Position of mandibular canal and ramus morphology after sagittal split ramus osteotomy

Ahmad Al-Sibai\textsuperscript{a}, Maha Shawky\textsuperscript{b} and Tarek El-Ghareeb\textsuperscript{a}

\textbf{Aim of the study} The aim of the study was to evaluate the change in position of mandibular canal (MC) and ramus morphology before and after bilateral sagittal split ramus osteotomy.

\textbf{Patients and methods} This study was conducted on six patients (12 sides) with either retrognathism or prognathism using cone beam computed tomograms to evaluate the change in position of MC after sagittal split ramus osteotomy for either mandibular advancement or setback at three levels of coronal cuts – namely lateral orbital rim (level 1), lateral malar bone (level 2), and anterior rim of the ramus (level 3) – at 6 months postoperatively. Evaluation of ramus morphology was carried out using axial cuts after fusion between the preoperative and postoperative radiographs at three levels after dividing the skull from the roof of the orbit to the inferior border of the chin into 14 cuts to choose cut number 4 as level 4, cut number 5 as level 5 and cut number 6 as level 6.

\textbf{Results} In class II, the MC was located more superiorly and there was an increase in ramus width postoperatively, whereas in class III the MC was located more inferiorly postoperatively.

\textbf{Conclusion} The MC in class II was moved superiorly postoperatively with an increase in ramus width, whereas it was moved inferiorly in class III without changes in ramus morphology postoperatively. \textit{Egypt J Oral Maxillofac Surg} 5:45–50 \copyright 2014 The Egyptian Association of Oral & Maxillofacial Surgeons.

\textbf{Keywords:} mandibular canal, ramus morphology, ramus osteotomy, sagittal split

\textsuperscript{a}Department of Oral and Maxillofacial Surgery, Faculty of Oral and Dental Medicine, Cairo University, Cairo, Egypt and \textsuperscript{b}Oral and Maxillofacial Surgery Department, Faculty of Dentistry, King Abdul Aziz University, Jeddah, Saudi Arabia

Correspondence to Tarek El-Ghareeb, BDS, MSc, DDS, FDSRCS, Department of Oral & Maxillofacial Surgery, Faculty of Oral & Dental Medicine, Cairo University, Cairo, Egypt Tel: +201227418235; e-mail: t.ghareeb@hotmail.com

Received 5 November 2013 accepted 10 December 2013

\textbf{Introduction}
The term orthognathic originates from the words orthos and gnathos (Gr. orthos = straight; gnathos = jaw). Orthognathic surgery refers to the surgical procedures designed to correct jaw deformities. Orthognathic procedures are divided into three categories: maxillary surgery, mandibular surgery, and bimaxillary procedures [1,2].

Bilateral sagittal split osteotomy (BSSO) is the most used orthognathic surgical procedure for the correction of mandibular dysgnathic deformities. The Obwegeser–Dal Pont osteotomy and the Hunsuck modification are frequently used to advance or setback the mandible [3–5].

In most cases, the treatment results are good, and severe complications are rare. Postoperative neurosensory disturbance of the lower lip and chin is a major concern in all mandibular osteotomies, particularly with the BSSO [6]. Neurosensory disturbance is reported to develop in the lower lip and mental skin in 30–40\% of patients after such surgery [7].

Factors that influence neurosensory disturbance after sagittal split ramus osteotomy include age of patient, intraoperative magnitude of mandibular movement, degree of manipulation of the inferior alveolar nerve (IAN), and the width of marrow space between the mandibular canal (MC) and the external cortical bone [8,9]. Yamamoto \textit{et al.} [8] showed that neurosensory disturbance was significantly more likely to be present 1 year after surgery when the width of the marrow space between the MC and the external cortical bone was 0.8 mm or less, if the screws are placed too inferiorly, or if the screws used with the miniplates are too long, which can enter the MC and damage the nerve resulting in edema or hematoma in the MC [10,11].

Although it is still unclear what factors affect the incidence of lower lip hypothesia after BSSO, it is very important to know the relationship between the mandibular bone and the inferior alveolar canal to avoid direct damage to the IAN preoperatively. Despite the paramount importance of postoperative bony changes of BSSO, very few reports have described the postoperative changes in the position of the MC and ramus morphology.

\textbf{Patients and methods}
This study was carried out on six patients (12 sides), two male patients and four female patients, selected from the outpatient clinic of Oral and Maxillofacial Surgery Department, Faculty of Oral and Dental Medicine, Cairo University, who were indicated for BSSO for correction of mandibular prognathism or retrognathism, with an age average of 21.3 years. Three of them had mandibular deficiency and were indicated for mandibular advancement, and the other three had mandibular prognathism and were indicated for mandibular setback. All patients had undergone orthodontic treatment before surgery for decompensation and after surgery when indicated.

The sample was composed of 12 sides (six rights and six lefts); the changes in the MC and ramus morphology were studied after BSSO either by advancement or
setback of the mandible (Fig. 1). Rigid fixation was achieved by miniplate and monocortical screws (Figs 2 and 3) after the surgery elastic traction was used to maintain the ideal occlusion for 10 days.

Cone beam computed tomograms were taken for all patients preoperatively and 6 months postoperatively. Three coronal cuts were taken to study the position of the inferior alveolar canal:

Level 1: lateral orbital rim (Fig. 4).
Level 2: lateral malar bone (Fig. 5).
Level 3: anterior ramus rim (Fig. 6).

The MC was studied in the resulting cross-sectional views in four directions: superior, inferior, buccal, and lingual.

(1) **Buccal:** from the inner cortical buccal bone of the mandible to the outer cortical bone of the canal from the buccal aspect.

(2) **Lingual:** from the inner cortical lingual bone of the mandible to the outer cortical bone of the canal from the lingual aspect.

(3) **Superior:** from the inner cortical bone of the alveolar process to the outer cortical bone of the canal from the superior aspect.

(4) **Inferior:** from the inner cortical bone of the inferior mandibular rim to the outer cortical bone of the canal from the inferior aspect.

The fusion technique was used to study ramus morphology. Axial cuts were made after the fusion of preoperative and postoperative radiographs to evaluate the changes in ramus morphology at three levels. The skull was divided from the roof of the orbit to the inferior border of the chin into 14 axial cuts, with 10 mm distance between each cut (Fig. 7). Thereafter, the ramus morphology, width, and anteroposterior length were studied at level 4, level 5, and level 6.

Ramus width measurement was performed posterior to the second molar from the outer buccal cortical bone of the ramus to its outer lingual cortical bone, and ramus length was measured from the most posterior point to the most anterior point next to the distal surface of the second molar (Fig. 8).

All of the patients signed a consent form before the study.

**Results**

No postoperative infection was reported, and wound healing was satisfactory and proceeded uneventfully. Nerve deficits occurred in two patients, which disappeared completely with complete edema salvation.

**Retrognathism (class II)**

MC was moved buccally and superiorly, but this change was not significant at level 1. At level 2 and level 3, MC
Fig. 4

Lateral orbital coronal cut with resulting cross-sectional cut.

Fig. 5

Lateral malar bone coronal cut with resulting cross-sectional cut.

Fig. 6

Anterior ramus coronal cut with resulting cross-sectional cut.
was moved buccally and superiorly, but this movement was not statistically significant in the buccal direction. Regarding ramus morphology, there was a statistically significant increase in ramus width at all levels, but the increase in ramus length was not statistically significant (Figs 9 and 10).

**Prognathism (class III)**

MC was moved inferiorly and buccally, but this change was not statistically significant at level 1; at levels 2 and 3, MC was moved inferiorly and buccally, but this movement was not statistically significant in the buccal direction.

Regarding ramus morphology, there was a decrease in ramus length and an increase in ramus width at all levels, but these changes were not statistically significant (Figs 9 and 10).

**Discussion**

The BSSO is an optimal operation for mandibular correction. Despite several risks inherent with this technique, it is the best choice for correction of severe malocclusions and deformations in the mandible, such as advancement and setback, it has been used to correct the mandibular asymmetry, and it is used as a technique to compensate reposition of the occlusal plane.
Neurosensory disturbance of the lower lip and chin induced by damage to the IAN is the most common immediate finding after BSSO. The high incidence of neurosensory disturbance immediately after BSSO is due to direct damage to the IAN, as sawing procedures were performed in close relationship to the inferior alveolar canal or by stretching it in bad split [12]. For this reason, many studies concerning locating the IAN and other landmarks such as lingula and antiligula were conducted preoperatively. These landmarks are of great importance to guide surgeons for safer procedures during ramus osteotomy. However, techniques such as conventional

**Fig. 9**
Bar chart representing the mean deviation of the changes in the position of mandibular canal in class II and class III.

**Fig. 10**
Bar chart representing the mean changes in ramus morphology in class II and class III.
radiographs, topography, and the use of human dry skull have been used to locate the IAN [13–17].

Studies were conducted preoperatively to overcome the common complication of this surgery and to avoid damage to the IAN during osteotomy and fixation, whereas there are few studies that followed the possible changes of its course and position after BSSO procedures.

Ueki [18] conducted a study on 30 patients (60 sides) with mandibular prognathism for locating the MC position and ramus morphology before and after BSSO; they used computed tomographic scan, and the position of the canal and ramus morphology were measured at three horizontal planes: at the mandibular foramen level (level A), 1 cm lower than level A (level B), and 2 cm lower than level A (level C). Thereafter, the MC and ramus morphology were measured preoperatively and postoperatively.

Regarding ramus length, it was measured from the most anterior point to the most posterior point of the ramus; ramus width was measured from the most medial point to the most lateral point. Thereafter, the canal position was studied in four directions from these axial views anteroposteriorly and mediolaterally.

In this study, we rely on coronal cuts and its resulting cross-sectional view to study the position of the MC in four directions – superior, inferior, buccal, and lingual – then on axial cuts after the fusion technique to study the ramus width and anteroposterior length.

Ueki [18] concluded that postoperative ramus width and canal length were significantly larger than the preoperative values at the three levels, and suggested that postoperative MC position was located more posteriorly and the postoperative lateral bone marrow became thicker compared with the preoperative state.

Depending on previous information, we found that this study completes the study by Ueki [18], as some results are the same, especially what regards the ramus morphology, because both studies depend on axial cuts even though the change was not statistically significant in our study, whereas the differences were in the MC position, as this study depends on the cross-sectional view for tracing the position of the MC postoperatively, and this view would not allow to study the variation of the MC in anteroposterior direction as Ueki [18] did in his study by the axial cuts.

There were no complications reported other than the intraoperative difficulty in intermaxillary fixation due to muscle traction; this was reported in a study by Martis [19] who consider it one of the problems to cause postoperative relapse; hence, adaptation of the suprathyroid muscles should be carried out before fixation, and that is what Reynolds [20] studied showing that the suprathyroid complex was elongated slightly less than the mandible, and the major adaptations (lengthening) occurred at the muscle–bone interface, the muscle–tendon interface, and within the belly of the anterior digastic muscle.

Conclusion
This study suggested that the MC in class II was moved superiorly postoperatively with an increase in ramus width, whereas it moved inferiorly in class III without changes in ramus morphology postoperatively.

Acknowledgements
The authors thank their colleague Amr Ikram, assistant lecturer, Oral and Maxillofacial Radiology Department, Faculty of Oral and Dental Medicine, Cairo University, for his great help and contribution in radiographic assessment.

Conflicts of interest
There are no conflicts of interest.

References
17. Hassanan Fahmy A. Condylar position following bilateral sagittal split ramus osteotomy and its effect on the TMJ. [PhD thesis], Cairo: Faculty of Oral and Dental Medicine, Cairo University; 1993.