Plastic and Aesthetic Research

Hemifacial microsomia: management of the vertical ramus compartment

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ABSTRACT

Hemifacial microsomia and Goldenhar syndrome pose unique challenges to the craniofacial surgeon. The O.M.E.N.S. classification provides a description of the craniofacial features. For the “M” of O.M.E.N.S. (the mandible), the Pruzansky-Kaban classification provides therapeutic guidelines for joint and face reconstruction. A sequence of standard procedures, including temporomandibular joint reconstruction, facial rotation surgery, gluteal fat grafting, and patient-specific titanium implantation, each have their intricacies. The author provides his expert opinion, acquired over thirty years of experience, with an emphasis on descriptions of and solutions for ten problematic issues.

Key words:
Congenital abnormalities, goldenhar syndrome, mandibular reconstruction

INTRODUCTION

Hemifacial microsomia is the second most common facial birth disorder, with a prevalence of one in 3,500-6,000 live births. In 70% of individuals, the condition is unilateral [Figure 1]. The “O.M.E.N.S.” acronym is the most commonly used way to categorize hemifacial microsomia. This acronym stands for orbital, mandibular, ear, facial nerve, and soft tissue deficiencies, which are rated on a scale of 0-3, according to their severity.[2] Most striking upon clinical examination are the external ear deformities [Figure 2] and the facial asymmetry. The latter is related to deficiencies in the vertical ramus compartment, originating from both skeletal tissues (mandible and skull base) and soft tissues (muscles of mastication and subcutaneous fat) [Figure 3]. The mandibular deformity, considered separately from the skull base (temporal bone and orbit) deformities, has been classified by Pruzansky and Kabanas Type I to III[3,4] [Figures 4-7].

From the mid-1970s to the mid-1990s, treatment modalities for Type I and Iia Pruzansky-Kaban mandibular deformities included orthognathic treatment during adolescence or “functional” orthodontic appliances[5] and early mandibular osteotomies to keep pace with the rate of vertical midfacial growth.[6] For Type IIb and III deformities in growing children, joint reconstruction with costochondral grafting was indicated. In the mid-1990s, early distraction osteogenesis, before skeletal maturation and/or permanent dentition, was believed to induce the formation of not only bone, but also of soft tissue. However, a study published in 2002[7] and a systematic review published in 2009[8] concluded that there are no long-term benefits to early osteodistraction in the vertical ramus.

The aim of this article was to explain the author’s protocol for the reconstruction of the vertical ramus compartment in hemifacial microsomia, highlighting the key issues of the technique.

KEY ASPECTS OF SURGERY

To illustrate the author’s treatment strategy for a deficiency of the vertical ramus compartment, 10 salient points are presented with illustrative photographs from a series of patients. The general approach for the different Pruzansky-Kaban types is presented in Table 1. Orbital-zygomatic and jaw angle reconstructions are performed in all types of hemifacial microsomia.
following the facial rotation procedure. Hard and soft tissue volume deficiencies can be addressed by free gluteal fat transplantation, three-dimensional (3D) printed patient-specific titanium implants or a combination of both.

**Point 1: Skeletal symmetrization increases left/right soft tissue volume discrepancy**

The facial rotation procedure, consisting of rotation of the maxillary, mandibular, and chin segments around a sagittal axis, while translating the midlines of all segments to the predetermined facial midline and advancing the lower face to the ideal facial profile in a sagittal plane, results in displacement of hard and soft tissues to the normal side [Figures 8-10]. This results in additional asymmetry when the left and right sides are mirrored, necessitating the next procedure: compensating for the volume deficit.

**Point 2: Early osteodistraction of the horizontal ramus**

Prior to orthodontic decompensation, at the age of 11-12, it is necessary to judge the retromolar bone stock. In view of the upcoming sagittal split osteotomy with the substantial advancement of the affected side, a decision must be made between removal of impacted second and/or third molars or osteodistraction of the horizontal ramus. Osteodistraction not only creates more bone to work with, but it can also partially correct the horizontal deficiency [Figure 11]. The fibrous tissues of the vertical ramus compartment can

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**Figure 1:** An O0 M2a E2 N0 S2 case. (a) Frontal view; (b) left profile view; (c) frontal occlusion view

**Figure 2:** Ear deformities from 0 to 3 dysmorphic severity, as indicated by the white arrow

**Figure 3:** Three-dimensional (3D) reconstruction of a multi-slice computed tomography (CT) scan of the skull of an O1M2b, E1, N0, S1 case of hemifacial microsomia. The skeletal asymmetry in this case is due to the absence of the right-sided ascending ramus, with compensating downward growth of the skull base and orbit at the affected side.

**Figure 4:** Pruzansky-Kaban Type I. All mandibular and temporo mandibular joint components are present and normal in shape, but they are hypoplastic to a variable degree, compared to the contralateral side. (a) Frontal facial view of an affected girl during childhood; (b) three-dimensional (3D) reconstruction of a multi-slice computed tomography (CT) scan of the skull of a Type I deformity, with deviation of the mandibular midline to the left; (c) submento-vertical projection of the same 3D CT scan, demonstrating mandibular asymmetry; (d) frontal view of an affected girl during adolescence; (e) frontal view of the occlusion of the same girl in (d), demonstrating cross-bite on the right; (f) orthopantomogram of the girl in (d), showing the joint structures with a normal shape and location, but with a degree of hypoplasia. Note the downward growth of the skull base on the affected side.
be stretched more easily when the process occurs gradually. After the latter procedure, vertical ramus lengthening is easier to perform, as more bony overlap allows for more stable osteosynthesis and improved healing.

Point 3: Choice of the pivot

Rotation of the maxilla around a sagittal axis determines the correction of the occlusal plane cant and helps to swing the mandible to the midline [Figure 12]. The dental midlines are translated toward the healthy side for alignment with the predetermined facial midline. Finally, the chin point is adjusted in a translational way to correct the skeletal mandibular midline. The chin point is often also rotated along a sagittal axis to deal with the symphyseal height difference.

Disimpacting the affected side necessitates a bone graft, obtained from the calvarium or iliac crest. Impacting the healthy side does not stretch the fibrous remains of the masticatory muscles on the other side and is possible only when a gummy smile exists on that side [Figure 13]. The decision for the pivot relates to aesthetic desiderata (normal tooth-to-incisor distance and limited gummy smile) and functional desiderata (anti-relapse biomechanics). Hence, the pivot can be located at one of three positions: at the zygomatic buttress of the healthy side, at the zygomatic buttress of the affected side, or at the nasal spine. Pivoting at the affected side (and hence impacting at the healthy side) provides the least risk of relapse.

Point 4: Skeletal suspension

Skeletal suspension is mandatory to control the correction of the occlusal plane cant and the dental midline during healing [Figure 14]. As most cases of

<table>
<thead>
<tr>
<th>Pruzansky-Kaban type</th>
<th>Treatment strategies</th>
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</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Orthognathic surgical correction “facial rotation”® after orthodontic alignment, coordination and decompensation. Standard Le Fort I, bilateral sagittal split osteotomies, and sliding genioplasty techniques are used</td>
</tr>
<tr>
<td>Type IIa</td>
<td>Surgery is only performed early at the age of 4 and older, when there is a centric occlusion-centric relation shift of more than 5 mm. The surgery involves joint reconstruction with costochondral grafting. Osteodistraction in the horizontal (not vertical) ramus is performed when there is insufficient bone stock to perform a sagittal split osteotomy after puberty. Orthognathic surgical correction “facial rotation” after orthodontic alignment, coordination, and decompensation is performed at puberty and later</td>
</tr>
<tr>
<td>Type IIb and III</td>
<td>Joint and ramus reconstruction at the age of 4 and older. Orthognathic surgical correction “facial rotation” after orthodontic alignment, coordination and decompensation, at puberty and later</td>
</tr>
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</table>

Table 1: General treatment strategies based on the Pruzansky-Kaban classification of mandibular abnormalities

Figure 5: Pruzansky-Kaban Type Ila. The mandibular ramus, condyle, and tempomandibular joint are present but hypoplastic and abnormal in shape. The mouth can be symmetrically opened. (a) Profile view of the affected side in an adolescent girl; (b) three-dimensional (3D) reconstruction of a multi-slice computed tomography (CT) scan of the viscro-cranium of the patient in a, demonstrating the abnormal shape and hypoplasia of the vertical ramus of the mandible.

Figure 6: Pruzansky-Kaban Type IIb. The mandibular ramus is hypoplastic and markedly abnormal in form and location, being medial, anterior and inferior. There is no articulation with the temporal bone. (a) Frontal view of an affected adolescent; (b) profile view of the affected side of the girl in (a); (c) three-dimensional (3D) reconstruction of a multi-slice computed tomography (CT), submento-vertical view, demonstrating the abnormal structures in abnormal location (the same patient as in (a) and (b)); (d) orthopantomogram of the girl in (a), (b), and (c), showing downward growth of the skull base on the affected side and no articulation.

Figure 7: Pruzansky-Kaban Type III. The mandibular ramus, condyle, and tempomandibular joint are absent. The lateral pterygoid muscle and temporalis muscle, if present, are not attached to the mandibular remnant. (a) Three-fourths profile view of an affected girl; (b) three-dimensional (3D) reconstruction of a multi-slice computed tomography (CT) scan of the same girl as in a, showing the absence of the vertical ramus. The patient also had a unilateral cleft lip, alveolus, and palate.
hemifacial microsomia are unilateral, the rotational movement leads to different relapse vectors at both sides. Interarch elastics will safeguard the occlusal relationships, but not the skeletal relationships. The focus of interest is the occlusal plane and the lower dental midline. An orthodontic bone anchor or piriform aperture suspension wire(s) provide a means to suspend the rotated mandible with postoperative elastics to a stable osseous midface structure. Suspending the mandible to the repositioned maxilla is not sufficient, as it may give way and derotate.

**Point 5: The reference plane**

The oculo-auriculo-vertebral spectrum encompasses both hemifacial microsomia and Goldenhar syndrome. In addition to the aforementioned features of hemifacial microsomia, individuals with Goldenhar syndrome may exhibit ocular dermoid cysts, coloboma in the upper eyelids, delayed tooth eruption, speech and hearing disorders, and a cleft lip, alveolus, and palate. They may also have extracranial anomalies, including heart and kidney defects and fused or missing vertebrae (which occur in 30% of cases). The resulting scoliosis causes the cranium to be obliquely positioned on the thoracic spine [Figure 15]. In hemifacial microsomia, a missing, deformed, or dystopic orbit may already cause the normal reference frames (bipupillary plane, infraorbital plane, and brow plane) to be unreliable. When the patient is also scoliotic, the surgeon is challenged to find the best compromise for craniofacial symmetrization, as a completely symmetrical face may focus attention on an obliquely positioned head. In some instances, the orbital dystopia is striking and correctable with an orbital relocation osteotomy [Figure 16].
Point 6: Two costochondral grafts from ribs six and seven

Two pieces of rib are required: one fully cartilaginous piece to reconstruct the fossa and one osseo-cartilaginous piece to reconstruct the missing condyle/ramus [Figure 17]. The zygomatic arch is reconstructed or reinforced by a cranial bone graft. The cartilaginous piece is inserted behind the arch onto the skull base and is retained by resorbable sutures placed around the de novo zygomatic arch. The condylar replacement is fixed onto the ramus, using the temporal approach alone or in combination with an intraoral approach for Pruzansky-Kaban Type III. The cartilaginous part of the condylar replacement may be 1 cm high, as growth is allowed. Swinging the mandible to the healthy side is permitted during joint reconstruction, but it should not cause strain. The main objective is to create a functioning joint, normal range of mouth opening, and abutment allowing for a stable facial rotation procedure at a later age. When obtaining the rib grafts, it is important to remember that rib cartilage may be required for ear reconstruction as well.

Point 7: Pruzansky-Kaban Type IIb reconstruction by a temporal approach

When only the upper part of the ascending ramus is absent, the craniofacial reconstruction (including calvarial
bone harvesting, donor defect reconstruction, zygomatic arch and glenoid fossa reconstruction, and condylar reconstruction) can be performed via a single, wave line incision in the temporal region, extending to the lowest part of the auricular appendage [Figure 18]. Adding a retromandibular incision will jeopardize the facial nerve, as its location is abnormal. Adding an intraoral incision increases the risk of infection of the bone graft.

**Point 8: Antero-medial reconstruction of the glenoid fossa versus posterolateral relocation of the joint**

The issue in Pruzansky-Kaban Type IIb and III deformities is the location for the reconstruction of the joint. Creating an abutting joint in a location that has been determined by the anomalous development is easier; however, it is doubtful whether medial reconstruction will allow symmetrization of the midface and lateral mandible at a later stage [Figure 19]. Relocation of the joint to a mirrored position is more difficult in terms of the healing of the reconstructed condyle being transplanted obliquely to the mandibular stump. The composition is mechanically unstable when it assumes a 30° angle in the frontal plane.

![Figure 16: Goldenhar syndrome with scoliosis and orbital dystopia. The left orbit has been repositioned 1 cm higher. Free gluteal fat grafting, micro lipofilling, and a face-lift on the affected side were also performed after joint reconstruction and facial rotation. (a) Frontal view before the aforementioned procedures; (b) frontal view after the aforementioned procedures; (c) profile view before the aforementioned procedures; (d) profile view after the aforementioned procedures; (e) intraoperative view of the transcranial orbital repositioning (with the assistance of P. Staels, neurosurgeon)](image)

**Figure 16**

![Figure 17: Pruzansky-Kaban Type IIb. Reconstruction of the temporomandibular joint. (a) Two harvested rib segments, one containing bony and cartilaginous components and the other containing only cartilage; (b) the zygomatic arch has been reconstructed using calvarial bone (two small arrows pointing at the micro osteosynthesis screws) and the fossa has been reconstructed using the cartilaginous segment (not visible). The condyle has been reconstructed using the costochondral segment, osteosynthesized via the temporal approach (big arrow pointing at oblique osteosynthesis screws)](image)

**Point 9: Respect the limits of lower facial advancement in favor of masticatory efficiency**

In extreme cases of sagittal deficiency such as that found in Pruzansky-Kaban Type III it is not necessarily desirable to advance the mandible into a position that will allow the soft tissue profile of the chin to be the ideal, as determined by Facewizz software (Orthoface R and D, Sint-Martens-Latem, Belgium) (www.facewizz.com). Such advancement will be opposed by the sphenomandibular ligament and the geniolymphoid muscles, thereby jeopardizing the maintenance of occlusal stability. Maxillary, mandibular, and chin advancements should be tailored to the encountered strain. In these instances, chin augmentation with calcium phosphate paste (Hydroset, Stryker, Kalamazoo, MI, USA) can be helpful in increasing chin projection [Figure 20].

**Point 10: Reconstruction of the lateral and posterior ramus with added manufacturing technology**

Several options exist for augmentation of the lateral aspect of the ramus, but few exist for augmentation of the posterior aspect. For lateral augmentation, sliced lyophilized cartilage grafting can be an option if this is still available. Bone grafting may lead to resorption, and alloplastic implants may lead to extrusion after infection, hydroxyapatite granules mixed with fibrin glue provide a better option.

Both lateral and posterior augmentation are possible using 3D printed titanium, designed according to the postoperative computed tomography scans. For this purpose, the authors use ProPlan CMF and 3-matic...
Figure 19: Pruzansky-Kaban Type III cases with joint reconstruction. (a) This patient underwent early joint reconstruction at the age of 4 but did not comply with physiotherapy and was lost to follow-up during the next 16 years. He returned with temporomandibular joint ankylosis and severe tooth decay; (b) the ankylosis was removed and a new costochondral graft was directed to the original fossa location; (c) frontal view immediately postoperatively of a patient who underwent late joint reconstruction. She had undergone surgery for plagiocephaly at a younger age. The joint was relocated more posteriorly and laterally. As a consequence, the rib graft was inclined at a 30° angle to the ascending ramus. Healing and postoperative physiotherapy were uneventful. A mouth opening range of 37 mm was obtained with full graft union; (d) three-fourths right profile view of the case in (c).

Figure 20: Pruzansky-Kaban Type III case undergoing a facial rotation procedure. The ideal profile line according to www.facewizz.com is coloured blue (g). The targeted profile is colored green. (a) Frontal view, relaxed, before facial rotation; (b) left profile view, relaxed, before facial rotation; (c) three-fourths profile view of the dental occlusion, before facial rotation; (d) three-fourths profile view of the dental occlusion, after facial rotation. Proper prosthetic rehabilitation can be undertaken secondary to occlusal stability; (e) frontal view, smiling, after facial rotation; (f) profile view, relaxed, after facial rotation; (g) planning of the advancement. A three-dimensional (3D) computed tomography (CT) reconstruction is layered over the profile cephalogram, which was used to predict the ideal advancement (blue profile line) and the targeted advancement (green profile line), based on the risk of postoperative relapse and the consequences related to dental occlusion.

Figure 21: Pruzansky-Kaban Type III, following joint reconstruction and facial rotation. (a) Frontal view showing mirroring with ProPlan CMF. The red colored volumes are those with “normal” anatomy on the other side. Substantial vault asymmetry exists as this patient was also treated for plagiocephaly in the 1st year of life; (b) three-fourths right profile view. The transparency shows the underlying original. Nonetheless, it is hoped that the comprehensive treatment planning described in this report may be used to promote optimal patient care ascending ramus; (c) frontal view. Implant design in pink; (d) three-fourths profile view. Transparent implant design indicates the fixation screws.

DISCUSSION

The vertical ramus compartment in hemifacial microsomia can exhibit variable degrees of hard or soft tissue deficiencies. Growth and development result in distorted proportions in both the transverse and sagittal dimensions. Surgical correction is challenging with respect to decision-making and execution, but is nonetheless highly rewarding. Older strategies have been tackled by newer technologies. The author has witnessed the rise in...
printed condyle/fossa reconstruction in adults with ankylosis\cite{18} with consideration for integration in the facial rotation procedure for hemifacial microsomia following rib graft failure.

This article represents level 5 evidence, and therefore simply provides an expert opinion. The variability of pathology, lack of a gold standard, different surgical experiences, duration of the phased treatment, desiderata, compliance and economic situation of the patients, and use of new technologies prohibit valid sampling and prospective analyses. Nonetheless, it is hoped that the comprehensive treatment planning described in this report may be used to promote optimal patient care.

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Neurovascular plexus theory for “escape pain phenomenon” in lower third molar surgery

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ABSTRACT

Pain during extraction of impacted mandibular third molars which can occur despite adequate local anesthesia is termed as “escape pain phenomenon”. Recently, it was described during elevation of a mesioangular impacted mandibular third molar and also while curetting an extracted third molar socket. This phenomenon has been overlooked, as it was previously considered secondary to pressure effect on the inferior alveolar neurovascular bundle (IANB). However, it is unlikely that the pain impulses originate from direct pressure on the IANB, as the nerve is blocked more proximally at its entry into the mandible. The authors speculated that the occasional presence of a neurovascular plexus (NVP) independent of the IANB causes the escape of a pain impulse upon stimulation by root pressure or instrumentation. To validate the presence of such a plexus, a meticulous literature search and review were performed. The search revealed evidence of the occasional presence of a NVP consisting of auriculotemporal and/or retromolar neural filaments. The plexus may be present around the inferior alveolar artery or embedded within the IANB, and does not innervate the tooth. This plexus likely propagates pain impulses only upon stimulation by compression or instrumentation in the apical area of the tooth socket. This theory explains the absence of pain during tooth sectioning and bone guttering in the presence of a complete inferior alveolar nerve block.

Key words: Inferior alveolar nerve, inferior dental plexus, escape pain phenomenon, third molar surgery

INTRODUCTION

The concept of the “escape pain phenomenon” (EPP) was described first by Carter and Keen¹ in 4-5% of patients following an inferior alveolar nerve block. This phenomenon was observed during the entire course of the extraction procedure.¹ Recently, a concern was raised regarding the incidence of pain upon the elevation of an impacted third molar.²,³ The pain typically manifested during elevation of the tooth and even during curettage of the extraction socket at the apical region. This pain was thought to be an alert for the proximity of root apices to the inferior alveolar canal.² However, the pain was absent during soft tissue retraction, bone guttering, and tooth section procedures.³

The purpose of the present article was to postulate a theory which explains the EPP while elevation or curettage steps of third molar surgery based on a systematic literature search.

A literature search was conducted through the MEDLINE database using PubMed Central, Science Direct Search, Scopus, and Google. The keywords “neurovascular plexus” (NVP), “lower third molar”, “inferior dental artery”, “inferior alveolar nerve”, “variation”, “impaction and neurovascular complications” were used in all combinations. All papers are scrutinized for relevancy by a
A total of six relevant papers (cadaveric studies on third molar innervations) were selected, and findings from the papers were recorded. The relevant information from each of these cadaveric studies is summarized below.

Carter and Keen[1] noted a fine network of neurovascular bundles in the area lateral to the roots of the mandibular molar teeth and extending up into the ramus. This network was traced backward to one or more foramina in the areas of insertion of the muscles of mastication. The most common connection occurred with bundles leaving the lateral pterygoid and temporal muscles. The neurovascular bundles leaving the temporalis muscle were traced to foramina in the retromolar fossa, where the lowest fibers of the temporalis gain their insertion. This part of the network ramified through the cancellous bone, and eventually established one or more obvious junctions with the main trunk of the inferior alveolar nerve. Branches of the mandibular division of the inferior alveolar nerve originating high in the infratemporal fossa and travelling to the base of the coronoid process (high and anterior to the mandibular foramen) to enter the mandible. These branches carried sensory innervations to the second and third molars. Branches of the mandibular division or of its inferior alveolar or buccal branches also noted to enter the mandible in the retromolar fossa area and to carry sensory fibers to the first and third molars. The better-documented of the accessory nerves includes the mylohyoid nerve, as well as branches of the mandibular division (V3) of the trigeminal nerve, all of which arise high in the cranium and enter the mandible each according to its own route. The incidence of mylohyoid innervation to the mandibular teeth is approximately 60%. The mylohyoid nerve can arise from the inferior alveolar nerve anywhere from 5 mm to 23 mm proximal to the level of the mandibular foramen, and it enters the mandible at a point distal to the mandibular foramen. Therefore, deposition of local anesthetic in the vicinity of the mandibular foramen during the administration of an inferior nerve block often does not block the mylohyoid nerve. The authors[6] recommended performing the mylohyoid nerve block in the vicinity of the retromental foramina.

Studies have reported the incidence of the retromolar foramen as 1.7%,[7] 7.7%,[8] and 19.5% in the general population,[9] 23% in native populations of North America[10] and 21.9% in the Indian population.[11] However, Bilecenoglu and Tuncer[12] found an incidence of 25% which is the second highest rate in the literature after Schejtman et al.[13] study (72%). The histopathologic investigation found the contents of the neurovascular bundle to be striated muscle fibers, thin myelinated nerve fibers, numerous venules, and a muscular artery having a lumen of 120-130 µm. This is similar to the results found in Schejtman's studies.[13] Compared to the nutrient foramina and canals, the retromolar foramen and canal were found to have vascular and neural contents. The presence of this type of canal may explain anesthetic insufficiency and/or bleeding at this location during routine surgery.[14] The distal end of the retromolar canal advanced to the
distal root of the third molar and retromolar area, and this distribution showed that the contents of this canal innervate and supplied the third molar and mucosa of the retromolar area.

Coleman and Smith\cite{14} speculated that aberrant nerve branches to the mandibular teeth and periodontium arising from major branches of the mandibular trunk high within the pterygomandibular space could also be bathed by anesthetic deposited at the mandibular neck. These branches would probably escape the drug when it is deposited at the mandibular foramen. The authors\cite{14} also cited Sutton’s\cite{15} and Rood’s\cite{16} papers which suggested that there may be accessory innervation of the mandibular teeth from branches of the lingual, buccal, facial, and upper cervical nerves from their clinical experience. With the exception of the buccal nerve, there is little anatomic evidence to support these opinions.

**Neurovascular plexus theory**

The above authors have demonstrated “accessory” nerves from the lateral pterygoid muscle, the temporal muscle, the auriculotemporal nerve, and the mylohyoid nerve. In most instances, these accessory nerves pass through foramina of the condylar neck, retromolar fossa, or within the infratemporal fossa to form a neural plexus which communicates with the inferior alveolar neurovascular bundle. However, all of the authors note that this accessory nerve or the plexus innervates the third molar. Conceptually, if this nerve plexus does, in fact, supply the third molar, then the pain would be expected from the commencement of tooth removal procedure, and not specifically during elevation of the tooth or socket curettage.

Based on the current literature search, the authors hypothesize that the EPP in lower third molar surgery can be attributed to the occasional presence of a NVP lying deep to the roots of the third molar which does not provide innervation. This plexus may be formed by various nerves including the auriculotemporal, mylohyoid, and retromolar plexus from the pterygoid and masseter muscles. The pain impulses may be generated upon compression or stimulation of the plexus and be carried away causing pain escape in the presence of a complete nerve block [Figure 1].

**DISCUSSION**

Since the early 1970s, dentistry has experienced a resurgence of interest in the neuro-anatomical basis of local anesthesia, resulting in many scientific reports on the subject.\cite{6,17} Numerous studies have provided a detailed knowledge of the anatomy of the trigeminal nerve, which is important in obtaining profound local anesthesia.\cite{16-21} To explain the incidence of inadequate anesthesia in the mandibular region despite an efficient inferior alveolar nerve block, an EPP was first described by Carter and Keen.\cite{11} It was suggested to deposit local anesthetic solution in the vicinity of the retromandibular foramen to prevent the pain escape.\cite{8} However, the persistence of pain escape noted even after infiltrating the retromolar area with lidocaine solution in 5 of our cases. Recently, Ngeow\cite{2} noted the incidence of EPP while the elevation of an impacted tooth and assumed it as a result of compression of inferior alveolar nerve. It was postulated that the release of sodium and potassium ions from the compressed nerve may be responsible for propagating the pain impulses.\cite{2} This hypothesis was criticized because the pressure would result in paresthesia which sustains long even after the procedure.

The theory based on present literature validated the presence of a plexus at the apical region of the tooth which may be stimulated by inadvertent tooth elevation or postextraction curettage.

The incidence of pain escape seems to occur only during third molar surgery because of the inclination impacted tooth, as well as the curvature of the angle of the mandible. This brings the neurovascular bundle in proximity to the tooth root. It is not seen in the first and second molar regions as there is no possibility of compression of the neurovascular bundle.

There was also a significant incidence of bleeding following the EPP, which usually noted immediately following the elevation of the tooth fragment. This may be secondary to damage inferior alveolar vessels or vessels from the NVP.

A large-scale cadaveric study would confirm the presence of these independent NVP and their third molar innervations.

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Role of topical heparin in the management of burns: experience in a district government hospital of Karnataka in South India

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ABSTRACT

Aim: Heparin is a multifaceted compound with uses not only as an anticoagulant, but also as an anti-inflammatory, anti-allergenic, anti-histaminic, anti-serotonin, anti-proteolytic and neoangiogenic agent. The aim of the study was to study the effect of topical heparin in the management of second-degree burns.

Methods: Between December 2005 and January 2007, 60 consecutive patients, aged 10-60 years, with first-and second-degree thermal injuries ranging from 10% to 60%, were randomly enrolled in the study divided into a control group (C) and a heparin group (H) of 30 patients each.

Results: Patients treated with topical heparin experienced statistically significant improved pain relief, faster healing, fewer complications and shorter hospital stays. The majority of the patients admitted were in an economically productive age group and were predominantly female. The distribution between the two groups according to age, type of burns and extent of burns was not statistically different.

Conclusion: The current study demonstrates the efficacy of topical heparin in the treatment of first- and second-degree burns.

Key words: Benefits, burns, cost, epidemiology, heparin

INTRODUCTION

The earliest account of the treatment of burns dates back to the Egyptian period and the Ebers Papyrus. Rhazes (850-923 AD) prescribed rosewater cooled by snow for burn wounds, and Avicenna (980-1037 AD) described the importance of using cold water in the management of burn injuries.[1]

Surgeons have advanced considerably from the use of oil-soaked cloth applications to the use of primary tangential excisions and skin grafts with recombinant skin. With the advent of dedicated burn critical care units, there has been a concomitant improvement in the survival rates of critically injured burns patients and their return to society as economically productive members.

Heparin is a multifaceted compound with anti-inflammatory, anti-allergenic, anti-histaminic, anti-serotonin and anti-proteolytic enzyme properties. It has been used in both parenteral and topical forms in the management of thermal injuries to prevent burn extension, limit cutaneous tissue loss, promote faster healing with fewer contractures, relieve of pain, reduce tissue edema and weeping, prevent infection, and to promote revascularization, granulation and reepithelialization of deeply burned tissue. This study was conducted to study the role of topical heparin in the management of thermal burns and to validate its efficacy and safety in a District Government Hospital in South India.
METHODS

A total of 326 patients with burns injuries were admitted to Government Wenlock Hospital, Mangalore, between December 2005 and January 2007. The first consecutive 60 patients with 10-60% second degree burns between the ages of 10 and 60 were enrolled in the study. Patients with liver disease, renal disorders, a blood-coagulating diathesis, an allergy to heparin, an active peptic ulcer, thrombocytopenia, active bleeding or potential bleeding from trauma were excluded. Patients who met the inclusion criteria were randomly assigned a control group (Group C) or heparin group (Group H). Thirty patients were started on topical heparin (Group H), while the other 30 patients in the control group (Group C) were treated with conventional dressings with silver sulfadiazine, intravenous antibiotics, analgesics and intravenous fluids.

The dose of heparin required for topical application was calculated to be 100,000 IU/15% burn surface area (BSA) per day in 3-4 divided doses. The medication was applied to the burnt surface drop by drop with a 50 mL syringe, until the pain was relieved, repeated for 2-4 times until blanching occurred. Beginning on the 2nd day, heparin was applied twice a day, using a diminishing quantity for 1 week.

Blisters were rinsed with heparin solution via hypodermic syringe and were not de-roofed. Blood was drawn to test for bleeding time, clotting time, and activated partial thromboplastin time, in addition to routine blood investigations.

Relief of pain as recorded by a visual analog scale, healing of wounds, dose of heparin, complications, mortality and duration of hospital stay were reported and analyzed. This was a single-blinded study that was approved by the Ethics Committee of the Institute. Written informed consent was obtained from the patients or guardians.

RESULTS

Among the 60 patients enrolled in the study, the age distribution between the two groups was not significantly different [Table 1]. The majority of the patients admitted were in the economically productive age group of 31-40 years old (19 patients, 31%).

There were equal numbers of male and female patients in Group H. The gender distribution among the two groups was not statistically significant [Table 2].

The study showed a statistically significant ($P = 0.017$) difference in the cause of burns between males and females. Accidental burns were seen in 33 patients as compared to 21 patients with homicidal intent, and 6 patients with suicidal aim. Males (18 patients) figured predominantly in the accidental group, whereas females were significantly more represented in the homicidal (17 patients) and suicidal (5 patients) subgroups [Table 3].

The distribution of the patients in the Group H and Group C cohorts as per the cause of burns was statistically not significant ($P = 0.176$) and is depicted in Figure 1.

The stratification of patients according to the extent of the thermal injury has been depicted in Table 4.

The division of burn patients in Groups H and C with respect to their duration of stay in the hospital revealed an earlier discharge from the hospital in Group H, except in cases of extensive burns of more than 50% BSA [Table 5]. The mean duration of hospital stay was significantly less in the Group H compared the Group C, in 10-20% burns (13 vs. 26 days), 20-30% burns (23 vs. 41 days), and 30-40% burns (26 vs. 67 days). A shorter hospital stay has many positive ramifications in an Indian family, in addition to the reduced economic burden of treatment.

Patients in Group C were prone to numerous complications as compared to Group H. The occurrence of these complications as depicted in Table 6 was highly statistically significant.

### Table 1: Age distribution of the patients under evaluation

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-20</td>
<td>6</td>
</tr>
<tr>
<td>21-30</td>
<td>6</td>
</tr>
<tr>
<td>31-40</td>
<td>11</td>
</tr>
<tr>
<td>41-50</td>
<td>4</td>
</tr>
<tr>
<td>51-60</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
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</tbody>
</table>

### Table 2: Distribution of patients according to gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>15</td>
</tr>
<tr>
<td>Female</td>
<td>15</td>
</tr>
</tbody>
</table>

### Table 3: Cause of burns

<table>
<thead>
<tr>
<th>Cause of burns</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental</td>
<td>18</td>
</tr>
<tr>
<td>Homicidal</td>
<td>4</td>
</tr>
<tr>
<td>Suicidal</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
</tr>
</tbody>
</table>

### Table 4: Number of patients according to extent of thermal injury

<table>
<thead>
<tr>
<th>Percentage of burns (%)</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-20</td>
<td>8</td>
</tr>
<tr>
<td>21-30</td>
<td>10</td>
</tr>
<tr>
<td>31-40</td>
<td>9</td>
</tr>
<tr>
<td>41-50</td>
<td>0</td>
</tr>
<tr>
<td>51-60</td>
<td>3</td>
</tr>
</tbody>
</table>
significant \( (P = 0.008) \). The majority of Group C patients (24 patients) had wound contamination by the 5th postburn day, whereas in Group H only 4 patients developed wound infection, a highly statistically significant difference \( (P < 0.001) \) [Figure 2]. None of the patients in Group H had weeping wounds, as compared to Group C in which 76.7% of the patients developed weeping wounds \( (P < 0.001) \).

A reduction in infections was observed in nonweeping wounds in Group H as compared to Group C.

Fisher’s exact test was used to calculate the significance of the lower analgesic requirement in Group H as compared to Group C [Table 7]. The lower requirement for opioids in Group H had a positive effect on care, as patients were significantly more alert \( (P < 0.001) \).

There were fewer mortalities in Group H (1 patient) as compared to Group C (5 patients), but this difference was not statistically significant \( (P = 0.197) \). The decreased mortality rate could not statistically be attributed to the effect of heparin alone.

**DISCUSSION**

Sushruta, considered to be the father of Indian surgery, described the clinical symptoms of burnt patients in 800 BC. In 1607, Fabricus Hildnus\(^{[1]}\) of Switzerland provided the first printed extensive description of burns, their classification and treatment in his book “De Combustionibus.”

Heparin has been shown to be very effective in the treatment of burns\(^{[2]}\) in a number of studies conducted in different centers across the globe.\(^{[3]}\) The use of heparin in burns has been shown to maintain blood circulation, inhibit blood clotting and infarctions, relieve pain, limit inflammation, revascularize ischemic tissue, enhance granulation, regulate collagen, and reduce scarring and contractures.\(^{[4]}\)

The addition of heparin affordably improved burn care in the current study. A majority of the burns were accidental (46.7% of Group C and 63.3% of Group H), while an appreciable number were homicidal in intent (36.7% of Group C and 33.3% of Group H).

The pain, erythema, and edema were reduced in patients who received treatment with heparin. The relief of pain with the use of heparin was remarkable as assessed on the visual analog scale as compared to the level of pain experienced in Group C. There was a direct relationship between the size of burns and the amount of heparin required to produce healing. The reduced use of pain medication and associated reduced side effects permitted Group H patients, who were more alert and cheerful, to ambulate sooner and participate in their burn treatment.\(^{[2]}\)

Irrigation of blisters in Group H removed the inflammatory exudates, and the skin functioned as an autologous biological dressing. Smooth new skin was evident beneath the dried thin blister when it usually flaked off in 10-14 days.
The revascularization of ischemic tissue was the key feature preventing extension of burns and hence a better outcome in patients treated with heparin. These improvements were presumed to be a function of heparin’s neoangiogenic effects.\(^{[3,7]}\)

Prior studies have suggested that orally administered antibiotics can reach burns secondary to an increase in blood flow mediated by the enhanced neoangiogenic-revascularization of the ischemic tissue.\(^{[8-10]}\) A reduction in intestinal bacterial translocation and sepsis found in another study may be another partial explanation for the reduction of infection seen in the current study.\(^{[11]}\)

The safety of large doses of topical heparin was demonstrated by laboratory determinations of blood clotting times, which were not altered. No bleeding problems or other serious complications occurred.\(^{[12]}\)

There were fewer skin grafting procedures required in Group H as compared to Group C, but this finding was not statistically significant. Mortality rates in Group H were lower than in Group C, with all of the deaths in the latter group occurring in 45-60% BSA injuries. Notably, there were more suicide patients in Group C (16.7%) as compared to Group H (3.3%), and suicide burns tend to be more severe. Early tangential excision and skin grafting are not practiced at our institute due to issues of nonavailability of blood products and lack of consent for surgery. Additional variables contributing to a prolonged hospital stay include the availability of free treatment in a government-aided hospital in conjunction with poor familial support.

In 1967, Dr. Saliba MJ Jr, originally published a report of the beneficial effects of intravenous heparin in large doses as a topical spray used to treat extensive burns in 28 patients.\(^{[13]}\) Another study conducted in 2007 showed the utility of the use of topical heparin in treating 100 patients with thermal injuries.\(^{[14]}\) Since that time, numerous studies have confirmed these results.\(^{[15]}\)

In conclusion, even as research for newer modalities in burn wound management continues, the authors find that some traditional modalities still have clinical relevance. Although there are numerous studies supporting the use of heparin in the treatment of burn wound management, many of these are uncontrolled and inadequately define the appropriate treatment and outcomes. Further research is needed to assess the clinical utility of using heparin in the treatment of burn injuries.\(^{[15]}\)

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Fat injection to correct contour deformities of the reconstructed breast: a single surgeon experience

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ABSTRACT

Aim: Autologous fat grafting has gained acceptance as a technique to improve aesthetic outcomes in breast reconstruction. The purpose of this study was to share our clinical experience using autologous fat injection to correct contour deformities during breast reconstruction. Methods: A single surgeon, prospectively maintained database of patients who underwent autologous fat injection during breast reconstruction from January 2008 to November 2013 at McGill University Health Center was reviewed. Patient characteristics, breast history, type of breast reconstruction, volume of fat injected, and complications were analyzed. Results: One hundred and twenty-four patients benefited from autologous fat injection from January 2008 to November 2013, for a total of 187 treated breasts. The patients were on average 49.3 years old (± 8.9 years). Fat was harvested from the medial thighs (20.5%), flanks (39.1%), medial thighs and flanks (2.9%), trochanters (13.3%), medial knees (2.7%), and abdomen (21.9%). An average of 49.25 mL of fat was injected into each reconstructed breast. A total of 187 breasts in 124 patients were lipo-infiltrated during the second stage of breast reconstruction. Thirteen breasts (in 12 separate patients) were injected several years after having undergone lumpectomy and radiotherapy. Of the 187 treated breasts, 118 were reconstructed with expanders to implants, 45 with deep inferior epigastric perforator flaps, 9 with latissimus dorsi flaps with implants, 4 with transverse rectus abdominis myocutaneous flaps, and 13 had previously undergone lumpectomy and radiotherapy. Six complications were noted in the entire series, for a rate of 3.2%. All were in previously radiated breasts. Average follow-up time was 12 months (range: 2-36 months). Conclusion: Fat injection continues to grow in popularity as an adjunct to breast reconstruction. Our experience demonstrates a low complication rate as compared to most surgical interventions of the breast and further supports its safety in breast reconstruction. However, caution should be used when treating previously radiated breasts.

Key words: Breast, contour deformities, fat injection

INTRODUCTION

Fat injection is a useful surgical modality to correct anatomic contour deformities. In 1987, the American Society of Plastic Surgeons published a report discouraging the use of autologous fat injections in the breast due to potential complications related to calcifications and detection of breast cancer. Improvements and technique
have since enhanced the clinical utility of fat grafting, and autologous fat injection is now commonly used to correct breast defects.\textsuperscript{[5,44]}

To date, retrospective studies have shown that complications associated with fat injection markedly decreased with the evolution of fat grafting protocols.\textsuperscript{[7,8]} Calcification and fat necrosis have been shown to correlate with the volume, as well as the technique of fat injection.\textsuperscript{[9-11]} There is also evidence that the volume injected correlates with survival of the grafted fat.\textsuperscript{[12]} The minimally invasive nature of the procedure allows patients to benefit from autologous tissue rather than foreign materials. As such, fat grafting has evolved into a safe procedure to correct contour deformities in the reconstructed breast.\textsuperscript{[7]}

Although some controversy remains with regards to the benefits and risks of autologous fat injections, it is widely used by reconstructive plastic surgeons to correct contour deformities in breast reconstruction.\textsuperscript{[8] Our experience suggests this is a safe procedure that provides significant improvement to breast contour following reconstruction. This study describes a Karl Schwarz (KS) experience with fat injection to correct contour deformities during breast reconstruction.

**METHODS**

**Patient population**

The present study was approved by the McGill University Health Centre Ethics Board. A Karl Schwarz (KS), prospectively maintained database of patients who underwent autologous fat injection during breast reconstruction from January 2008 to November 2013 at McGill University Health Centre was reviewed. Patient characteristics, breast history, type of breast reconstruction, volume of fat injected, and complications were analyzed retrospectively.

**Technique**

Autologous fat was harvested using previously described techniques.\textsuperscript{[13]} Donor sites included medial thighs, flanks, trochanters, arms, or abdominal subcutaneous fat. Under sterile conditions, fat was harvested using the Tulip liposuction system (Tulip Medical Products, San Diego, CA) with a 3 mm cannula. No donor site morbidity was observed in any of the patients enrolled in this study. The fat was then purified on large Telfa pads (Covidien, Mansfield, MA) as previously described by Kanchwala et al.\textsuperscript{[13]} Once the fat reached a custard-like consistency, it was loaded into 10-ml syringes [Figure 1]. Based on preoperative topographic markings, fat was then injected into the breasts in 1 ml aliquots, distributing it evenly in multiple tissue planes, using multiple passes, to visibly correct the previously present contour deformity [Figure 2].

**Review of the literature**

As a measure of comparison with previously published studies, we conducted a literature search of the PubMed database using the keywords “fat graft breast” in PubMed. Our search yielded 149 articles, of which 12 met our inclusion criteria requiring that the studies enroll at least 10 patients, measure fat grafting in a clinical context, and include outcomes and complications [Table 1].

**RESULTS**

One hundred and twenty-four patients benefited from autologous fat injection from January 2008 to November 2013, for a total of 187 treated breasts. The patients were on average 49.3 years old (± 8.9 years). Fat was most often harvested from the medial thighs (20.5%), flanks (39.1%), medial thighs and flanks (2.9%), trochanters (13.3%), medial knees (2.7%), and abdomen (21.9%). An average of 49.25 mL (ranging from 8 to 210 mL) of fat was injected into each reconstructed breast [Table 2]. A total of 174 breasts in 112 patients were injected with autologous fat during the second stage of breast reconstruction. Thirteen breasts (in 12 separate patients) were injected after having undergone lumpectomy and radiotherapy. Eight breasts (in 5 separate patients) underwent a second round of fat injection 6 months after the initial lipoinjection. Of the 187 treated breasts, 118 were reconstructed with expanders to implants, 45 with deep inferior epigastric perforator (DIEP) flaps, 9 with latissimus dorsi flaps with implants, 4 with transverse rectus abdominis myocutaneous flaps [Table 3]. Thirteen of the breasts had previously undergone lumpectomy and radiotherapy. Representative images of patients treated with autologous fat grafting are shown in Figures 3 and 4.

Six complications in 3 separate patients were noted in the entire series, for a rate of 3.2%. All were in previously irradiated breasts. One patient developed an isolated area of fat necrosis but also an occult pneumothorax treated conservatively. One patient developed a cellulitis treated successfully with antibiotics, and another patient developed an infection that was drained with a pig-tail catheter. Oil cysts were noted in 3 breasts.

**DISCUSSION**

Our experience suggests that autologous fat injection is a safe and effective procedure for correcting contour deformities following breast reconstruction. Of the 187 treated breasts in our study, we identified complications in only 6 patients for a complication rate of 3.2%. It should be noted that each of these complications occurred in previously irradiated breasts, which have been associated with impaired healing secondary due to radiation damage.\textsuperscript{[15]} Although our reported rates of fat necrosis and oil cysts are low in nonirradiated breasts, it must be noted that they only represent those discovered on physical exam. It is likely that radiographic evaluation would yield higher rates.

Assessment of the literature and the data presented in this article suggest that fat injection can be a safe procedure. Although the studies reviewed demonstrate significant variability among complication rates, our 6 complications in 187 treated breasts lies on the lower end of the spectrum.
Figure 1: Fat is allowed to separate by gravity and then refined on a Telfa Pad until it reached a custard-like consistency. The refined fat was then transferred in 10-mL syringes.

Figure 2: Relying on preoperative topographic markings, fat was injected on the breast in multiple tissue planes, through multiple passes.

Figure 3: A 52-year-old female who had a left lumpectomy and radiation 3 years ago. She was treated with lipoinjection of the lateral contour deformity.

Figure 4: A 62-year-old female with a history of bilateral mastectomy and radiation therapy on the left breast; followed bilateral deep inferior epigastric perforator flap reconstruction. She benefited from 2 rounds of fat injection of the left upper breast contracture and serial excision of breast skin paddle.

Table 1: Review of the literature

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Number of patients (n)</th>
<th>Average volume of fat injection (mL)</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pérez-Cano et al.</td>
<td>2012</td>
<td>71</td>
<td>140</td>
<td>14.1% of patients developed cysts</td>
</tr>
<tr>
<td>Khouri et al.</td>
<td>2012</td>
<td>81</td>
<td>277</td>
<td>16% of patients report fat necrosis after 1-year</td>
</tr>
<tr>
<td>Rubin et al.</td>
<td>2012</td>
<td>27</td>
<td>526.5</td>
<td>25.5% of patients developed oil cysts</td>
</tr>
<tr>
<td>De Blacam et al.</td>
<td>2011</td>
<td>49</td>
<td>67</td>
<td>3.6% of patients developed fat necrosis</td>
</tr>
<tr>
<td>Kijima et al.</td>
<td>2012</td>
<td>21</td>
<td>123</td>
<td>4.7% of patients developed fat necrosis</td>
</tr>
<tr>
<td>Kamakura and Ito</td>
<td>2011</td>
<td>20</td>
<td>240</td>
<td>11% of patients developed oil cysts</td>
</tr>
<tr>
<td>Losken et al.</td>
<td>2011</td>
<td>107</td>
<td>40</td>
<td>11% of patients reported fat necrosis, erythema, keloid scarring, and pain</td>
</tr>
<tr>
<td>Serra-Renom et al.</td>
<td>2011</td>
<td>28</td>
<td>39.36</td>
<td>0% fat stable in all patients</td>
</tr>
<tr>
<td>Sinna et al.</td>
<td>2011</td>
<td>244</td>
<td>176</td>
<td>2% of patients developed fat necrosis</td>
</tr>
<tr>
<td>Yoshimura et al.</td>
<td>2010</td>
<td>15</td>
<td>264</td>
<td>1.2% of patients developed infection</td>
</tr>
<tr>
<td>Illouz and Sterodimas</td>
<td>2009</td>
<td>820</td>
<td>145</td>
<td>0% no reported complications</td>
</tr>
<tr>
<td>Panettiere et al.</td>
<td>2009</td>
<td>61</td>
<td>24.5</td>
<td>0% no reported complications</td>
</tr>
</tbody>
</table>
Despite having experienced few complications, all patients with a suspicious lesion or nodule were encouraged to follow-up with their breast surgeon and oncologist. Fortunately, radiographic evaluation can reliably distinguish calcifications, fat necrosis and oil cysts from malignant lesions.

The complications identified in our patients occurred only in radiated breasts. Despite the paucity of data regarding fat injection in radiated breasts, there is evidence demonstrating the success of fat injection into radiated tissue. While prior radiation may be a risk factor for fat necrosis, it appears that lipoinjection alleviates the damage associated with radiation. Clearly, further studies are needed to elucidate the advantages and pitfalls of fat injection in radiated breasts.

It is important to point out that familiarity with the technical aspects of fat injection affects the incidence of complications. While the incidence of fat necrosis and graft resorption is reduced when small aliquots are injected in multiple tissue planes, there is evidence that the long-term viability is increased with greater overall injection volumes.

A discussion on the safety of fat injection would not be complete without addressing the potential effects of lipoinjection on local breast cancer recurrence. The increase in vascularity promoted by injected adipose tissue may present a theoretical risk for recurrence. A study by Petit et al. describes early follow-up data suggesting that fat grafting does not present an increased risk for cancer recurrence, however, a follow-up cohort study by the same author suggests that the risk for recurrence could increase in women with high-grade intraepithelial neoplasia under the age of 50. An additional study funded by The Plastic Surgery Foundation is ongoing to further evaluate the oncologic safety of fat grafting in breast cancer patients.

In conclusion, contour irregularities are common problems associated with breast reconstruction and can lead to suboptimal cosmetic results. Fat injection is a powerful tool that provides surgeons the ability to achieve esthetically superior results. Meticulous technique and proper planning, particularly assessing the recipient site and limiting injection volumes, allows surgeons to deliver results with low complication rates.

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Use of the multiplane internal mastopexy for ptosis correction revision-augmentation mammoplasty

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ABSTRACT

Aim: Augmentation mammoplasty is a commonly performed procedure with a high satisfaction rate. Multiplane pocket was described for simultaneous internal mastopexy and augmentation using inframammary crease incision for selected primary and secondary mammoplasties. The use of the technique is presented with a larger experience for correction of ptosis in a patient presenting for revision surgery following subglandular augmentation mammoplasty. Methods: A retrospectively collected data were analyzed using the Excel Spread Sheet. A total of 25 patients had multiplane augmentation with the internal mastopexy following augmentation mammoplasty in subglandular pocket. Data of 25 patients who had their revision surgery in multiplane were analyzed. Results: The group included 25 patients with a mean age of 36.6 years (range: 25-54 years) with mean implant duration of 6.4 years (range: 1.5-13 years). Twenty-three of the patients were nonsmokers, 1 smoker and 1 patient’s smoking status was not mentioned. Eighteen patients presented with grade I capsular contracture, 3 patients with grade II contracture and 4 patients had a combination of grade I and II capsular contracture. Pseudoptosis was present in 6, class B ptosis in 6, A/B ptosis in 3, water-down deformity in 5 and rippling in 5 patients. Average preoperative size of implant used initially was 334.4 mL (range: 250-340 mL) and the mean implant size selected for revision surgery was 416 mL (range: 260-525 mL). Mean follow-up time was 18 months (range: 6-48 months). Of 25 patients, 21 had a bilateral procedure whereas the technique was used unilaterally in 4 patients for the correction of asymmetry. All patients had a single dose of intravenous antibiotics and followed by an oral course for 5 days, there was no infection noted in the series. In the current series, no patient required revision surgery following the multiplane internal mastopexy. Conclusion: Multiplane internal mastopexy can be useful in selected cases of revisionary augmentation mammoplasty.

Key words: Breast ptosis, internal mastopexy, mastopexy with augmentation, revision-augmentation mammoplasty

INTRODUCTION

Primary and revision-augmentation mammoplasty is a commonly performed procedure. The incidence of implant related mammoplasties for both primary and revision mammoplasties is on the rise and is due to the information available on the product, premarket surveys, enhanced implant safety, and regular quality checks.[1] It is not surprising that augmentation mammoplasty is one of the most commonly performed procedure and in 2012 alone 330,631 implant related mammoplasties were performed in USA.[2] However, the data represent implant-related surgeries performed both for primary and secondary surgery making it difficult to obtain number of secondary or revision mammoplasties performed during the same period of time.[3] Secondary procedures following mammoplasties can be divided into early or late. Early
reasons for redo are uncommon and include infection and bleeding, but both may necessitate urgent attention or an emergency surgery.[11] The late complications are more common and do not generally constitute emergency procedures.[11] These late complications include capsular contracture, change for implant size and shape, implant rippling, asymmetry of shape, implant rupture or ptosis. Revision surgery for these complications is either performed alone or in combination, depending on the presentation. Revision surgery in these complications often requires a change of implant. These complications and their corrective surgery can often be challenging for a surgeon and requires a detailed history of previous surgery, thorough examination, patient’s wishes for a desired results and a well thought, clear and meticulous plan. Patients presenting with these complications may have an associated ptosis that may require simultaneous mastopexy using either periareolar, vertical scar, wise pattern markings or their modifications.[9] The pocket for implant replacement can be subglandular, partial submuscular, subfascial or muscle splitting.[8] Multiplane internal mastopexy (MIM) or use of more than one pocket for augmentation and the internal mastopexy using an inframammary crease has been described and was used in selected patients. The technique allows avoidance of scar in the border line ptosis and especially suits those patients who are not interested in obvious scarring associated with conventional nipple mobilization. The technique was used for primary cases with a limited experience in revision mammoplasties.[8] The current article describes a larger experience in selected patients who had their initial augmentation mammoplasty in subglandular pocket. The technique allows an addition to the armamentarium of surgeons for patients who present for revision surgery with minor to moderate ptosis following augmentation in subglandular pocket.

METHODS

A retrospectively collected data were analyzed in the Excel Spread Sheet (Microsoft). Between January 2008 and October 2013, 25 patients had MIM following their augmentation mammoplasty in subglandular pocket. Relevant data of 25 patients who had their revision surgery in multiplane pocket was further analyzed. Six months postoperatively, patients were asked whether they were very satisfied, satisfied or dissatisfied with the outcome of the surgery.

Examination

All patients are examined in standing and supine position. Supine position allows any excess pocket extension in lateral dimension. Breast ptosis with or without upper and medial quadrant rippling is an indication for the conversion technique. Lower and lower lateral skin envelope rippling is unlikely to be improved by muscle splitting conversion or any other submuscular technique. Degree of capsular contracture is noted, and information is gathered about the size and profile of the existing implants.

Technique

All procedures are performed under general anesthetic with full muscle relaxation and as a day case. Patients were placed in the supine position with arms abducted in less than 90°. Inframammary crease was used for the pocket access.

After explantation of the device, pocket was examined for its dimensions and extent and nature of the capsule. In grade 1 or 2 capsular contractures, only lower pole capsulotomies were performed. Breast presenting with advanced capsules, partial or complete capsulectomy was performed. The next step was to identify Pectoralis Major and marked by light scoring on the posterior layer of capsule, starting from the junction of the middle and lower third of sternum medially and going up and laterally to the anterior axillary fold. This line of the muscle split was transposed and marked anteriorly by scoring the anterior layer of the capsule, this scoring should ideally be at or just below the nipple level in the midline.

Pectoralis split was commenced medially at the junction of the middle and lower third of the sternum. Pectoralis muscle is pinched and lifted off the sternal margin using Gillis toothed forceps, and a small incision is made using cutting diathermy. The incision should be large enough to allow index finger, and once the finger is inserted, submuscular dissection was performed using index finger extending up to the 2nd intercostal space and to the anterior axillary line laterally. Once the submuscular dissection is completed, incision is usually large enough allowing the breast retractor to be inserted with its distal end pointing towards anterior axillary fold. Muscle split begins medially using cutting diathermy, and once the split gets closer to the anterior axillary fold, the dissection is slowed down. Here, coagulation of the muscle is performed before splitting or cutting it up further. The maneuver avoids inadvertent bleeding resulting from damage to thoracoacromial axis branches.

Once pectoralis split is completed, the lateral capsulotomy is extended upward to join the lateral extent of muscle split. The lower border of the upper split pectoralis is now stitched to the breast envelope below the marked and scored anterior capsule using 2-0 Vicryl interrupted stitches vicryl (Ethicon) [Figure 1a-c]. The level at which the anterior capsule is stitched to the lower border of upper split pectoralis depends on the degree of ptosis but should not be less than 2 cm [Figure 1a]. Hemostasis is achieved, and a preoperatively selected implant is placed in its new pocket. Before wound closure and once the new implant is in place, the flat of the hand is run over the skin envelope sliding the skin inferiorly over the mound of the implant. Creation of a crease or fold, due to an internal stitch placed too low inside the skin envelope, is an indication of replacing the stitch to a little higher position. The head end of the table can also be raised to confirm the fold, which depends from the anchoring suture inside and can also be felt by doing a bimanual digital examination using index
finger and thumb through inframammary incision. The incorrect positioning of the stitch is not visible without this maneuver when patient is lying in a supine position. More commonly, the sliding or tilting of the table may show minor puckering or dimpling of the skin envelope that can be left alone. Once suture incorrect position is established, implant is removed, and sutures are repositioned at a slightly higher level, using previously scored anterior capsule as a reference point and implant is replaced. The procedure can be repeated to assess the position of the newly position stitch.

Wound closure is done using continuous 2-0 Vicryl to deep fascial layer, subcutaneous 3-0 Vicryl interrupted and intradermal 4-0 continuous Monocryl stitch (Monocryl (Ethicon). Once the wound closed and dressed, external support to breast envelope is provided using adhesive dressings. The external supportive dressings are applied starting from the lower pole and pulling, supporting, and stabilizing the breast envelope at a higher and desirable position. Support garments are applied, and patients are discharged on the same day.

Postoperatively, there is often some puckering of the skin envelope due to internal stitches. This puckering almost always disappears within 4-6 weeks after surgery [Figure 2a-d].

Patients are reviewed 2 and 4 weeks later to check for wound healing. Patients are generally allowed to drive and return to work 10 weeks off work.

RESULTS

The group included 25 patients with an average age 36.6 years (range: 25-54 years) with mean implant duration 6.4 years (range: 1.5-13 years), 23 of the patients were nonsmokers, 1 smoker and 1 patient’s smoking status was not mentioned. Eighteen patients presented with grade I capsular contracture, 3 patients with grade II ptosis and 4 patients had a combination of grade I and II capsular contracture. Pseudoptosis was present in 6, class B ptosis in 6, A/B ptosis in 3, sliding ptosis or water-down deformity in 5 and rippling in 5 patients. Average size implant from the initial surgery was 334.4 mL (range: 250-340 mL) and the mean implant size selected for revision surgery was 416 mL (range: 260-525 mL). Of 25 patients, 21 patients had a bilateral procedure whereas the technique was used unilaterally in 4 patients for the correction of asymmetry. Mean follow-up time was 18 months (range: 6-48 months). All patients had a single intravenous dose of predominantly Augmentin and followed by an oral course for 5 days, there was no infection noted in the series. In the current series, no patient required revision surgery following MIM. Patient satisfaction data were retrieved from the spreadsheet, 20 patients (80%) were very satisfied with the outcome and 5 patients were satisfied with the results, no patients showed dissatisfaction with the procedure.

DISCUSSION

Augmentation mammoplasty is primarily done either in front or behind the muscles.[7,8] All modifications are the extensions of these 2 primary pockets. The existence of these 2 planes in each subject has the potential of these 2 pockets being used at the same time. Breast ptosis is the slackening and downward descent of the nipple areolar complex (NAC) and breast envelope in relation to the inframammary crease as defined by Regnault.[9] The ptosis correction is commonly performed by using periareolar, vertical scar or wise pattern markings, depending on the presentation of the breast, wishes of the patient and the

Figure 1: (a) Intraoperative picture showing scored anterior skin envelope marked with a Vicryl suture held at its loose end. Below and to the right in the picture, lower edge of the upper split muscle is also marked with Vicryl suture; (b) anterior capsule/wall of the pocket on the left and lower free edge of upper split muscle on the right, held separately in forceps before suturing; (c) tied suture knot between the marked anterior capsule/wall of envelope and lower edge of the upper split pectoralis major in place

Figure 2: (a) Illustration showing side profile of an implant in subglandular pocket; (b) illustration showing dissected muscle splitting pocket with anchoring stitch placed between lower border of upper split muscle and breast envelope at a level just under the nipple areolar complex (NAC). Note the relative position of the sixth rib and the nipple areolar complex; (c) illustration showing the implant placed in muscle splitting pocket with a tied anchoring stitch between muscle and breast envelope. Note the puckering of the skin below NAC, gathered skin above NAC and relative position of the sixth rib; (d) implant in its new muscle splitting position with puckering and skin gathering settled
experience of the surgeon.\textsuperscript{[4,10]} Markings for mastopexy used are independent of the pocket, and choice of the pocket can be independent of markings.\textsuperscript{[4,5]} Even though breast lies in front of the muscle, most of the patients can have satisfactory breast volume restoration or further enhancement in partial submuscular pocket. Muscle splitting augmentation is a pocket that can be used primarily where an implant is placed behind the muscle in its upper part and front of the muscle in lower part of the breast pocket. The advantage of this technique is that the results have a more natural appearance with the advantage of muscle support in the ever-changing upper breast envelope.\textsuperscript{[11-14]} The use of muscle splitting pocket is also described for secondary procedures where partial submuscular and subglandular pockets are converted into muscle splitting pocket.\textsuperscript{[15-18]} Muscle splitting augmentation allows an immediate natural outcome, and the longevity of the results has been reported with a satisfactory outcome and reduced revision rate when compared with other commonly used techniques.\textsuperscript{[19]} The Multiplane technique is a procedure where muscle splitting procedure is used for submuscular implant placement and subglandular pocket is used for breast lift or mastopexy. In a previously published article, postoperative suprasternal notch to NACs distance was reported to be reduced when augmentation mammoplasty with multipline technique distances was compared with its preoperative measurements.\textsuperscript{[20]} On the other hand, suprasternal notch to NACs distance was increased postoperatively following mammoplasty in subglandular and partial submuscular augmentation, with their respective preoperative measurements.\textsuperscript{[21]} The changes and distances are measured more following sub glandular than sub muscular mammoplasty and are primarily due to the support of an extra muscle layer added to the breast skin envelope when sub muscular pocket is used.\textsuperscript{[20]} In current series, average size of the implants used for the initial procedure was 334 mL as compared to 416 mL selected for the revision cases, a trend normally seen in revision mammoplasties.\textsuperscript{[2,21]} In revisionary aesthetic mammoplasty, patients almost always request for a larger implant size. The larger size of implant used in MIM acts as an internal splint and put an even pressure on the skin envelope that helps to stabilize the draped skin in this form of mastopexy. This internal splinting is supported by external supportive dressings while envelope is settling down in its relocated position. Since this form of mastopexy does not involve skin reduction, necessary thinning of the skin envelope is achieved when a larger implant is used. When subglandular to muscle splitting submuscular site change or pocket changed was performed for rippling alone without an internal mastopexy, and in a patient without ptosis or skin excess, moderate reduction in implant sizes did not show any untoward skin laxity or puckering, when skin envelope finally settled down. However, when a patient presents with breast ptosis and skin envelope excess and wishes to choose a smaller implant for replacement or go down in breast cup size, conventional skin reduction mastopexy with NAC mobilization is the recommended procedure of choice. The multiline technique was initially described for primary cases with a limited experience for ptosis and rippling correction in patients following augmentation mammoplasty in subglandular pocket.\textsuperscript{[6]} The concept of the use of the two planes is not new and submuscular pocket for implant placement, and subglandular pocket dissection for breast envelope draping has been described in the past. However, the draping of mobilized breast envelope in Multiplane pocket is secured internally while the technique described by Hilton Becker relied on external support using dressings and adhesives bandages alone. Becker\textsuperscript{[22]} also used an expander prosthesis with an occasional combination of periareolar mastopexy in certain cases. Similarly, implant site change or pocket change from subglandular to submuscular, submuscular to neoepical or subfascial is not new, and the idea has been frequently used and documented.\textsuperscript{[17]} Subglandular, dual plane and partial submuscular to muscle splitting biplane has also been reported for revisionary surgery with acceptable long-term results in various forms of aesthetic breast revisionary surgery.\textsuperscript{[23-25]} With the high number of aesthetic revisionary performed today, preexisting pockets conversion to muscle splitting biplane submuscular pocket, a combination of submuscular and subglandular pocket, remains a suitable option. The use of acellular dermal matrix (ADM) in revisionary aesthetic breast surgery has introduced another horizon to deal with various problems encountered in secondary aesthetic breast procedures.\textsuperscript{[26]} In small case series of three patients, the preemptive use of ADM in lower pole of poor quality breast tissue has been described for internal mastopexy in order to minimize the risk of ptosis in primary cases and in one patient ADM was used for internal mastopexy to correct an established ptosis following augmentation mammoplasty with mastopexy.\textsuperscript{[27]} The report is promising, however, a larger series with longer follow-up will be required to evaluate the efficacy of the technique. In a review article regarding the use of biological and synthetic meshes used in implants surgery, the use of these materials was predominantly limited to breast reconstruction following mastectomy. Even though the use of ADM has gained some popularity following the safety of skin or nipple sparing mastectomies, a high number of seroma, higher infection rate and the cost of the product has restricted its use in aesthetic secondary augmentation mammoplasties.\textsuperscript{[28]} The use of long-term synthetic mesh has shown more promising results in breast reconstructive and cosmetic surgery, however, the available data of its use in primary or secondary augmentation mammoplasties and augmentation mastopexies are limited.\textsuperscript{[29]} Breast implant capsule flaps are reported quite frequently, and various techniques have been described for its use in primary and secondary cosmetic and reconstructive surgeries with very good results.\textsuperscript{[30]} However, the use of these implants flaps, biological matrices and synthetic meshes is limited to support breast envelope, following mastectomies. These alternatives are also aimed to correct implant malposition, redefine or reconstruct inframammary crease both in cosmetic, as well as reconstructive surgery.\textsuperscript{[28-30]} The author also has described the use of existing capsules to recreate
new pockets for the correction of bottoming out, double bubble deformity and animation deformities.\textsuperscript{[15-16]} The use of these materials or techniques as supplementary breast supporting products are limited to reinforce or reconstruct breast dimensions, to support weak breast envelope or to prevent explant exposures but without the ability of reversing the NAC-inframammary crease (IMC) relationship seen following breast ptosis and as defined by Regnault.\textsuperscript{[9]}

On the other hand, MIM has a unique ability to restore or improve the altered NAC-IMC relationship and without extra scarring in selected cases.

The augmentation mammoplasty with the internal mastopexy in prepectoral or subglandular pocket in revisionary cases has a marked advantage over simultaneous augmentation mammoplasty with the internal mastopexy in primary cases. In primary cases, especially those presenting with large size breasts, initial acceptable results may later show sliding ptosis of the NAC over the mound of the implant. However, when MIM is performed in secondary cases, initial mammoplasty in sub glandular pocket has generally compressed the breast tissue over a period of time. This comparatively thinner layer of the breast envelope is far easier to be elevated, anchored, and secured at a higher position on the muscle, in a predictable way and with longevity of results. The current series has a mean follow-up of 18 months (range: 6-48 months) with high satisfactory results. Despite the much desired scar-less MIM in selected cases, a longer follow-up will be desirable for a comparison with other conventional mastopexy techniques used today. The obvious disadvantage of MIM is the indirect measurements for a nipple areolar repositioning as compared to precise markings used in conventional skin reducing and nipple areolar mobilizing techniques. Minor asymmetry, if present, is well-tolerated and accepted by patients due to the normally occurring asymmetries in breast and NAC.\textsuperscript{[31-33]}

The other disadvantage with MIM is that the technique does not allow areolar reduction that may overshadow the true lift achieved in such cases presenting with large size NAC [Figure 3a and b]. In some cases, breast envelope puckering along the lower edge of the upper split muscle can be obvious in the early period of healing but resolves in time [Figure 4]. The added use of external supportive dressings stabilizes the mobilized skin envelope and conceals the temporary puckering that can be worrying for the patients in the early stage of healing. Removal of the dressings in 2 weeks’ time almost always leaves behind a smoother skin envelope and muscle expansion and relaxation allows the implant to settle with more natural three-dimensional results [Figures 5 and 6].

Even though the study did not include a very large number of patients, the outcome showed a very high satisfaction...
The Khan has been performed in the series analyzed. Had an acceptable results, and no further corrective surgery follow-up of 18-48 months) all patients are not keen on conventional external scarring. With a mean patients and can be a good choice especially in those who desirable.

The technique allows avoidance of external scars in selected patients and can be a good choice especially in those who are not keen on conventional external scarring. With a mean follow-up of 18 months (range: 6-48 months) all patients had an acceptable results, and no further corrective surgery has been performed in the series analyzed.

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INTRODUCTION

Sagittal split osteotomy of the ramus may be the procedure which defined the evolution of the art and science of oral surgery. Although the basic design of the sagittal split ramus procedure evolved very quickly, the elimination of complications has taken longer.[1] The procedure has been modified many times since its introduction by Trauner and Obwegeser.[2] One modification frequently used is a shortened medial horizontal osteotomy, which, instead of extending the cut to the posterior border, is carried only to the lingual fossa posterior to the lingula.[3] In the majority of cases, this technique allows for adequate splitting of the mandible.[3] However, this modification is not devoid of complications, as the medial cut can be misdirected due to anatomic variability of the ramus, or an improperly directed osteotomy cut, resulting in a bad lingual split.

Various studies have reported an incidence of bad splits ranging from 1.7% to 9.1%.[4] Although the most common unfavorable splits involve a buccal plate fracture, these bad lingual splits may result in serious complications including fracture of the lingual cortical plate, condylar neck and coronoid process.[4]

The purpose of this article is to suggest a modification of the medial osteotomy cut which will prevent misdirection while overcoming anatomical variations and technical problems.

METHODS

Surgical access for the sagittal split osteotomy is performed in the standard fashion. Following fine dissection over the anterior border of mandible, the insertion of the temporalis muscle is detached and elevated to the level of the sigmoid notch. The anterior ramus is then isolated with retraction of the soft tissues. The medial ramus is accessed by subperiosteal insertion of a malleable retractor above the foramen, and the inferior alveolar nerve is identified at the level of the lingula.[5] The medial osteotomy cut is directed parallel[3] to the occlusal plane [Figure 1] at the level of superior aspect of lingula in the standard fashion, but ends at a point midway between the lingula and the ascending ramus.

ABSTRACT

Aim: To present a simple technical modification of a medial osteotomy cut which prevents its misdirection and overcomes various anatomical variations as well as technical problems. Methods: The medial osteotomy cut is modified in the posterior half at an angle of 15°-20° following novel landmarks. Results: The proposed cut exclusively directs the splitting forces downwards to create a favorable lingual fracture, preventing the possibility of an upwards split which would cause a coronoid or condylar fracture. Conclusion: This modification has proven to be successful to date without encountering the complications of a bad split or nerve damage.

Key words: Guiding oblique osteotomy cut, lingual bad splits, medial cut, sagittal split ramus osteotomy

A guiding oblique osteotomy cut to prevent bad split in sagittal split ramus osteotomy: a technical note

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This completes the anterior half of the traditional medial cut. The posterior half of the osteotomy cut is completed by directing the bur obliquely downwards at an angle of 15°-20° to the anterior half of the osteotomy cut which is parallel to occlusal plane. Care is taken to avoid damage to the inferrior alveolar neurovascular bundle.

After completing the guiding oblique (GO) osteotomy cut, rest of the procedure is continued following routine standard technique.\[3\]

RESULTS

The GO cut extends downwards 3 mm posterior to the lingula from the point where the anterior half of the osteotomy cut was concluded. This creates an oblique angle between anterior and posterior osteotomy cuts and thus completes the modified medial ramus osteotomy. As the GO cut directs the splitting forces downwards, there is no possibility of the split propagating upwards to cause a coronoid or condylar fracture.

DISCUSSION

A major disadvantage of the traditional medial osteotomy cut is the effect that the anterior orientation of the bur has on the direction of the posterior cut. Another shortcoming of the cut is its abrupt termination at the posterior end. This produces a sharp angle at the junction of the buccal and lingual cortical plates of ramus of mandible. The forces applied in the sagittal split may concentrate at this angle, and the stress may be propagated in any direction to create bad splits. This is especially true in cases in which the posterior cut terminates in the monocortical area of the medial ramus rather in the bicortical region.

In contrast to the conventional medial cut, a simple modification which incorporates a GO cut in its posterior half minimizes the stress concentrated at this angle, and directs the cut downward to give a favorable lingual split. The surgical design also provides flexibility in placing the anterior half of the cut downwards in favorable bicortical region in cases of anatomical variation this avoids the possibility of coronoid fracture.

Advantages of a GO osteotomy cut in specific situations to prevent bad splits are as follows: (1) in regular situations a GO cut provides flexibility in adjusting the direction of the posterior medial cut if the anterior cut has been placed in an unfavorable direction; (2) in cases in which the ramal occlusal plane angle\[3\] is < 70°, a parallel osteotomy would be directed superiorly, cutting the inferior portion of the neck of the condyloid process.\[1\] To prevent this from occurring, it is advised to place the horizontal osteotomy cut at an altered angle of 10°-15° inferirorly.\[2\] As the suggested modification already includes a 15° bur angulation for the anterior cut, it is not necessary to adjust the osteotomy cut further; (3) in cases with a high lingula, there is an increased incidence of unfavorable fractures.\[3\] A high lingula will place the medial osteotomy in a region of the mandibular ramus that has little or no cancellous bone.\[8\] In this situation it is suggested that the medial osteotomy be angled from its typical location in the mid-ascending ramus up to the lingula of the medial ramus.\[5\] If cancellous bone is not encountered, the medial cut is widened at the expense of cortex along the inferior aspect of the medial osteotomy until cancellous bone is seen.\[8\] However, the widening creates an oblique medial cut directed upwards which increase the possibility of bad split. This complication is successfully avoided by the proposed modification which allows to place the anterior half of the cut in the favorable (bicortex) cancellous part of anterior ramus which is independent of the direction of posterior cut. A similar modification can be applied in cases of a thin mandible in which there is little cancellous bone; and (4) several investigators have demonstrated an increased risk of unfavorable fractures associated with the presence of third molars at the osteotomy site during sagittal split ramus osteotomy.\[25-28\] The authors have observed a concentration of stress at the angle created by the buccal and lingual cortex of impacted third molar during the sagittal split which may result in a lingual plate fracture. For the same reason a lingual back cut\[5\] posterior to the lingula is suggested. The addition of a lingual back cut helps direct the lingual fracture to a more favorable split at the inferior border of the osteotomy.\[5\] The present GO cut acts as a back cut when directed 3-4 mm downwards with the same angulation which directs the lingual split laterally and inferiorly to the impacted molar providing a favorable split at the inferior border of the osteotomy.

In conclusion, splitting the straight medial cut into two components with angulation in the midpoint makes the anterior and posterior cuts independent of each other. Although there are many advantages and applications, a larger study is required to compare its versatility to that of the traditional medial cut. Nonetheless, the current modification has proven to be successful to date in the author’s hands while avoiding the complications of a bad split or nerve damage.
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Hyperbaric oxygen therapy and surgical delay improve flap survival of reverse pedicle flaps for lower third leg and foot reconstruction

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ABSTRACT

Aim: The purpose of the study is to present a management protocol for various types of soft tissue defects of the distal third region of leg and foot treated with pedicle flaps, by including hyperbaric oxygen (HBO) therapy in the treatment regimen with flap delay. Methods: We present a prospective study of 23 patients with various types of soft tissue defects of the foot, and lower third of leg managed in our institution from December 2012 to December 2013. All soft tissue defects were treated by a reverse pedicle flap. Twelve patients were managed with flap delay with HBO therapy and 11 patients with immediate flaps without HBO therapy. The postoperative period, hospital course, and follow-up were documented. Results: Of 12 patients with flap delay and HBO, 10 patients did not suffer any complications secondary to flap transfer. One patient had discolouration of the tip of the flap, which settled without intervention, and 1 patient had recurrent abscess formation, which required debridement and closure. Of 11 patients with direct transfer, 6 patients presented with complications including flap congestion, partial flap loss, and tip necrosis, which required secondary intervention. Conclusion: HBO therapy is a useful adjunct in flap delay of the reverse pedicle flap for soft tissue reconstruction of the lower third of the leg and foot regions.

Key words: Flap delay, hyperbaric oxygen therapy, reverse pedicle flap, soft tissue reconstruction

INTRODUCTION

Although numerous techniques ranging from skin grafting to free-tissue transfer have been utilized for reconstruction of soft tissue defects of the foot, and lower third of the leg regions, very few have yielded entirely satisfactory results. A safe, easy and reliable reconstructive option is required for reconstruction of the lower third of the leg and foot regions. The lateral supramalleolar flap[1,2] from the lateral aspect of the lower leg, and the flap supplied by a perforating branch of the dorsal peroneal artery are commonly used for coverage of the dorsum of the foot, the medial and lateral arches, and all regions of the heel. The reverse sural flap[3,4] is raised from the posterior aspect of the calf and is commonly used for coverage of the hind foot, dorsum, and the lateral malleolus. Distally-based flaps based on the posterior tibial artery or the peroneal artery perforator plus flap[5] also assist in the soft tissue coverage of defects of the distal third of the leg. In this prospective study, 23 patients were treated with distally-based pedicle flap coverage in which 12 patients underwent flap delay with hyperbaric oxygen (HBO) therapy, and 11 patients underwent immediate flap transfer without HBO therapy. The study was undertaken prospectively over a period of
13 months in a tertiary care unit. The purpose of this study was to present a management protocol for various types of soft tissue defects of the distal third of the leg and foot with pedicle flaps, by including HBO therapy in the treatment regimen with the flap delay.

**METHODS**

A total of 23 patients with soft tissue defects of lower third of the leg and foot were treated over a period of 13 months (December 2012 to December 2013). On the basis of the defects, lateral supramalleolar, reverse sural and distally-based posterior tibial artery perforator plus flaps were utilized for soft tissue coverage. Of 23 patients, 12 patients were managed by flap delay with HBO therapy as an adjunct, and 11 patients were managed by direct flap transfer without HBO therapy. Outcomes following the different types of management and secondary procedures performed were noted.

**RESULTS**

The mechanism of injury for 20 patients was a road traffic accident, 1 patient presented with an open wound secondary to a diabetic ulcer, 1 defect was due to osteomyelitis and 1 was due to a snake bite injury. Of 23 patients, there were 6 females (26.1%) and 17 males patients (73.9%). The mean age was 42 years (range: 13-68 years).

In 12 patients, the flap delay was performed, and HBO therapy was used as an adjunct. Of these 12 patients, 2 patients had sustained the defect due to an infectious source, and 10 cases occurred secondary to a road traffic accident. Among these 12 patients, 5 patients had diabetes mellitus, and 1 patient had soft tissue loss due to a snake bite injury. Two patients were scheduled for extended sural artery flap, and 1 patient had varicose veins as a comorbid condition. Five flaps were lateral supramalleolar flaps, 1 was a distally-based posterior tibial artery perforator flap, and 6 were reverse sural artery flaps. Among the 6 reverse sural flaps, 2 were extended reverse sural flaps. The severity of injury, time of referral, comorbid conditions, age of the patients, and the extent of the flap were considered to be qualifying conditions for flap delay with associated HBO therapy. One patient developed a recurrent abscess at the ankle joint, which required incision and drainage, and 1 patient had discoloration of the flap tip which resolved without intervention.

For 11 patients, direct transfer of the flap was performed. Of these 11 patients, 1 child had suffered soft tissue loss secondary to osteomyelitis, and the rest of the defects were due to road traffic accidents. Four flaps were lateral supramalleolar flaps and 7 were reverse sural artery flaps. Six patients developed postoperative complications. Five patients suffered tip necrosis, which required debridement and skin grafting, and 1 patient sustained partial loss of a reverse sural flap, which subsequently required skin grafting [Tables 1-3].

**Case 1**

A 34-year-old male with a crush injury to the right heel pad and ankle region was referred to our center 3 weeks following injury. The patient presented with necrosis of the heel pad with multiple lacerations over the ankle on both the medial and lateral aspects [Figure 1a-c]. The wound was debrided, and HBO therapy sessions were started. On postdebridement day 2, an extended reverse sural flap was elevated with flap delay [Figure 1d], continuing the hyperbaric sessions. On postdebridement day 4, flap inset was completed [Figure 1e]. The donor area was covered with a split-thickness skin graft. HBO therapy was administered for an additional 12 sessions. The postoperative period was uneventful [Figure 1f and g].

**Case 2**

A 68-year-old male developed an ulceration on the lateral malleolus with exposure of the ankle joint [Figure 2a]. HBO therapy sessions were started. The wound was debrided, and lateral supramalleolar flap coverage was planned [Figure 2b]. The lateral supramalleolar flap was elevated, and flap delay was performed, with continuation of the hyperbaric sessions [Figure 2c]. On postdebridement day 4, flap inset was completed, and the donor area was covered with a split-thickness skin graft [Figure 2d]. HBO therapy was administered for 12 additional sessions. The postoperative period was uneventful [Figure 2e].

**Case 3**

A 21-year-old male sustained injury to the lower third of the right leg with soft tissue loss and exposure of the tibial bone [Figure 3a]. Following debridement, a distally-based posterior tibial artery perforator plus flap was planned. A distally-based posterior tibial artery perforator plus flap was elevated, and flap delay was performed with continuation of the hyperbaric sessions [Figure 3b and c]. On postdebridement day 4, flap inset was completed, and the donor area was covered with a split-thickness skin graft [Figure 3d]. HBO therapy was administered for an additional 6 sessions. The postoperative period was uneventful [Figure 3e].

**Case 4**

A 39-year-old male sustained injury to the right foot secondary to a road traffic accident and presented with soft tissue loss over the medial malleolus and calcaneal regions [Figure 4a]. The wound was debrided, and a reverse sural artery flap was performed [Figure 4b and c]. The patient developed flap tip necrosis and required a skin graft for coverage [Figure 4d].

**DISCUSSION**

Soft tissue defects of the lower third of the leg and foot may be covered with skin grafts, local flaps, distally or proximally-based island flaps, and distant tissue transfer or cross leg flaps. In 1983, distally-based fasciocutaneous flaps were introduced, providing flaps with a reliable vascular supply regardless of their length to width ratio. The reverse sural artery flap, lateral supramalleolar flap, and inferiorly-based medial and lateral fasciocutaneous flaps
<table>
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<th>No.</th>
<th>Age (years)/gender</th>
<th>Trauma/etiology</th>
<th>Co-morbidities</th>
<th>Site</th>
<th>Defect size (cm²)</th>
<th>Flap size (cm²)</th>
<th>Details</th>
<th>Type of flap, delay procedure, HBOT</th>
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<td>Exposure of the lateral malleolus and ankle joint</td>
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<td>Mid-distal junction of dorsum of foot</td>
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<td>Exposure of extensor tendons of 2nd, 3rd, 4th, 5th toes</td>
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<td>7 × 4</td>
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<td>Achilles tendon</td>
<td>4 × 4</td>
<td>5 × 4</td>
<td>Exposure of distal Achilles tendon</td>
<td>Lateral supra malleolar fasciocutaneous flap</td>
<td>Nil</td>
</tr>
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<td>Lateral malleolus</td>
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<td>6 × 4</td>
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<td>Lateral supra malleolar fasciocutaneous flap</td>
<td>Nil</td>
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<td>6</td>
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<td>6 × 4</td>
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<td>Exposure of distal third of tibia</td>
<td>Posterior tibial artery perforator plus flap</td>
<td>Nil</td>
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<tr>
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<td>Diabetes mellitus</td>
<td>Achilles tendon</td>
<td>6 × 4</td>
<td>7 × 4</td>
<td>Exposure of distal Achilles tendon</td>
<td>Reverse sural artery fasciocutaneous flap</td>
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<td>5 × 4</td>
<td>6 × 4</td>
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<tr>
<td>9</td>
<td>62/female</td>
<td>Road traffic accident</td>
<td>Diabetes mellitus</td>
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<td>6 × 4</td>
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<td>Extended reverse sural artery fasciocutaneous flap</td>
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<td>7 × 4</td>
<td>Exposure of distal medial malleolus and ankle joint</td>
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<td>5 × 4</td>
<td>6 × 4</td>
<td>Exposure of lower third of tibia and medial tendons</td>
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<td>Road traffic accident</td>
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<td>14 × 5</td>
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HBO: Hyperbaric oxygen, HBOT: Hyperbaric oxygen therapy
<table>
<thead>
<tr>
<th>No.</th>
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<th>Co-morbidities</th>
<th>Site</th>
<th>Defect size (cm²)</th>
<th>Flap size (cm²)</th>
<th>Details</th>
<th>Type of flap, delay procedure, HBOT</th>
<th>Complications and secondary procedure</th>
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<td>Flap tip necrosis and skin grafting</td>
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<td>5 × 4</td>
<td>6 × 4</td>
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</tr>
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<td>4 × 4</td>
<td>5 × 4</td>
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<td>Lateral supra malleolar fasciocutaneous flap</td>
<td>Flap tip necrosis and skin grafting</td>
</tr>
<tr>
<td>4</td>
<td>37/male</td>
<td>Road traffic accident</td>
<td>Nil</td>
<td>Midfoot dorsum</td>
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<td>6 × 4</td>
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<td>Flap tip necrosis and skin grafting</td>
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<td>5 × 4</td>
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<td>Nil</td>
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<td>Flap tip necrosis and skin grafting</td>
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<td>12 × 5</td>
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<td>Reverse sural artery fasciocutaneous flap</td>
<td>Nil</td>
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<tr>
<td>9</td>
<td>43/female</td>
<td>Road traffic accident</td>
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<td>5 × 4</td>
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<tr>
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<td>23/male</td>
<td>Road traffic accident</td>
<td>Nil</td>
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<td>14 × 5</td>
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<td>Reverse sural artery fasciocutaneous flap</td>
<td>Partial flap loss and skin grafting</td>
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</table>

HBO: Hyperbaric oxygen, HBOT: Hyperbaric oxygen therapy
Table 3: Table comparing HBO with flap delay and direct flap transfer without HBO

<table>
<thead>
<tr>
<th>No.</th>
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<th>HBO with flap delay groups</th>
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<th>Direct transfer without HBO group</th>
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<td>Lateral supra malleolar flap</td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>48</td>
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<td>Lateral supra malleolar flap</td>
<td>Lateral supra malleolar flap</td>
<td>Lateral supra malleolar flap</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>43</td>
<td>47</td>
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<td>Lateral supra malleolar flap</td>
<td>Lateral supra malleolar flap</td>
<td>Lateral supra malleolar flap</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>36</td>
<td>37</td>
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<td>Lateral supra malleolar flap</td>
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<td>Recurrent infection to joint, debridement and suturing</td>
<td></td>
<td></td>
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<tr>
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<td>52</td>
<td>48</td>
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<td></td>
<td></td>
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<tr>
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<td>39</td>
<td>Diabetes mellitus</td>
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<td>Flap tip necrosis and skin grafting</td>
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<td>Varicose veins</td>
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<td>43</td>
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<td></td>
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<td>Cellulitis</td>
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<td>Flap tip necrosis and skin grafting</td>
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<td>Reverse sural artery flap</td>
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<td></td>
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</tr>
<tr>
<td>12</td>
<td>34</td>
<td></td>
<td>Multiple wounds in ankle region</td>
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<td>Reverse sural artery flap</td>
<td>Reverse sural artery flap</td>
<td>Nil</td>
<td>Flap tip necrosis and skin grafting</td>
<td></td>
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</tr>
</tbody>
</table>

HBO: Hyperbaric oxygen
based on the peroneal or posterior tibial artery perforators are frequently used for reconstruction of defects in this region.\textsuperscript{1-3} These flaps may be harvested as fasciocutaneous, islanded fasciocutaneous, adipofascial, or propeller flaps, or may be harvested as delayed extended flaps.

One common complication encountered during the utilization of distally-based flaps for such defects is venous congestion, which may result in failure at the distal aspect of the flap, which may be covering a critical region of the defect. Causes for venous congestion include compression of the pedicle due to poor elasticity of the skin over the roof of the tunnel in island flaps, valvular incompetence, edema at the pedicle region, compartment syndrome, and compression of the pedicle by hematoma.

Figure 1: (a) Crush injury to the right heel pad and ankle regions with multiple lacerations on the medial aspect of the foot; (b) crush injury to the right heel pad and ankle regions with multiple lacerations on the lateral aspect of the foot; (c) picture showing necrotic heel pad tissue; (d) extended reverse sural artery flap was elevated on day 2 following debridement; (e) extended reverse sural artery flap delay performed; (f) flap inset was completed on day 4 following debridement; (g) postoperative day 21 following surgery-posterior view.

Figure 2: (a) Ulceration on the lateral malleolus with exposure of the ankle joint; (b) picture following wound debridement and planning of a lateral supramalleolar flap; (c) lateral supramalleolar flap was elevated on day 2 following debridement; (d) lateral supramalleolar flap delay performed; (e) flap inset was completed on day 4 following debridement.

Figure 3: (a) Posttraumatic soft tissue defect exposing the lower third of the tibia; (b) distally-based posterior tibial artery perforator plus flap elevated; (c) distally-based posterior tibial artery perforator plus flap delay performed; (d) flap inset was completed on day 4 following debridement; (e) late postoperative picture of flap.
Almeida et al.[3] experienced partial flap necrosis (22.1%), total flap necrosis (4.2%), infection (8.5%) and venous congestion (4.1%) in a total of 71 cases of transferred reverse sural flaps. Zayed et al.[9] experienced venous congestion in five out of 25 cases of lateral supramalleolar flap coverage. Voche et al.[2] reported venous congestion and partial flap necrosis (5-30%) in 41 cases of a lateral supramalleolar flap used for ankle and foot defects. Kneser et al.[4] suggested a delayed neurofasicocutaneous sural flap, which is initially completely elevated and then fixed again at the donor site using running sutures for 7-15 days. After confirming the flap’s survival, the flap is raised again and transposed into the soft tissue defect. This delay procedure could be an alternative to increase the reliability and viability of the distally-based fasciocutaneous flap. However, delay procedures are not feasible in every patient as they require a significant time delay for coverage of vital structures. Ulküür et al.[5] demonstrated the usefulness of HBO treatment during the delay period of the flap which can lessen the time period required for delay, and which can also increase the effect of flap delay. This technique of reducing the delay period could well be utilized in the reduction of the duration of flap transfer in flap delay procedures. In addition, HBO therapy helps to prepare the recipient and donor areas, and the flap to be transferred during the delay period. There appears to be no harm in administrating HBO therapy during the delay period, as it reduces the edema of the delayed tissue and provides an optimal outcome following transfer.

In our center, HBO is administered in a monoplace chamber in which a single patient is placed in a chamber, which is then pressurized with 100% oxygen. Vasoconstriction reduces edema and tissue swelling while ensuring adequate oxygen delivery and is thus useful in acute trauma wounds as well as in delayed flaps. Hyperoxegenation causes immune stimulation by restoring white blood cell function and enhancing their phagocytic capabilities and neo-vascularization in hypoxic areas by augmenting fibroblastic activity and capillary growth.[8] Adequate shock management, debridement and repair of soft tissues, and stabilization of bony elements are of paramount importance. HBO therapy as an adjunct should be administered as early as possible to minimize the frequency and extent of tissue necrosis, reduce edema, control infection, support healing and prevent reperfusion injury.[9]

A recent retrospective analysis of 70 consecutive sural flaps reported a complication rate of 59% (41 of 70 flaps), with complete necrosis in 19% flaps and partial necrosis in 17%.[10] In a series of lateral supramalleolar flaps by Ehab et al.,[6] a total of 5 patients (20%) suffered complications out of 25 patients. Two cases were managed conservatively, 2 cases required revision with suturing, and 1 case required alternative flap coverage. Kang et al.[11] experienced 4 patients with partial necrosis (30%) among 13 patients where distally-based sural artery and lateral supramalleolar flaps had been utilized for soft tissue defects of the leg and foot. We noted complete flap survival in patients who received HBO with flap delay in spite of their associated co-morbidities. In the transfer group without HBO treatments, 5 patients of 11 (45.4%) experienced flap tip necrosis, and 1 patient had partial flap loss.

At our institution, we have developed a strategy to successfully manage patients with defects of the lower third of the leg and foot using a combined approach that maximizes tissue perfusion and oxygenation, allowing for optimal surgical correction of such injuries. Our treatment algorithm begins with early surgical debridement and initiation of HBO therapy. Combination of the modalities allows preservation of marginal tissue, prevention of extension of ischemia, reduction of tissue edema and congestion, and maximum preservation of the transferred distally-based flap. In our series, no complications were noted in patients treated with this approach. However, several cases of the flap tip or partial necrosis were noted in patients who received direct flap transfer. In this series, flap delay procedures were scheduled based on various factors including severity of injury, time of referral, co-morbid conditions, patient age, reach of the flap, patient toleration of use of the chamber, and affordability of treatment. However, additional studies are required to determine any additional indications, as well as the optimal timing and dosage of HBO therapy for such procedures. The patients in the current series did not experience the common side effects of HBO therapy such as aural or pulmonary barotrauma or a transient reversible myopia. Optimal usage of HBO therapy may reduce the duration of flap delay and increase the effect of flap delay procedure, helping to an optimal outcome for the transferred tissue.

In conclusion, distally-based flaps provide effective coverage of variable sized soft tissue defects of the lower third of leg, ankle and foot following trauma. Adjunctive HBO therapy should be considered when possible for improved flap survival and optimal surgical outcomes.

REFERENCES


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Rupture of the flexor carpi radialis tendon secondary to trauma: case report and literature review

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ABSTRACT

The flexor carpi radialis (FCR) is one of the long flexors, which is important in flexing and abducting the hand at the wrist. It originates at the medial epicondyle of the humerus and attaches at the base of the second metacarpal. Closed rupture of the long flexors of the finger is well-described, especially in association with rheumatoid hands. However, rupture of the FCR is rare; only 11 cases reported in the literature, most of them associated with scaphotrapezial-trapezoidal osteoarthritis. We describe 1 case of complete FCR rupture secondary to trauma, showing that long-term disability following FCR rupture is minimal.

Key words:  
Flexor carpi radialis, rupture, trauma

INTRODUCTION

Closed rupture of the long flexors of the finger is well described, especially in association with rheumatoid hands. However, rupture of the flexor carpi radialis (FCR) is rare with only 11 cases reported in the literature. Many of the described cases were associated with scaphotrapezial-trapezoidal (STT) osteoarthritis. We describe 1 case of complete FCR rupture secondary to trauma.

CASE REPORT

A 24-year-old right-hand dominant, professional male boxer suffered a traumatic blow to the left forearm during a sparring match. Four weeks after injury he presented to the clinic with a complaint of pain in his left wrist and a notable swelling in the region of the left FCR. On examination, there was tenderness along the course of the FCR as well as a palpable mass at the FCR origin. There was minimal loss of function on range of motion. Ultrasound/X-ray examination confirmed complete rupture of the FCR at its distal insertion. The FCR tendon and muscle belly retracted to approximately the proximal third of the forearm. In addition to the tendinous injury, radiograph revealed an osseous fragment attached to the distal end of the torn tendon.

Conservative treatment was decided to be the best management of this patient given the 4-week delay from onset of injury to presentation in the clinic. Furthermore, given the patient's profession as an athlete and minimal functional impairment, the decision was made to avoid operative intervention and proceed to aggressive physiotherapy. He was followed at 3 months, 6 months, and 1 year, and was able to return to boxing 2 months after injury as deemed appropriate by the physical therapist, occupational therapist, and surgeon.

DISCUSSION

The FCR tendon runs through a synovial fibro-osseous tunnel in the forearm to its insertion at the base of the
second metacarpal. As the tendon traverses the carpal bones, it passes over the ulnar aspect of the scaphoid tubercle and along a groove in the medial surface of the trapezium. Two laminae (superficial and deep) of the transverse carpal ligament enclose the FCR tendon. The superficial lamina inserts on tubercle of the scaphoid and trapezium while the deep inserts on the medial lip of the groove of the trapezium. The tendon passes through the scaphotrapezial joint line to insert at the base of the second metacarpal. The course of the tendon over the scaphotrapezial joint is of importance because of the increased incidence of rupture associated with scaphotrapezial osteoarthritis.

In the English and French literature, 11 cases of closed spontaneous ruptures of the FCR tendon are described. Five cases of rupture were associated with a severe rheumatoid collapse. These cases were treated operatively with debridement and synovectomy, but no splinting. Occupational therapy is considered the functional results have been reposted from simple conservative, as the deficit is relatively minor. Good functional results have been reposted from simple splinting. Occupational therapy is considered the standard of treatment and consists of active and passive range of motion exercises after 3 weeks of splinting. Functional problems after tendon rupture are minimal, and retraction of the tendon stump often makes reattachment difficult. In fact, the FCR is a useful donor for arthroplasty tendon can be safely used in the reconstruction.

In the case of partial ruptures, management with immobilization has been reported to successfully treat pain. Given the association of FCR rupture and osteoarthritis, severe and localized pain has been described to be worse than rupture of other tendons of the wrist.

Rupture of the tendon of the FCR is rare. Our case as well as the literature review demonstrates that long-term disability following FCR rupture is minimal. Although, commonly associated with scaphotrapezial osteoarthritis, our case demonstrates that rupture secondary to trauma is possible and should be considered in the differential diagnosis of pain and swelling on the flexor surface of the wrist and forearm.

REFERENCES


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Aesthetic rehabilitation of a patient with an anterior maxillectomy defect, using an innovative single-step, single unit, plastic-based hollow obturator

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E-mail: vishwas211@yahoo.co.in

ABSTRACT
What could be better than improving the comfort and quality of life of a patient with a life-threatening disease? Maxillectomy, the partial or total removal of the maxilla in patients suffering from benign or malignant neoplasms, creates a challenging defect for the maxillofacial prosthodontist when attempting to provide an effective obturator. Although previous methods have been described for rehabilitation of such patients, our goal should be to devise one stage techniques that will allow the patient an improved quality of life as soon as possible. The present report describes the aesthetic rehabilitation of a maxillectomy patient by use of a hollow obturator. The obturator is fabricated through a processing technique which is a variation of other well-known techniques, consisting of the use of a single-step flasking procedure to fabricate a single-unit hollow obturator using the lost salt technique. As our aim is to aesthetically and functionally rehabilitate the patient as soon as possible, the present method of restoring the maxillectomy defect is cost-effective, time-saving and beneficial for the patient.

Key words: Aesthetics, maxillectomy, palatal obturator, plastic-based, squamous cell carcinoma

INTRODUCTION
A conventional surgical excision is the most common method for treatment of a maxillary oral squamous cell carcinoma (SCC). The resulting surgical defect often includes part of the hard palate which results in oro-antral communication.[⁹] Patients undergoing surgery alone without closure or obturation of the surgical defect face numerous problems in phonetics and mastication secondary to the passage of air, food and liquids into the nasal and maxillary sinus. In addition to the functional deficit, there is a marked effect on aesthetics without the presence of an obturator.

An obturator is that component of a prosthesis, which fits into and closes a defect within the oral cavity or another body defect.[³] In the past, various methods have been used to restore the maxillary defect using silicon bulb obturators, implant-supported obturators, and cast metal obturators. This clinical report describes a method for aesthetic rehabilitation of a patient with a partial maxillectomy defect, using a light-weight, single-unit, closed hollow obturator fabricated by an innovative single-step flaking technique using the lost salt method. The technique assists in fabrication of an obturator, which restores aesthetics, function, speech, and dental appearance.

CASE REPORT
A 47-year-old man, diagnosed with SCC of the palate extending into the maxillary sinus, underwent a partial
maxillectomy and was subsequently referred to the Department of Prosthodontics and Implantology, Eklavya Dental College and Hospital, Rajasthan, India. Immediate surgical reconstruction was not recommended given the need for further treatment with radiation therapy. External beam postoperative radiotherapy was administered over a period of 6 weeks. The patient tolerated the radiation well and was subsequently referred to possible prosthetic restoration of the oral defect after radiation therapy. Examination revealed a partial maxillectomy defect on the left side crossing the midline. The left side naso-maxillary region was depressed due to bone loss, and this was also evident in extra oral examination. The defect was a Class IV according to the Aramany Classification of Defects\(^3\) [Figure 1].

Aesthetic rehabilitation can be accomplished either surgically or prosthetically.\(^4\) The choice of rehabilitation depends on the site, size, severity, patient age, and patient preference. Contraindications to surgical reconstruction include advanced age, poor general medical condition, a history of radiation therapy, a complex anatomical defect and the patient’s refusal to undergo further surgery.\(^5\)

Various modalities for prosthetic reconstruction were discussed with the patient, and he requested an economical solution. The treatment plan therefore was to provide a plastic-based, light-weight obturator to meet the aesthetic demands by replacing bone and teeth while assisting phonetics and mastication.

**Procedure**

An irreversible hydrocolloid was used to make an impression of the maxillary defect area after blocking all undercuts with wet gauge. The impression was poured, and the final cast was obtained, on which a custom tray was made using a self-curing autopolymerising resin. Border molding for recording the soft tissue borders of the defect was carried out using a low-fusing impression compound. Additional silicone was used to make a wash impression, and the final master cast was poured. All undercuts on the cast were blocked out with plaster and wax [Figure 2]. The final denture base and occlusal wax rims were prepared to record maxillomandibular relations. After the maxillomandibular jaw relations had been obtained, the record was articulated, and teeth arrangement was performed. On completion, the wax prosthesis was verified at the trial insertion appointment. The wax prosthesis was invested, and the wax was eliminated [Figure 3]. A sheet of plastic based heat cure acrylic polymer in the dough stage was placed over the defect and the palatal area on the master cast. Pressure then applied to the base of the defect resulted in a cup-shaped depression of acrylic polymer over the defect [Figure 4]. Salt was then used to fill the depression [Figure 5]. Another thin sheet of acrylic polymer was placed, and packing was performed with conventional prosthodontic protocols. Finally, three to four holes were drilled on the palatal surface of the prosthesis covering the bulb [Figure 6]. Warm water was injected through the holes to dissolve and eliminate the salt present in the bulb [Figure 7], resulting in a hollow space inside the bulb. The holes were sealed with a layer of self-curing acrylic, and final finishing and polishing of the prosthesis was done [Figure 8].

The plastic-based hollow obturator was inserted into the defect, and the patient was instructed on home care and the prosthesis maintenance. To sanitize the wound, the patient was instructed to gently remove any exudates with a wet cotton tip soaked with a 5% Betadine solution and to clean the intaglio surface of the prosthesis once...
a day. Post treatment photographs of the patient showed a marked improvement in aesthetics by replacement of missing teeth and restoration of the previously depressed nasomaxillary region [Figure 9a and b]. The patient was scheduled for his first adjustment 3 days following insertion. At the appointment, the surgical wound was examined to ensure health of the tissues and any part of prosthesis exerting pressure on the wound was smoothened. Hygiene and home care were emphasized, and the patient was advised to return in 3 months.

**DISCUSSION**

Orofacial rehabilitation of patients with use of an obturator is an appropriate treatment modality for maxillofacial defects.[8] Oromaxillary defects are associated with inflow and outflow of oral and nasal microflora, regurgitation of oral fluids, voice changes secondary to asynchrony in resonance, and difficulty in speech and swallowing. In addition, acquired maxillary defects have
a marked effect on facial aesthetics. Hence, effective treatment modalities for these defects are mandatory. Small defects can be managed by surgery, but large defects require prosthodontic rehabilitation by obturators. A multidisciplinary team consisting of an oncologist, an oral and maxillofacial surgeon, a maxillofacial prosthodontist, a specialist nurse, a dietician and a speech therapist is ideal for care of head and neck cancer patients. A high level of cooperation between the prosthodontist and the surgeon prior to surgery is critical to achieving adequate rehabilitation for patients with maxillary defects.

This clinical report describes the rehabilitation of a Class IV maxillary defect with a plastic based light weight hollow obturator. Class IV defects represent the classic maxillary defect in which the hard palate, alveolar ridge, and dentition are removed beyond the midline. Advantages of hollow bulb obturators include decreased weight of the obturator, decreased pressure on surrounding tissues, and ease of deglutition. In addition, the light weight of the obturator minimizes excessive atrophy and physiological changes in muscle balance. The hollow bulb adds resonance, thus improving the clarity of speech.

Although prior techniques described in the literature fabricate obturators with the use of wax, sponge, polyurethane, foam and gas injection, the present technique uses a single-step flashing procedure, resulting in a comfortable, light-weight prosthesis with reduced fabrication time.

In conclusion, the goal of rehabilitation is creation of a prosthesis, which can restore aesthetics and function, while being easy to use, easy to clean to prevent recurrent infections, and which can be readily fabricated by simple time saving techniques. In order to achieve these goals, a single unit plastic based polymethylmethacrylate closed hollow obturator was fabricated by the lost salt method using single-step flashing. The prosthesis rehabilitated the patient aesthetically by replacing lost teeth and adding bulk to the depressed facial region, and functionally by providing better masticatory efficiency and phonetics. The present obturator is an additional alternative for plastic surgeons, oncologists and prosthodontists when planning treatment of such cases. In addition to being used following tissue healing, it can be used as an immediate surgical obturator by fabricating it on a presurgical model and trimming the affected area on the cast.

Educating and motivating the patient about the type of prosthesis and its limitations are the first steps in successful treatment. As this obturator is economical, time-saving and light in weight, the surgeon can recommend it to patients who require an economical alternative or who are not willing or able to undergo surgical reconstruction of their defect.

The light-weight plastic-based hollow bulb obturator fabricated in the present case rehabilitated the patient aesthetically and functionally, providing him an opportunity to live his life as close to normal as possible.

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Use of tensor fascia lata flap for reconstruction of the defect created following inguinal block dissection in a case of carcinoma penis: a case report and brief review of literature

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ABSTRACT

Tensor fascia lata (TFL) flap is a versatile myofasciocutaneous flap. It has varied usages as both free and pedicled flap. As a pedicled flap, it is a good option for reconstructing soft tissue defects after tumor ablation. The TFL perforator flap is a good alternative for anterolateral thigh (ALT) flap. The advantages of TFL flap are that dissection can be made through the same incision, without impairment of other donor sites. The reconstructive plan remains same as that of ALT flap. TFL flap offers a good volume of skin and can be made thin removing variable portions of muscle. The present case is a 63-year-old patient with a carcinoma penis who underwent left ilioinguinal block dissection resulting in a defect of 8 cm × 8 cm in the left inguinal region. TFL flap was raised with U-shaped incision and used for closure of the defect with good result.

Key words:
Groin reconstruction, myofasciocutaneous flap, tensor fascia lata flap

INTRODUCTION

Tensor fascia lata (TFL) flap is a myofasciocutaneous flap. In 1934, Wangensteen,¹¹ first described it for abdominal wall reconstruction. It is a versatile flap with many uses in reconstructive plastic surgery like in management of pressure sores, facial reanimation and as a free flap in head and neck reconstruction.²⁶²⁶ As a pedicled flap, its strong fascial layer has the advantage of reaching the lower abdomen and the groin. Thus, it is a good option for reconstructing soft tissue defects after tumor ablation.

The problem with TFL is distal necrosis in both pedicled and free form. The flap’s safe dimensions and adequacy to minimize distal tip necrosis for a sound abdominal wall reconstruction remains controversial.²⁷²⁷ The aim of the present case report was to share our experience and clinical observations with TFL flap used in the reconstruction of a challenging defect following inguinal block dissection in a case of the carcinoma penis.

CASE REPORT

A 63-year-old male patient who was a diagnosed case of the carcinoma penis with bilateral inguinal lymphadenopathy underwent partial penectomy 6 months back. Left inguinal lymph node dissection was also planned after 2 weeks, and he was discharged on antibiotic cover. The patient defaulted for 3 months and presented with a fungating left inguinal lymph nodal mass. He was treated with external radiotherapy with 60 Gy in 30 fractions over 6 weeks.
Later, the patient presented with a residual mass over left inguinal region. There was a hard swelling of 4 cm × 3 cm with restricted mobility in left inguinal region [Figure 1]. Also, multiple small lymph nodes were palpable on the right side, the largest measuring 1 cm × 1 cm.

Magnetic resonance image of the left inguinal region showed enlarged necrotic lymph node, anterior to femoral vessels in the subcutaneous plane. There was a loss of fat planes with left femoral vein. Left femoral artery and right inguinal region were normal. Fine needle aspiration cytology was done from bilateral inguinal lymph nodes. The left inguinal lymph node showed squamous cell carcinomatous deposit. The right inguinal lymph nodes were reactive in nature without any tumor deposit. Chest X-ray was reported as normal. Routine hematological and biochemical investigations like complete hemogram, serum urea and creatine were within normal limit. Viral markers like human retroviral antigen, hepatitis B and C were also negative.

He underwent left ilioinguinal block dissection. Perioperatively, there were necrotic lymph nodes of 4 cm × 4 cm in size, abutting the femoral vein. Multiple lymph nodes were present in iliac region, largest measuring 3 cm × 1 cm. The Cloquet lymph node was also present. Three cm skin margin was taken beyond the indurated area thereby creating a defect of 8 cm × 8 cm in the left inguinal region [Figure 2].

It was decided to cover the defect with TFL pedicle flap. We followed the same technique of harvesting of TFL as described by various authors.[2,4] The donor flap outlining was done with U-shaped incision on the thigh. The elevation was carried out in a subfascial plane from distal to proximal. The lateral circumflex femoral artery was then easily identified high up as it passes between the rectus femoris and the vastus lateralis, where it gives the transverse branch, which pierces the TFL muscle accompanied by venae comitantes. Then dissection was performed to sufficiently mobilize the flap for proper defect coverage [Figure 3]. The medial end of the incision was joined to the lateral aspect of the inguinal defect. The free end of the flap was then rotated upward and medially [Figure 4] and sutured to the defect created by the inguinal dissection. Donor site could be approximated without any tension [Figure 5]. Drain was placed, and wound was closed in layers.

Postoperative period was uneventful. Flap was healthy on the seventh postoperative day, and the patient was discharged. He was advised to undergo regular follow-up. Suture and skin stapler was removed on the 14th day. There was no necrosis or dehiscence, and the cosmesis was acceptable.

Other options for alternative flaps in this case would have been perforator based anterolateral thigh (ALT) flap.
DISCUSSION

The soft tissue tumors in the groin area need adequate resection to achieve optimal local treatment and to minimize recurrence. The resultant wounds are slow healing in nature and are frequently exposed to vital structures like femoral vessels, thereby increasing the complication rate.[6-9]

Several flaps have been described to cover established groin defects, namely, inferiorly based rectus abdominis muscle or myocutaneous flap, rectus femoris, sartorius with abdominal skin flap, internal oblique muscle flap, and vastus lateralis flaps.[2,5] These flaps have their advantages and disadvantages. Abdominal weakness, bulging or hernia, and knee weakness are some of the complications associated with these flaps.[2]

ALT flap is considered as the gold standard in head and neck reconstructions as free flaps and as pedicle flaps in abdominal wall reconstruction.[10,11] The advantage of this flap is that it offers a good volume of pliable tissues and a pedicle characterized by good caliber and adequate length. Its main disadvantage is its anatomical variability in number and location of perforator vessels. The absence of perforators is rare, but can occur. In these instances, TFL perforator flap can be a good alternative to ALT flap.[10,11]

TFL flap is a myocutaneous flap that can either be used as a free flap or as a pedicle flap depending on the site. It can be used as a free flap in the head and neck reconstruction, and as a pedicled flap in abdominal wall reconstructions. The advantage of TFL flap is that it allows the usage of the same donor site thereby avoiding another surgical incision. Its anatomy is more constant. Perforators are almost always present, and their pedicles are of sufficient length (average of 8 cm). As a perforator flap, a thinner and more pliable flap can be obtained, removing a variable portion of muscular tissue and leaving only a cuff around the pedicle. Therefore, it can be used for almost the same indications of ALT flap.[6-8]

The published reports of TFL flap in groin reconstruction following inguinal node dissection have enumerated partial flap necrosis, distal tip necrosis, flap infection and lymphedema as various complications.[2,3,5]

In our case, we found TFL perforator flap to be the best choice because it allowed maintaining the same reconstructive plan made with the ALT flap.

In conclusion, the TFL flap is a reliable flap for inguinal area defect reconstruction, without any donor site morbidity. Because we could close the defect primarily without skin graft, it was cosmetically very well accepted by the patient.

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