

The Role of Multiple Segment Osteotomies in Orthognathic Surgery

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Abstract

Multiple segment orthognathic (MSO) surgery is an effective approach to deal with a wide range of dento-facial deformities that have occlusal problems. The indications for MSO surgery were patients with dentofacial deformities and malocclusion requiring stable correction within a short overall treatment period.

From 1991 to 1998, 107 patients had MSO orthognathic procedures done at Chang Gung Memorial Hospital for maxillary protrusion/deformity (34 cases), maxillary protrusion and mandibular prognathism (69 cases), and non-cleft maxillary retrusion (4 cases). Follow up period ranged from 6 months to 7 years and results showed stability in movements with only 3 complications. The average overall treatment time was approximately 15 months.

Our experience with 107 consecutive patients have shown the results of MSO surgery to be good and the procedure safe with no tooth or segment loss.

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Introduction

Multiple segment osteotomy (MSO) orthognathic surgery serves to combine total or segmental maxillary and mandibular correction of dentofacial deformities with concurrent diastematic procedures to provide immediate repositioning of dental-osseous elements. In addition, splitting the palate may often be necessary to correct a functionally poor relationship of the maxilla to the mandible or the facial skeleton by realigning the maxillary arch. These multiple segment procedures also allow a rotational dimension to provide repositioning of displaced dento-osseous elements. All this serves to surgically attain the correct tooth spacing and ensure proper arch alignment in the shortest possible time in lieu of prolonged orthodontic therapy.

Adult patients with dentofacial deformities and malocclusion usually desire a treatment programme that is short but with permanent results. Traditional orthognathic surgery often involves lengthy periods of preoperative and postoperative orthodontic therapy to first decompensate before and subsequently adjust and maintain the surgically achieved result postoperatively.

The length of overall treatment time affects the lives and productivity of working patients. This concept of MSO promotes early and aggressive surgical movement of not only major segments but also minor dento-osseous segments. By doing so, orthodontic therapy and the resultant overall treatment time can be shortened considerably. Cases of maxillary and/or mandibular excess or insufficiency that also present with anterior or posterior malpositioned teeth, poorly inclined tooth segments, super-eruption of teeth and excessive spacing, crowding or improper inclination of individual teeth are suitable candidates for MSO surgery.

We have defined MSO surgery as the procedure which divides the tooth bearing arch of the maxilla or mandible into 3 or more segments. The types of osteotomies included in such orthognathic surgery are the LeFort I, anterior segmental osteotomies of the maxilla or the mandible, palatal split, posterior segment, single tooth or double tooth segments. A combination of such osteotomies resulting in 3 or more segments of the tooth bearing arch of the maxilla and or the mandible concurrently is defined as MSO orthognathic surgery.

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Materials and Methods

Patient Data

From 1991 to the beginning of 1998, 107 consecutive patients underwent MSO procedures at the Craniofacial Center at Chang Gung Memorial Hospital (Linkou). Most patients underwent preoperative orthodontic treatment ranging between 3 to 6 months in duration. Their ages ranged from 11 to 42 years. There were 76 females. The main presenting problem was mandibular prognathism in association with maxillary protrusion (69 cases). Of the remaining patients, 34 had maxillary protrusion/deformity and 4 presented with non-cleft maxillary retrusion.

Planning

The necessity for MSO surgery should be recognised by both the surgeon and orthodontist prior to the commencement of treatment. MSO surgery, like other forms of orthognathic surgery, requires careful examination and planning. It includes periapical radiographs of the affected tooth or tooth segment, panorex views, cephalometric assessment and study model analysis. Periodontal status and the vitality of the teeth in the region

of surgery is determined. The key to the planning is the evaluation of adjacent root relationships with the aid of periapical radiographs. Inter-radicar distance should be greater than 1.5 mm before vertical cuts can be planned for one tooth or small segment osteotomies. Model surgery must be as accurate and as exact as possible to facilitate the construction of acrylic occlusal wafer-guides. This splint will ensure accurate positioning of all the major and minor segments involved in the procedure.

Based on established cephalometric relative norms, the types and the combination of multiple segments necessary to achieve the desired dentofacial symmetry and occlusion are determined. The considerations for planning include the age of the patient, skeletal maturity, facial aesthetics, the facial midline, and finally the dental occlusion. The key is to always stay within the biological limits based on established relative norms. Orthodontic decompensation before surgery is kept simple. No extreme or large movements are planned aside for lingual or labial decompensation. When dental aesthetics is not a concern to the patient, extractions are performed prior to surgery to treat crowding or where indicated in the planned surgical procedure.



Fig. 1. Frontal and profile preoperative views of a 30-year-old female with bimaxillary protrusion.

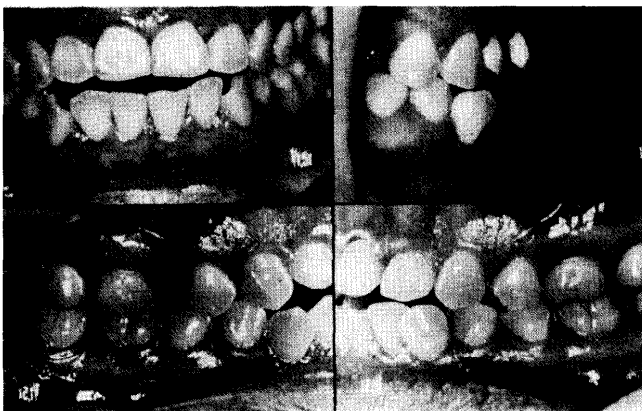


Fig. 2a. Preoperative occlusion showing anterior open bite.

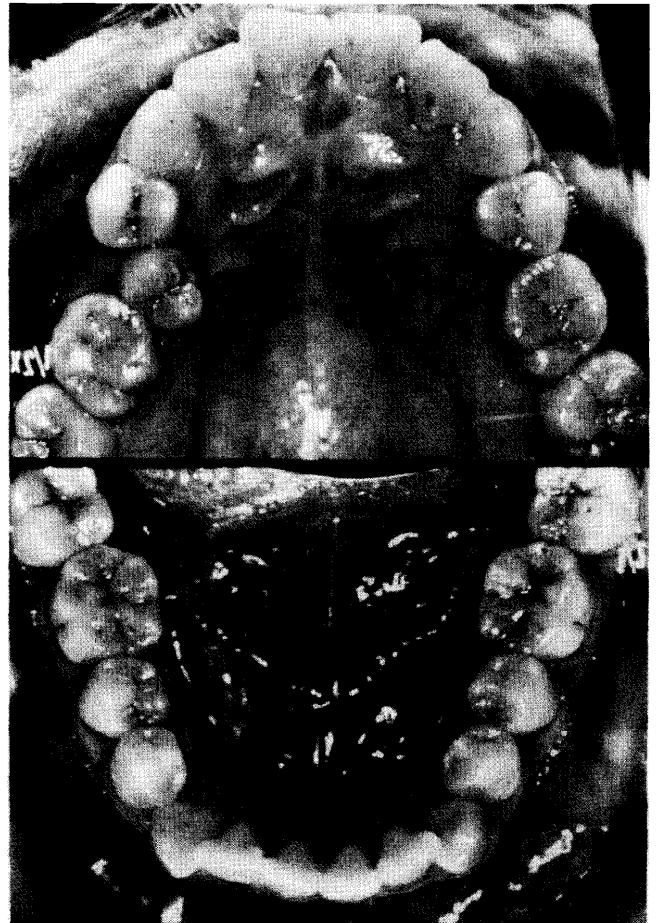


Fig. 2b. She also had crowding of the maxillary arch.

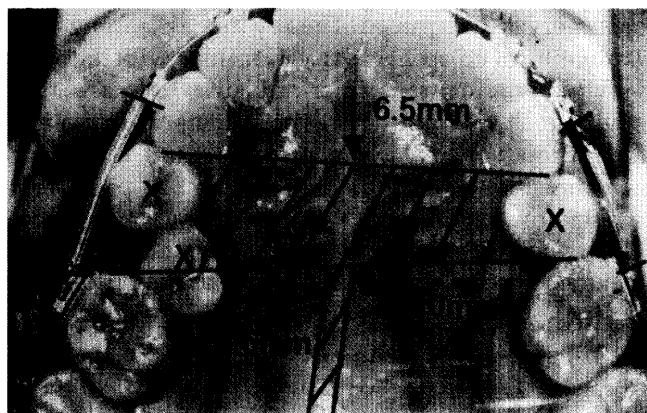


Fig. 3. A 3-piece multiple segment osteotomy of the maxilla (left) and an anterior segmental mandibular osteotomy (right).



Fig. 4. Frontal and profile views of the post-surgical results showing improved facial aesthetics.

Results

The follow-up period for all 107 patients ranged from a minimum of 6 months up to a maximum of 7 years. Our data showed that a total of 102 maxillae and 17 mandibles had MSO surgery. The breakdown of the number of segments involved is shown in Table I.

There was a complication rate of 2.8% (3 patients). While 1 patient had partial gingival loss, 2 others had

unilateral permanent inferior mental nerve paraesthesia. The partial gingival loss was limited to the right upper lateral incisor and canine as a result of poor wound closure. We did not experience any incidence of tooth or segmental loss due to vascular compromise, irrespective of the combination of osteotomies performed. The average duration of postoperative orthodontic treatment was between 9 and 12 months. The combined

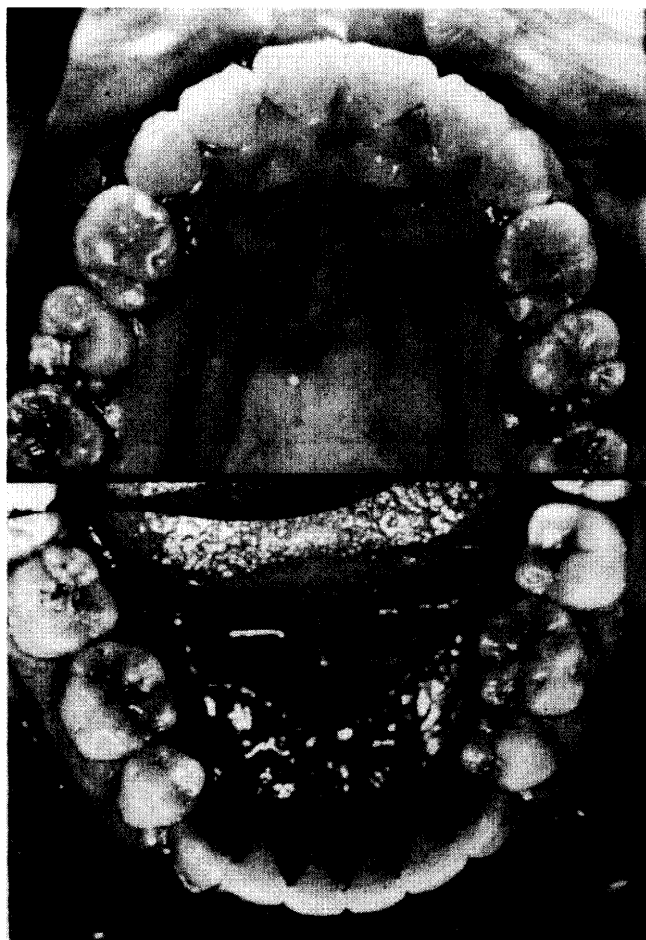


Fig. 5b. Maxillary and mandibular dental arch at the end of treatment.

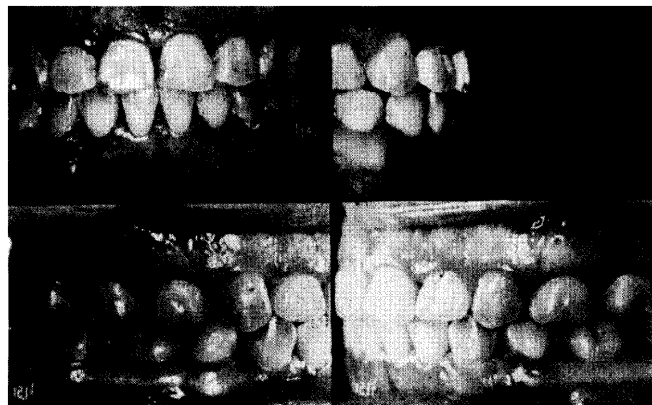


Fig. 5a. Post-surgical occlusion showing correction of the anterior open bite.

TABLE I: TOTAL NUMBER OF SEGMENTS IN BOTH THE MAXILLAE AND MANDIBLES OPERATED UPON

No of segments	Maxilla	Mandible
3 segments	70	5
4 segments	10	9
5 segments	11	1
6 segments	1	2

preoperative and postoperative orthodontic treatment was apparently shortened by at least 6 months with an average total treatment time of 15 months. Clinical examination and cephalographics immediately post-surgery and sequentially at 6 months and at 1 year confirmed stability of both the occlusion and skeletal movements without significant relapse. No patients requested nor required repeat or revision surgery.

Discussion

Abnormal relationships between the maxilla or mandible often result in a wide range of disharmonious facial patterns. The degree of occlusal aberration and dentofacial deformity may vary from minor imperfections of tooth alignment to severe distortion in the dentition with the accompanying jaw retrusions, protrusions or facial asymmetries. Traditional orthognathic surgery often involves lengthy periods of preoperative and postoperative orthodontic therapy to first decompensate before and subsequently adjust and maintain the surgically achieved result there. A variety of osteotomies are now available to the maxillofacial surgeon to achieve aesthetic and occlusal changes. A combination of as many osteotomies as necessary should be performed to obtain the ideal result in a single procedure.

Patient analysis revealed that maxillary and mandibular malrelationships can be corrected not just by total movement of the maxilla or mandible, but also by shifting the anterior, or posterior segments of the maxilla, or mandible, and when necessary, by movement of one tooth or double tooth dento-osseous segments. Interincisal osteotomies for the surgical repositioning of dento-osseous elements have been described by Cole and Staples,¹ Bell,² Merrill and Pederson,³ Burk et al,⁴ Spilka and Matthews,⁵ and Fielding and Montano.⁶ By combining such small segment surgery with the more traditional orthognathic segmental procedures, rapid constriction or expansion with good alignment of the arch form can be achieved often with predictable results.

With traditional orthodontic-orthognathic treatment, relapse has been attributed mostly to the persistent improper axial inclination of the tooth roots as well as the interdental soft tissues.⁷ MSO surgery provides long-term stability that is superior to orthodontic tooth movements in the same direction. In addition, treatment goals can be achieved in a much shorter time frame. Multiple

segment orthognathic surgery allows us to realign the improper axial inclination of the tooth roots as well as to disrupt the transseptal and interdental fibres. This serves to eliminate the 2 major factors that cause relapse of orthodontic dento-osseous movements. Speed of movement, multi-directional movement and the elimination of long-term retention appliances are additional advantages of MSO. With our average overall treatment time of 15 months for MSO surgery, we have found this to be noticeably shorter than that for traditional orthognathic surgery. However, we have not been able to statistically analyse the difference in overall treatment time with a matched control group. This advantage of segmental orthognathic surgery has also been reported by previous authors such as Bell,² Merrill and Pederson,³ Burk et al,⁴ Spilka and Matthews,⁵ and Fielding and Montano.⁶

Animal experiments by Bell⁸ and bone healing studies by Ware and Ashamalla,⁹ have laid the vascular basis for MSO orthognathic surgery. They showed that intraosseous and intrapulpal circulation associated with the surgical movement of single and or multiple dento-osseous segments was maintained essentially by the palatal mucoperiosteum. Bell² in 1973 showed that immediate surgical positioning of one and two-tooth dento-osseous segments was clinically feasible and safe. The vascular basis and associated wound healing for total and large segment maxillary surgery has also been described by Bell et al¹⁰ and Quejada et al.¹¹ Castelli et al¹² in 1975 and Meyer and Cavanaugh¹³ in 1976 showed that although the major blood supply to the mandible was from the inferior alveolar vessels, areas of major muscle attachments provide supplemental or when necessary, collateral vascular supplies to the dento-osseous segments of the mandible.

The operative technique for MSO is dependent on the planned number of segments necessary to achieve the desired dentofacial correction. Based on the vascular studies previously mentioned, there are several technical points that are critical to avoiding avascular sequelae. In the maxilla, all care must be taken to avoid damage or transection of the greater palatine vessels. There should be no incisions on the palatal mucosa and subperiosteal mobilisation for the anterior segmental osteotomy of the maxilla should be done with care to prevent any damage to the palatal pedicle. Care must also be taken to avoid unnecessary stripping of the palatal mucosa on the mobilised anterior segments. After fixation of the maxillary segments, any entrapment of the palatal pedicle or mucosa between segments should be avoided. The anterior labial pedicle should be as wide as possible. Vertical incisions should be avoided and subperiosteal stripping done only in the line of the planned vertical osteotomy.

Anterior segment osteotomies of the mandible are approached through a lower buccal sulcus incision.

Optimal vascularity to the osteotomised segment can be ensured by optimising the buccal pedicle by both flap design and the maintenance of maximal attachment to the segment. Stripping of the lingual mucoperiosteal pedicle should be avoided. The horizontal osteotomy should be at least 30 mm from the lateral incisor edge to obviate damage to the tooth roots and to include maximal suprahyoid and genial muscle attachment to provide collateral blood supply. As in the maxilla, no vertical incisions are made on the buccal mucosa, subperiosteal exposure is obtained only in the line of the planned interradicular osteotomies.

From our experience, we believe that adherence to the surgical principles and technique described has ensured that we have not encountered a single case of vascular compromise. While other authors^{2,4} have all reported cases of tooth or segment loss, our experience has shown that it is possible to minimise and even eliminate such avascular sequelae by ensuring that the vascular pedicle is preserved during surgery. Our single complication occurred in a patient with partial gingival loss. Two other patients had persistent inferior alveolar paraesthesia. This was unrelated to MSO but rather to the sagittal splitting of the mandibular ramus. In our 1 patient with partial gingival loss, this was attributed to poor surgical technique by using continuous over and over sutures to close the incision, causing ischaemia to the suture line.

MSO surgery is therefore unique in that the procedure facilitates treatment of complex dentofacial deformities in the vertical, transverse and sagittal dimensions simul-

taneously with differential repositioning, thereby permitting the correction of complex dento-skeletal abnormalities.

REFERENCES

1. Cole J R, Staples A F. Correction of diastemas by anterior osteotomy and midline osteotomy. *J Oral Surg* 1973; 31:308.
2. Bell W. Immediate surgical repositioning of one- and two-tooth dento-osseous segments. *Int J Oral Surg* 1973; 2:265.
3. Merrill R G, Pederson G W. Interdental osteotomy for immediate repositioning of dental-osseous elements. *J Oral Surg* 1976; 34:118.
4. Burk J L Jr, Provencher R F, McKean T W. Small segmental and unitooth osteotomies to correct dentoalveolar deformities. *J Oral Surg* 1977; 35:453.
5. Spilka C J, Matthews P H. Surgical closure of diastema of central incisors. *Am J Orthod* 1979; 76:443.
6. Fielding A F, Montano R. Anterior maxillary corticotomies. *Int Dent J* 1980; 30:289.
7. Edwards J G. Soft tissue surgery to alleviate orthodontic relapse. *Dent Clin N Am* 1993; 37:205.
8. Bell W. Revascularisation and bone healing after anterior maxillary osteotomy: a study using adult rhesus monkeys. *J Oral Surg* 1969; 27:249.
9. Ware W H, Ashamalla M. Pulpal response following anterior maxillary osteotomy. *Am J Orthod* 1971; 60:156.
10. Bell W H, Fonseca R J, Kennedy J W, Levy B M. Bone healing and revascularization after total maxillary osteotomy. *J Oral Surg* 1975; 33:253.
11. Quejada J G, Hiroshi K, Finn R A, Bell W H. Wound healing associated with segmental total maxillary osteotomy. *J Oral Maxillofac Surg* 1986; 44:366.
12. Castelli W A, Nasjleti C E, Diaz-Prez R. Interruption of the arterial inferior alveolar flow and its effects on mandibular collateral circulation and dental tissues. *J Dent Res* 1975; 54:708.
13. Meyer M W, Cavanaugh G D. Blood flow changes after orthognathic surgery: maxillary and mandibular subapical osteotomy. *J Oral Surg* 1976; 34:495.