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CASE REPORT

Early intervention following an unusual late complication of cantilever nasal costochondral grafts

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Abstract The concept of the cantilever bone graft, popularised by Millard (1966), and its subsequent modification by Chait *et al.* (1980), led to the idea of the costochondral cantilever graft for nasal dorsum augmentation. Over 150 costochondral nasal grafts have been performed at the Australian Craniofacial Unit (ACFU) over the last 25 years, and the aim of this study was to review a cohort of fractured costochondral graft in patients treated at the ACFU. The notes of patients with nasal costochondral grafts were reviewed, those with a fractured graft forming the basis of this study. Patients with Binder Syndrome accounted for nearly 30% of the cohort. Other diagnoses included Opitz syndrome, frontonasal dysplasia and other craniofacial abnormalities. 3 patients were identified with late fractured costochondral grafts. The prominent position of the nose makes it easily susceptible to trauma, and very often, low energy impact can produce fractures of the nasal bones. To the best of our knowledge, this is the first reported series of fractures of costochondral nasal grafts and their subsequent management. We would advocate early surgical management of the fractured grafts when conservative treatment has failed. In our present series, all 3 patients still maintained a satisfactory cosmetic and functional result after a mean of 8.5 years following the reparative surgery.

Introduction

Saddle nasal deformity, characterized by a hypoplastic nasal dorsum with or without a poorly supported nasal tip, is one of the stigmata of craniofacial anomalies and a possible consequence of trauma. Other potential causes include syphilis, Wegner's granulomatosis and post rhinoplasty. The main aim of surgery is to improve the contour of the nose and also enhance its function. This can be achieved by the use of various autogenous or alloplastic implants, the latter being shown to be less efficacious as a result of a higher rate of infection, extrusion and rejection (Tardy, 1990). Bone and cartilage are the most widely used autogenous materials for nasal dorsal augmentation, bone grafts being harvested from the calvarium, iliac crest or rib, while cartilage grafts can be obtained from the nasal septum, ear concha or rib (McDowell, 1970a; McDowell, 1970b; Jackson *et al.*, 1983).

The concept of the cantilever principle for nasal dorsal augmentation was introduced in the 1950s (Farina and Villano, 1971), and later popularised by Millard (Millard, 1966) in 1966. A cantilever graft is used when nasal tip projection is required, with the distal end of the graft being inserted between the lower lateral cartilages in an attempt to preserve normal tip appearance. However, excessive tip rigidity and increased bone resorption have been reported by Farina and Villano (Farina and Villano, 1971) with the use of bone grafts as cantilever grafts. To address this issue, Chait (Chait *et al.*, 1980) described the maintenance of a segment of cartilage with the resected 'bony' costal graft, which

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subsequently gave rise to the costochondral graft.

At the Australian Craniofacial Unit, the principle of cantilever nasal grafting has been extensively used in the management of the nose in patients with craniofacial deformities and severe facial trauma. Patients with Binder syndrome account for the majority of cases, with other conditions such as frontonasal dysplasia, Saethre-Chotzen syndrome, Opitz syndrome, Pfeiffer syndrome, craniosynostosis, Tessier clefts and trauma forming the rest of the cohort.

Although it has been suggested that total resorption of a bone graft may occur following fracture of the graft (Holmström, 1986), to the best of our knowledge, a fractured costochondral cantilevered nasal graft has not been described in the literature and we wish to present 3 patients in whom the graft was fractured following trauma occurring between 3 and 13 years after the initial nasal reconstruction. In the senior author's experience, simple manipulation of undisplaced fractured nasal grafts may produce a satisfactory outcome. However, when the graft is displaced, as was the case in the 3 reported cases, then passive manipulation is not usually effective. In such situations, the initial pathology is severe enough to disrupt the stable projection of the graft, which is best managed with replacement of the graft to restore a stable projection. In the 3 reported cases, a replacement costochondral strut was used to replace the fractured graft.

Operative technique

Access to the plane of the ribs is gained by sharp dissection via a 4-5 cm infra-mammary curvilinear incision usually overlying the sixth rib. Either the 5th or 6th rib can be harvested by this approach. As the sixth rib lies along the lowermost portion of pectoralis major, it requires the least amount of muscle stripping during the dissection. Once the rib is identified, a longitudinal incision is made along the midsurface of the osseous rib and a careful subperiosteal circumferential dissection is performed, protecting the neurovascular bundle at the inferior aspect of the rib, and the parietal pleura at the deep surface of the rib. The required length of osseous rib is skeletonised and cut with rib shears. The rib can then be harvested with a variable amount of cartilage attached to one end, with periosteum and perichondrium left intact at the junction. Saline is then placed in the wound to assess for pleural integrity prior to closure of the rib periosteum and the chest wound. Marcaine is infiltrated in the wound for analgesia at the end of the procedure.

Access for graft insertion varies from patient to patient. If a coronal incision is used for a synchronous procedure, this can be used to dissect the nasal pocket. Otherwise, a vertical incision can be made along the midsagittal line of the nose at the naso-frontal junction. The graft can then be either lagged to the naso-frontal region or fixed with a contoured miniplate to the forehead region to achieve the required cantilever projection. The access can occasionally be supplemented via a midline incision in the columella. If the whole graft needs to be replaced, then an additional intranasal approach may be required, e.g. intercartilaginous. Occasionally, only bony segment of the graft needs to be replaced, with the distal cartilaginous segment left in-situ, while maintaining a stable projection. Early intervention allows for easier access to the fractured graft, with the replacement giving stable projection to the nasal tip.

Case 1

A 32 year old patient with Binder Syndrome underwent a septoplasty in 1986 and subsequent costochondral nasal reconstruction in 1990, with satisfactory results (Figure 1). Thirteen years later, she struck her nose against a kitchen table, fracturing and displacing the graft. Facial radiographs revealed a comminuted fractured graft. She underwent replacement of the graft with a new costochondral unit 2 weeks post the initial injury and has achieved a satisfactory long-term result.

Case 2

A 29 year old patient, with hemifacial hyperplasia, underwent bimaxillary surgery and a cantilever costochondral nasal graft for a hypoplastic nose in 1995. Eight years later, he walked into a door, injuring his nose (Figure 2), with the subsequent radiographs showing a fractured and displaced graft at the cephalad end. He underwent replacement of the fractured graft within 2 weeks of injury and has had a satisfactory outcome.

Figure 1 Patient with Binder Syndrome, pre and post nasal reconstruction with costochondral graft. Radiograph showing a comminuted fracture of the costochondral graft (Case 1).

Figure 2 Patient injuring the cephalad end of the graft. Radiograph showing fracture and displacement of the graft (Case 2).

Figure 3a Patient with an infected bone segment of the costochondral graft (Case 3).

Figure 3b Patient with left sided nasal blockage following injury to nose (Case 3).

Figure 3c Patient following costochondral nasal grafting, combined with a septorhinoplasty and a columellar strut (Case 3).

Case 3

A 31 year old patient, with Binder syndrome, was initially seen at the age of eight with an infected silastic nasal implant, which was removed. Two years later, she underwent cantilever costochondral nasal bone grafting; however, the bone segment became infected (Figure 3) one month post-operatively and was removed, with the nasal tip graft left in situ, as it showed no signs of infection. Three years later, she hit her nose against a wall and noted a clicking movement at the nasal tip, with left sided nasal blockage. She underwent further costochondral nasal grafting, combined with a septorhinoplasty and a columellar strut, and proceeded to a satisfactory result.

In all cases, the old incision was used and an adjacent rib used for harvest of the new costochondral graft. In cases 1 and 2, the costochondral graft was partly reabsorbed and well vascularised, and the proximal segment was found to be soundly fixed to the bony segment.

Discussion

The reconstructive options for the saddle nasal deformity can be broadly classified into the use of autologous and alloplastic materials. Although there are a wide array of alloplastic implants for nasal framework reconstruction, their main benefits of no donor site morbidity and sustained shape are greatly outweighed by their significant potential complications, such as infection, extrusion, dislodgment and lack of potential for growth.

The use of autologous tissues is mainly restricted to bone and cartilage, both which have the required rigidity for reconstructing the nasal skeleton and the ability to maintain nasal shape changes, by withstanding the pressures exerted by the skin envelope on the grafts (Horton and Matthews, 1992). Bone grafts can be easily harvested from the rib, calvarium and iliac crest, while the nasal septum, ear concha and rib are common donor sites for cartilage grafts. The strength, shape and natural thinness of the rib make it ideal for the nasal cantilever technique. The rib can be harvested in its entire thickness, but splitting along the superior and inferior borders with an osteotome and contouring the rib with a Tessier rib bender not only doubles the amount of bone available for grafting (Barone *et al*., 2008), but also allows for a greater contact with the adjacent nasal bones and potentially ensuring quicker revascularisation of the graft. Although the use of calvarial bone has become a popular donor site for bone grafts (Jackson *et al*., 1983; Jackson *et al*., 1998), various laboratory-based (Millard, 1966) and clinical (David and Moore, 1989) studies have failed to show any advantage over grafts harvested from the axial skeleton. The iliac crest is another donor site for harvesting large segments of bone with a cartilaginous component. However, the main disadvantages of this area are the contour deformity and the peri-operative ambulatory morbidity, which may not be acceptable in craniofacial patients, who tend to be children. This is not an issue when harvesting grafts from the ribs, both in the long and short term (Gurley *et al*., 2001).

The choice between the uses of cartilage versus bone remains subjective. While cartilage can be easily harvested from the nasal septum, ear concha and rib, it has various potential drawbacks that include warping of the graft (Gurley *et al*., 2001), resorption and collapse. Also, as cartilage does not undergo remodeling, irregularities can become apparent over time (Ortiz-Monasterio and Olmedo, 1981). On the other hand, bone grafts are subject to remodeling and do become slimmer and less irregular with time (Gewalli *et al*., 2008). However, they are subject to resorption, especially if the grafts become loose, thus emphasizing the need for appropriate fixation; when adequately fixed, the presence of infection does not always result in loss of the whole graft, as was the situation in Case 3, where only the infected bony part of the graft was removed, with the distal non-infected cartilaginous end of the graft preserved (Holmström, 1986; Wheeler *et al*., 1982; Thatte *et al*., 1990).

Although the use of costochondral grafts for nasal reconstruction has been in practice for over 40 years, since its description by Millard, few studies have assessed the long-term results of the technique. Of the 2 studies that have done so, no resorption nor any loss of projection have been noted in the long term (Chait *et al*., 1980; Gurley *et al*., 2001).

The prominent position occupied by the nose makes it easily susceptible to trauma, and very often, low energy impact is all that is required to produce a fracture of

the nasal bones and nasal bone grafts. To the best our knowledge, this is the first reported series of fracture of costochondral nasal grafts and their subsequent management by replacement with a new costochondral strut. We would advocate the early management of the fractured grafts. In our present series, all 3 patients still maintained a satisfactory cosmetic and functional result after a mean of 8.5 years following the secondary surgery.

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