more important and challenging, especially in the case of facial burns [15]. The external appearance of the human face is largely supported by the facial skeleton. In cases of chemical burns, the level of tissue destruction would appear to be more severe than is the case for thermal burns. Without optimal wound care, the end result of a chemical burn injury to the face may be that the insulted area is largely constituted by a scar with unstable skin coverage.

The scar tissue typically expresses a poor level of vascularity and compliance, and may register extreme contractile forces over the entire injured structure [14]. There are many synthetic implants that have previously been introduced in order to attempt to achieve desirable nasal or facial augmentation for related cases. These include silastic (Dow-Corning Corp., Midland, MI, USA), Mersilene (Ethicon Corp., Somerville, NT, USA), Supramid (S. Johnson Inc., Alexandria, VA, USA), Teflon (CR Bard Inc., Burlington, MA, USA), Proplast (Jiteck Inc., Houston, TX, USA), hydroxyapatite (Integrated Orbital Implants, San Diego, CA, USA), Gore-Tex (W.L. Gore, Phoenix, AZ, USA), and Medpor Surgical Implants (Porex Surgical, College Park, GA, USA). The use of such implanted synthetic materials still feature a variety of problems including extrusion, infection, and/or prosthesis displacement [16-20]. Apart from other potential complications, silicone implants may reveal a palpable and visible capsule, which may sometimes erode the skin, this being the case especially for those with pre-existing nasal scar tissue, while the alloplastic materials tend to demonstrate a greater rate of prosthesis extrusion than autogenous tissue. On occasion, following restorative surgery, bony tissue can even withstand minor exposure to the atmosphere for short periods, although the extruded portion needs to be trimmed and possibly re-shaped, before being reburied under an adequately tensioned skin flap. Following this, the bone graft will typically survive and eventually become revascularized.

The nose is located in the central and most-visible portion of the face. The triangular outer contour appears to reveal a complex three-dimensional structure, with the cornerstone being the nasal skeletal structure, which tends to provide the entire contour of the nose. Nasal dorsum augmentation aims to acquire a good shape to the nose and projecting nasal tip. For the severely burned face, the resultant scar will experience substantial tension, and exert a powerful contractile force over the face which will tend to level the nose, often to the extent that the nostril angle becomes obtuse. A rigid autogenous split calvarial bone graft is able to provide satisfactory skeletal support in an attempt to counter the tensioning
forces of a developing scar, and to maintain a good nasolabial angle. After surgically assembling the whole framework of the nose, the sequential correction of the nasal structure and its inner lining should be scheduled for surgical restoration in order to achieve good surface architecture of the restored nose and also to improve such aspects of the nose’s appearance as skin color, symmetry and/or even surface texture. The intended final result of such reconstruction is to attempt to regain complete facial harmony. In order to attempt to prevent bone-graft resorption, we followed Kaxamoto and co-workers [21] 1982 method to achieve solid fixation and to establish a wide contact with recipient bone in order to enhance neovascularization and demonstrate a solid union. An intact pen osteum is necessary to be achieved surrounding the bony implant in order to optimize the prospects for graft survival. In clinical practice, patients experiencing burns to the face typically experience scarring and skin tensioning combined with burn-induced alopecia. The staged excision of scar of alpecia is able to be completed simultaneously with the harvesting of the split calvarial bone graft.

References