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Original Article

The role of genioplasty in the management of craniofacial deformities

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Abstract The function of a genioplasty is to produce an aesthetically pleasing chin contour and improve facial proportions. The aim of this study was to review the role of osseous genioplasty in the management of patients with craniofacial deformities. 52 patients (24 males and 28 females) treated at the Australian Craniofacial Unit in Adelaide, Australia over a 25-year period; who required a genioplasty as part of their craniofacial management were reviewed. Patients ranged from 17-44 years (median: 26 years) and the age at which the patients underwent genioplasty was between 9 and 36 years (median: 17 years). Pre and 6 months post op cephalograms were compared, showing a mean chin advancement of 7mm and a mean osseous resorption of 20%. One patient was under-corrected and another had post-operative asymmetry, both requiring repeat genioplasty. No long-term nerve dysfunction was noted. The osseous genioplasty is an effective procedure for correcting the chin deformity often seen in patients with craniofacial abnormalities. It is an easy technique to master and is associated with a low degree of morbidity.

Keywords: Craniofacial deformities, genioplasty.

Introduction

The chin is one of the complex elements of the face that contributes to facial harmony and balance (McCarthy *et al.*, 1990; Gonzalez-Ulloa, 1962). Traditionally, the 'ideal' face is divided in three equal thirds, with the trichion, glabella, subnasale and menton forming the landmarks. However, through art and sculpture, this concept of the 'ideal' face has changed over time, and today, an attractive face has a proportionately greater lower third (Strauss and Abubaker, 2000; Farkas *et al*., 1985). Since antiquity, man has been attempting to alter the size, shape, volume and position of the chin with the use of precious/ semiprecious metals and ivory (Strauss and Abubaker, 2000; McBride and Bell, 1980); Aufricht in 1934 commented on the use of dorsal nasal cartilage as an augmentative material (Aufricht, 1934). Nonetheless, it is only in the last 50 years that techniques have been devised to manipulate the contour of the chin in a reliable and reproducible manner.

Before any treatment, it is fundamental to assess the chin and identify any deformities in the antero-posterior, vertical and transverse spatial (McBride and Bell, 1980; McCarthy and Ruff, 1988). From the front, the lower third of the face is divided into 3 equal thirds, with imaginary lines passing through the subnasale, the stomion, the deepest part of the labiomental fold and the menton (Fig. 1). The maxillary and mandibular symmetries are compared to the facial midline. The bite is also assessed to ensure that it lies within a natural occlusal plane. From the side, the facial features are compared to a vertical reference line, defined as a line passing through the subnasale and the junction of the naso-frontal junction. The lips are anterior to this vertical reference, with the upper lip being slightly more prominent (Cohen, 2000).

Patients with craniofacial anomalies can sometimes suffer from mandibular dysostosis and their management depends on the severity of the underlying disease. Patients with minimal deformity either require no treatment or a genioplasty to improve their facial appearance, while those with profound deformities require more complex surgery, including bone grafts, orthognathic surgery and staged genioplasty. The complications of genioplasty can include infection, non-union, mental nerve damage and thermal injuries to the lip (Strauss and Abubaker, 2000). The purpose of this study was to review the role of genioplasty in the management of the chin, in patients with craniofacial anomalies treated at the Australian Craniofacial Unit (ACFU) between 1978 and 2003.

Materials and methods

The database of the ACFU was reviewed and patients with craniofacial anomalies who had undergone a genioplasty as part of their overall management at the Unit between 1978 and 2003 were identified. Data from the case notes were collected according to a set proforma and the relevant radiographs were reviewed.

Fig. 1 Lower face proportions. The distance between the subnasale to the vermillion border of the lower lip is equal to the distance between the lower lip to menton. Distance from the subnasale to the stomion is equal to the distance from the stomion to the labiomental fold, which is equal to the distance from the labiomental fold to the menton. Alterations of each segment would differentiate vertical lengthening or shortening of the maxilla, chin, or both.

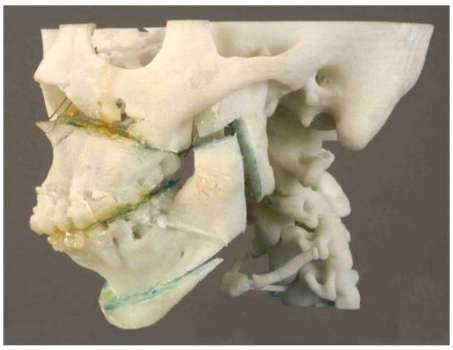

Fig. 2 Stereolithograpic nylon model as an aid to planning the osteotomies in complex cases.

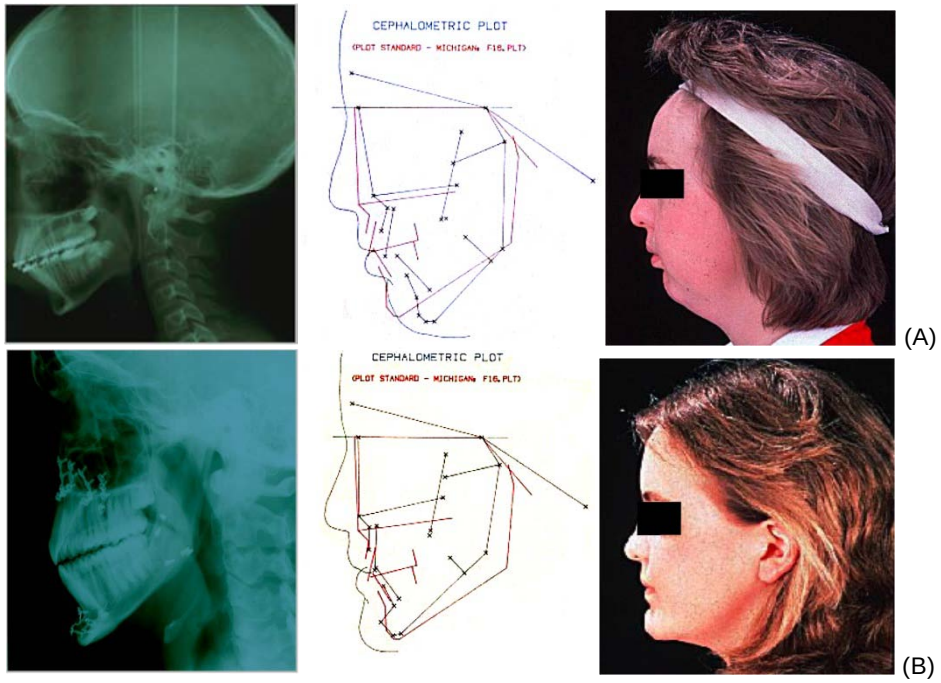

Fig. 3 Radiographs, cephalograms and clinical photographs of pre (A) and post (B) genioplasty compared to assess degree of advancement and resorption.

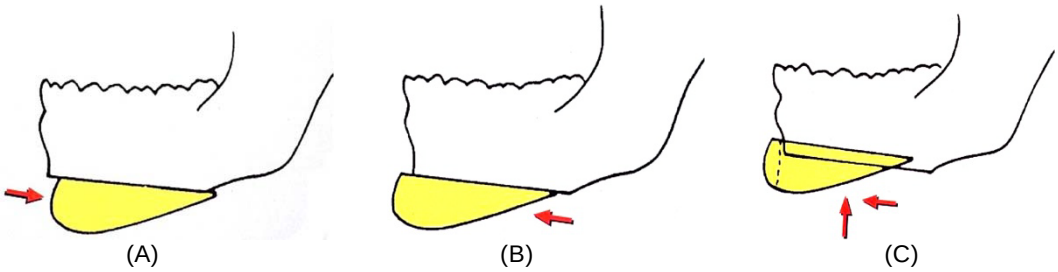

Fig. 4 Different types of genioplasties. (A) reduction genioplasty, (B) sliding genioplasty, (C) jumping genioplasty.

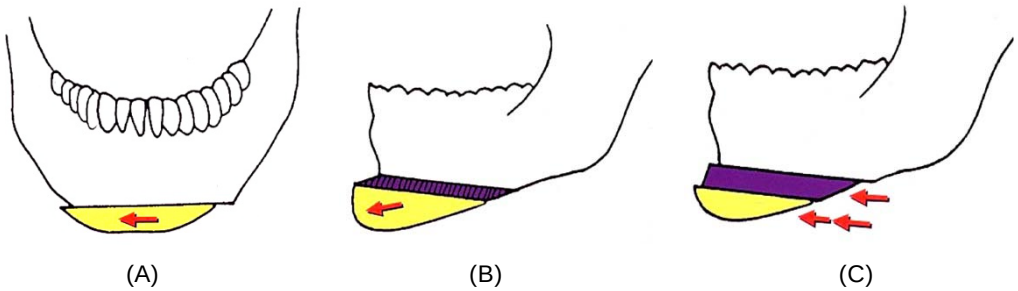

Fig. 5 Different genioplasty techniques. A and B: Centering genioplasty, C: Genioplasty with inter-positional bone graft.

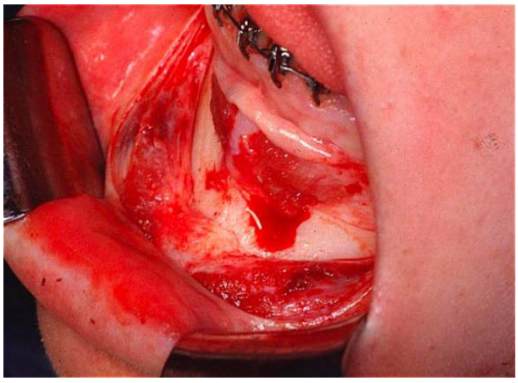

Fig. 6 The symphysis is exposed, with adequate mentalis and mucosa left behind for closure.

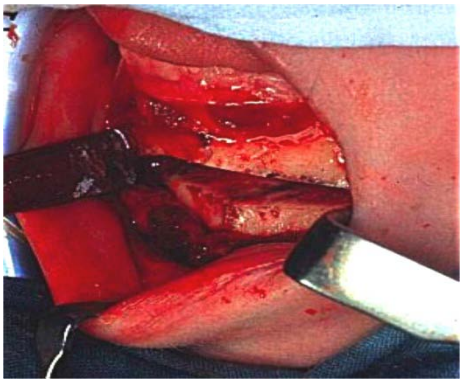

Fig. 7 The midline is marked with an oscillating saw, the mental foramina identified and a horizontal osteotomy is performed 6 mm inferior to the foramina to prevent damage to the inferior alveolar nerves and teeth roots.

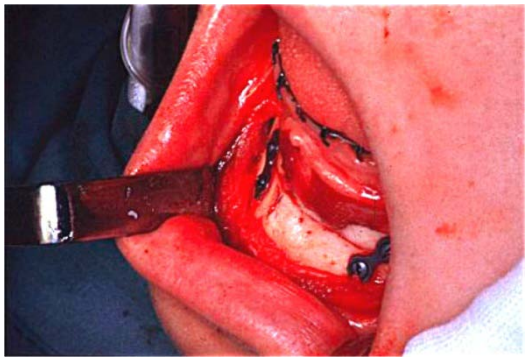

Fig. 8 The genial segment is fixed in place using plates and screws.

Fig. 9 Patient with Binder Syndrome. She had undergone a LeFort I osteotomy, costochondral nasal graft and genioplasty.

Patients treated at the ACFU are managed by a multidisciplinary team and most cases required significant preoperative orthodontic treatment. The majority of the patients required additional surgical procedures, including cranial vault reshaping, fronto-orbital advancement, hypertelorism correction, Le Fort I/III correction, bone grafting and mandibular reconstruction. The genioplasty was usually performed as the final corrective procedure and a nylon model was sometimes prefabricated to aid in the planning of the surgery in complex cases (Fig. 2). All patients underwent an osseous genioplasty and cephalograms performed preoperatively and 6 months post-operatively were compared to assess the degree of osseous advancement and resorption (Fig. 3).

The osseous genioplasty

The osseous genioplasty is a versatile procedure that allows for correction of most chin deformities and a variety of techniques have been described, depending on the specific chin dysmorphologic findings (Cohen, 2000) (Fig. 4, Fig. 5).

An incision is usually made in the gingivobuccal sulcus to expose the symphysis, while leaving behind an adequate amount of mucosa and cuff of muscle that will be used for closure (Fig. 6). The midline is scored and a subperiosteal dissection is then carried out to expose the anterior border of the symphysis, up to the junction of the chin and the mandibular body, while adequate soft tissue attachment is left on the inferior border of the symphysis and the menton. The mental foramina are identified and the horizontal osteotomy, usually performed with an oscillating saw, is made approximately 6 mm inferiorly, so as not to injure the inferior alveolar nerve, as it dips inferiorly prior to exiting the foramen, and to prevent any damage to the teeth roots (Ousterhout, 1996) (Fig. 7). Depending on the deformity and required correction, the surgeon can alter the degree of movement of the osteomised segment to achieve the desired correction, before fixation with plates and screws (Fig. 8). The use of an interpositional bone graft may be used when significant augmentation is required. The intra-oral wound is then closed in layers.

Results

Fifty-two patients (28 females and 24 males) with craniofacial anomalies underwent osseous genioplasty as part of their overall management at the Australian Craniofacial Unit between 1978 and 2003, with an age range of 17 to 44 years (median age: 26 years). The age at which the patients underwent a genioplasty ranged between 7 and 36 years of age (median age: 17 years).

The commonest syndromes included Treacher-Collins (10), Crouzon (7), Goldenhar (5) and Binder (5). Non-syndromic craniofacial anomalies included hemifacial microsomia (4), coronal synostosis (3), hemifacial hemiatrophy (2) and cleft lip/palate (2). Most patients underwent more than one operation and the number of procedures per patient ranged between 2 and 15, with a median of 5 procedures per patient. The commonest procedures included septorhinoplasty (19), onlay malar bone grafting (38), Le Fort I osteotomy (15), canthopexy (11), cranial vault surgery (10) and mandibular osteotomy (8).

The commonest genioplasty performed was the sliding genioplasty. The chin advancement ranged between 4 and 20 mm, with a median of 7 mm (Fig. 9). Cephalograms performed at 6 months post-operatively showed that the median advancement of 7 mm was maintained and a mean osseous resorption of 20%, mainly along the antero-superior border of the bony segment, thus displacing the pogonion downwards.

Only 2 patients suffered postoperative complications. One patient was under-corrected and subsequently required repeat genioplasty, while the second patient was noted to be asymmetric post-operatively and required further reshaping of the chin contour. No long-term inferior alveolar nerve dysfunction was noted.

Discussion

The purpose of a genioplasty is to produce an aesthetically pleasing contour and improve facial proportions. Hofer (1942) is credited with the description of the first horizontal osteotomy of the mandibular symphysis and advancement of the lower fragment for the correction of microgenia in what would appear to be a cadaver (Hofer, 1957). Sir Harold Gillies performed the first extra-oral 'jumping' genioplasty in 1947 on a patient with Treacher-Collins-Franchetti Syndrome (Gillies and Millard, 1957). Trauner and Obwegeser (1957), Köle (1961) and Converse and Wood-Smith (1964) described and subsequently popularised the intra-oral genioplasty (Trauner and Obwegeser, 1957; Köle, 1961; Converse and Wood-Smith, 1964). Despite its existence for over half a century, there is still considerable debate between the proponents of alloplastic and osseous genioplasty. Although genioplasty is now the second most commonly performed osteotomy of the facial bones after rhinoplasty (Rosen, 1997), many surgeons prefer to use implants, leaving the osseous genioplasty in the realms of the craniofacial and maxillofacial surgeon. However, mastering the ability to perform an osseous genioplasty, allows the surgeon to manipulate the chin in all 3 dimensions. While most reports refer to its use in the cosmetic arena, we feel that the genioplasty should be an indispensable stage in the management of the patient with craniofacial deformities. It is rarely an end in itself, but is a component in the treatment of the facially compromised patient.

It is generally accepted that a patient with mild retrogenia and requiring an advancement of up to 5 mm would benefit from either an alloplastic or osseous genioplasty, depending on the surgeon's practice (Wolfe *et al.*, 2006), while at the same time achieving a high level of patient satisfaction (Guyuron and Raszewski, 1990). Interestingly, an osseous genioplasty with a minimal advancement can sometimes be technically more challenging to stabilise than one with a larger advancement. However, in marked retrogenia and microgenia, as is often seen in patients with craniofacial deformities, an osseous genioplasty is the superior and most appropriate modality, as not only does it allow for the correction of the chin in all 3 dimensions (Ward *et al.*, 2007), but it also improves the cervicomental angle (Jones and Vesely, 2006), and in some cases, has been shown to improve the airway in patients with craniofacial deformities, when used in conjunction with other procedures such as hyoid advancement procedures (Heller *et al.*, 2006). Patients with Treacher Collins and Nager syndromes often suffer from obstructive sleep apnoea caused by posterior tongue collapse, secondary to retrognathia. In such patients, performing an advancement genioplasty and improving the position of the epiglottis with hyoid improvement procedures can improve the sleep apnoea (Heller *et al.*, 2006).

Obwegeser and Converse's initial description of the osseous genioplasty involved stripping the osteomised segment of all the soft tissues and advancing the chin as a free bone graft. The latter was subsequently subjected to a high degree of resorption and the authors soon realised the importance of preserving the blood supply. As such, the symphysis should not be skeletonised, in an attempt to reduce the rate of resorption and should remain as a myocutaneous vascularised pedicled flap (Ward *et al.*, 2007). Moreover, the advantages of maintaining a broad soft tissue pedicle include a low rate of infection, reduced osseous resorption and similar change of the bone and soft tissues, which some authors have attributed to the continuous blood flow to the segment immediately after surgery (Vedtofte *et al.*, 1991a; Vedtofte *et al.*, 1991b). Scheideman *et al.* felt that the use of a broad pedicle offsets the tension acting on the soft tissues located behind the osteomised segment and subsequently reduced the soft tissue thinning at the pogonion, thus producing a more predictable 1:1 hard/soft tissue change (Scheideman *et al.*, 1981).

Despite its existence for more than 50 years and predictable results achieved with current techniques, there is still

considerable debate on the type of genioplasty to be performed. Proponents of each would advocate ease of use, predictability and excellence of results. The potential disadvantages of alloplastic genioplasty include higher rates of infection, bone resorption under the implant, rejection, migration, capsular contracture and less predictable soft tissue responses. Similarly, the purported downsides to an osseous genioplasty can include the need of a general anaesthesia and power tools, the potential increased complexity, a higher incidence of nerve injury and paraesthesia, and tooth devitalisation. On the other hand, the potential advantages of an alloplastic genioplasty would include ease and reduced length of the procedure, reduced patient discomfort and less risk of damaging the mental nerve. Similarly, the osseous genioplasty allows the chin to be moved in all 3 dimensions, while improving the jaw and necklines. Also, there is potentially reduced risk of infection, and a more predictable soft tissue response (Cohen, 2000).

A good understanding of the function of the mentalis muscle and its role in lip competence should be appreciated. Zide and McCarthy have described the role of this muscle strip in preventing lower lip incompetence (Zide and McCarthy, 1989). Subsequent authors have altered their management and emphasised the importance of meticulous handling of the muscle, in an attempt to reduce any lip incompetence (Jones and Vesely, 2006; Chaushu *et al.*, 2001). A sound knowledge of the anatomy and course of the inferior alveolar nerves is of great importance. It is advised that the osteotomy be made 6 mm inferior to the mental foramen, in attempt to avoid the inferior alveolar nerve as it dips caudally just before exiting the foramen as the mental nerve (Ward *et al.*, 2007). Avoidance of traction on the mental nerves intra-operatively will also help avoid any potential transient lower lip numbness.

Conclusion

The lower third of the face plays an important, and often overlooked, role in facial aesthetics. As such, appropriate assessment and choice of genioplasty is crucial. The osseous genioplasty should play an important part in the armamentarium of the aesthetic surgeon, as well as the craniofacial and maxillofacial surgeon. It is a reliable procedure with predictable bone to soft tissue responses. It is easy to master and was associated with a low degree of morbidity in our study. We feel that the osseous genioplasty has a significant place in the management of patients with craniofacial deformities, as not only does it allow the chin to be mobilised in all 3 dimensions with predictable soft/hard tissue changes in order to enhance the appearance of the patients, but it can also be used to provide symptomatic relief, for example, in patients with obstructive sleep apnoea.

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