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The proximal segment in sagittal split ramus osteotomy

Reza Sharifi [1], Majid Beshkar [1*], Gholamreza Shirani [2]

1. Department of Oral and Maxillofacial Surgery, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran; Craniomaxillofacial Research Center, Tehran University of Medical Sciences, Tehran, Iran.

2. Department of Oral and Maxillofacial Surgery, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

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**Corresponding author:*
Majid Beshkar

Department of Oral and Maxillofacial Surgery, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran; Craniomaxillofacial Research Center, Tehran University of Medical Sciences, Tehran, Iran.

Tel: +98-21-42794000
Fax: +98-21-84902473
Email: majid.beshkar@Gmail.com

ABSTRACT

Bilateral sagittal split ramus osteotomy is one of the most versatile techniques in orthognathic surgery that allows for the repositioning of the mandible in all directions. This osteotomy splits the mandible into two proximal condyle-bearing segments and one distal tooth-bearing segment. Intraoperatively, the surgeon is usually focused primarily on the proper positioning of the distal segment to achieve the planned amount of advancement or setback. However, particular attention should be paid to the position of the proximal segment, as improper positioning of the proximal segment during fixation gives rise to immediate or late relapse of the surgical outcomes. The goal of this paper is to provide some background knowledge about the proximal segment for the novice surgeons, based on a review of the relevant literature. What is the proper position of the proximal segment, and what is the best technique to guide the proximal segment into its proper position?. These questions do not have clear-cut answers that the majority of surgeons agree on.

Keywords: Orthognathic surgery; Osteotomy; Mandibular condyle; Proximal segment; Sagittal split.

Introduction

In orthognathic surgery, sagittal split ramus osteotomy (SSRO) is the most common technique for repositioning of the mandible. Bilateral SSRO splits the mandible into three separate segments: two proximal segments, and a distal segment. The proximal segment is the condyle-bearing segment, and the distal segment is the tooth-bearing segment (Figure 1). The proximal segment includes the condyle and the coronoid process. Depending on the pattern of osteotomy, the proximal segment also includes a variable amount of the ramus, angle, and body of the mandible. In SSRO procedure, it is very important to keep the proximal segment in a proper position during fixation. Improper positioning of the proximal segment during fixation could give rise to postoperative malocclusion, skeletal relapse, and TMJ dysfunction. For this reason, several techniques have been introduced to keep the

proximal segment in a correct position during fixation. But what is the correct position of the proximal segment during fixation, and what is the best technique to keep the proximal segment in its correct position during fixation in SSRO? In this paper, we attempt to find answers to these questions based on the available scientific evidence.

Positional changes of the proximal segment

Intraoperative changes in the position of the proximal segment relative to its preoperative position could occur via pure rotation, pure translation, or a combination of rotation and translation of the proximal segment. The fulcrum of rotational movements of the proximal segment is located in the condylar region. These rotational movements could be analyzed by means of the following three angular measurements: the axial condylar angle, the coronal condylar angle, and the sagittal condylar angle. The axial condylar angle is the angle between the axial condylar axis and the midsagittal line. The axial condylar axis is the line that passes through the medial and lateral poles of the condyle in the axial view (Figure 2A). Inward axial rotation of the proximal segment causes a decrease in the axial condylar angle, while outward axial rotation causes an increase in this angle.

The coronal condylar angle is the angle between the coronal condylar axis and the Frankfort horizontal plane. The coronal condylar axis is the line that passes through the center of condylar neck and the center of condylar head in the coronal view (Figure 2B). Inward coronal rotation of the proximal segment causes a decrease in the coronal condylar angle, while outward coronal rotation (also called flaring) causes an increase in this angle. The sagittal condylar angle is the angle between sagittal condylar axis and Frankfort horizontal plane. The sagittal condylar axis is the line that passes through the center of condylar neck and the center of condylar head in the sagittal view (Figure 2C). In the sagittal plane, forward rotation of the proximal segment causes a decrease in the sagittal condylar angle, while backward rotation causes an increase in this angle.

The correct positioning of the proximal segment

There is no consensus about the correct position of the proximal segment in SSRO. Consequently, there is no consensus about how to guide the proximal segment into its correct position intraoperatively. In this section, we review different perspectives on these two issues. Cortese et al. [1] believe that centric relation of the condyles in the articular fossa is necessary to obtain accurate and stable surgical outcomes as well as optimal TMJ functions. To achieve this supposedly correct position, they suggest using two surgical guides designed by CAD-CAM technology. Each guide has two U-shaped ends and fits on the last molar crown over the distal segment and on the anterior border of the ramus over the proximal segment. The guides are fixated to the proximal segment by a single monocortical screw on each side. The authors argue that these bilateral surgical guides allow for precise positioning of the two proximal segments during fixation.

The idea that centric relation is the best position of the condyle during fixation of the proximal segment is not supported by scientific evidence. "In dentistry, centric relation is the mandibular jaw position in which the head of the condyle is situated as far superior and posterior as it possibly can be within the mandibular fossa/glenoid fossa. This position is used when restoring edentulous patients with removable or either implant-supported hybrid or fixed prostheses. Centric relation is an old concept in dentistry based on an old mechanical viewpoint of dentistry. There are more than 26 different definitions of centric relation since the term was first developed as a starting point for making dentures. It is not a physiological position but rather a border position that is used for reproducibility. The TMJ does not normally function in a centric relation position" [2]. Reproduction of the preoperative centric relation by the use of surgical guides or condylar positioning devices (CPDs) lacks scientific evidence. A review of the literature by Ueki et al. [2] has demonstrated that the preoperative position of the condyle is not the desired postoperative position in SSRO. The authors argue that "the most favorable postoperative condylar position, including the disk position and horizontal condylar angle may not match the preoperative one, but would not be dramatically different except for cases with TMD or asymmetry." Costa et al. [3] conducted a review of literature from 1990 to 2007 concerning the use of CPDs in SSRO and found that "there is no scientific evidence to support the routine use of CPDs in orthognathic surgery".

The first CPD was a relatively simple device introduced by Luhr [4]. The Luhr device is in fact a conventional bone plate adapted and fixated to the lateral surfaces of the ramus and the zygoma on each side. The device is fixated to these surfaces before the osteotomy of the jaws, and while the teeth are secured over a centric relation occlusal splint. Once fixated, the plate is removed and the osteotomies are completed. Before fix-

ating the osteotomized segments, the positioning plate is reapplied to the previously determined position. Gerressen et al. [5] have demonstrated that the utilization of the Luhr device is not better than the manual positioning technique in terms of skeletal stability after SSRO. The authors argue that "in many cases the use of positioning appliances does not result in an accurate reproduction of the preoperative condyle position or a therapeutically favorable position for the proximal segments". Based on a review of the literature, Ellis [6] suggests maintaining the proximal segment in as close to its preoperative position as possible during the surgical procedure to improve stability of the treatment outcomes. "However, there is some information in the literature that suggests the preoperative position of the condyle may not be a stable position for maintenance of the occlusion after correction of certain deformities" [6].

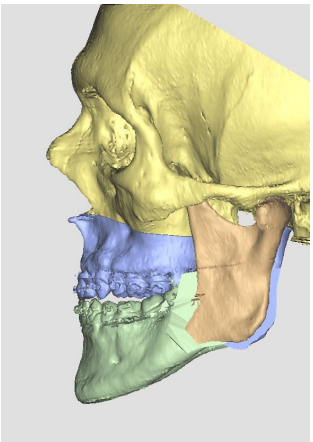

Figure 1. This 3D reconstruction of the craniofacial bones shows the proximal (condyle-bearing) and the distal (tooth-bearing) segments of the mandible in different colors.

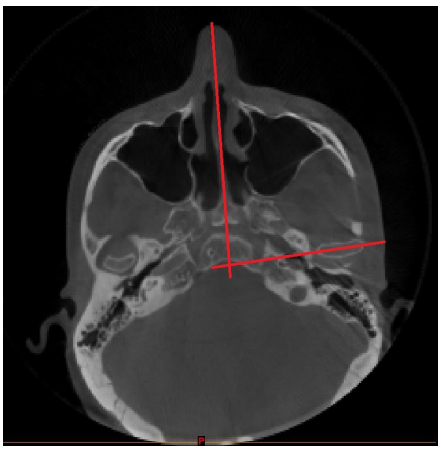

Figure 2A. The axial condylar angle.

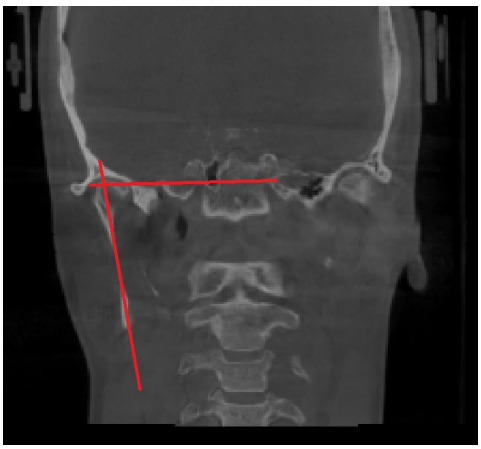

Figure 2B. The coronal condylar angle.

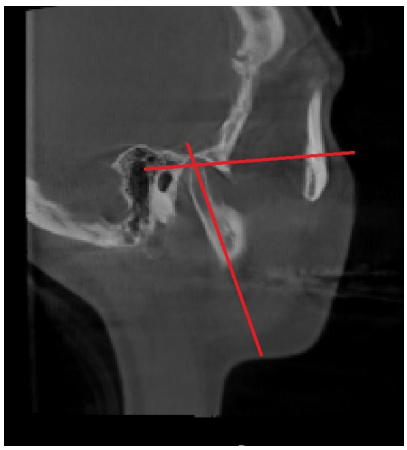

Figure 2C. The sagittal condylar angle.

Discussion

"Because of the complexity, time involved, and added costs of many of these techniques, surgeons tend to overlook the importance of this surgical step, preferring manual methods. The most frequently used technique involves some form of manual positioning of the proximal fragment intraoperatively and visual inspection of the superior and inferior borders of the osteotomy during fixation." Cortese et al. (2019). Most surgeons rely on manual repositioning of the proximal segment to obtain the best possible relationship of the condyle within the fossa. Even some of the surgeons who once advocated the use of CPDs, have abandoned using them. Ellis (1994) asked 9 surgeons who published articles on the use of CPDs to determine if they still use them. "Six of the nine surgeons no longer routinely used condylar positioning devices. Three of the six stated that they use them very infrequently in "difficult" or "extreme" cases and/or those with preoperative TMDs. The reason cited for abandoning use of the condylar positioning devices on a routine basis by the six surgeons were 1) too time consuming; 2) difficult

to use; 3) condyle position no better than when done manually; 4) simpler methods work as well, such as marking osteotomy sites; 5) didn't know which condylar position to reproduce; 6) more complications with positioning devices than without; 7) there would frequently be a bone gap between SRO fragments, raising the question of whether a bone graft should be inserted; and 8) they are unnecessary because there is some adaptability of condyle that takes care of any malpositioning in most patients" Ellis (1994).

Given the lack of strong scientific evidence to support the routine use of CPDs, it seems that manual positioning of the proximal segment continues to be the method of choice in SSRO. To increase the accuracy of the manual positioning techniques it is recommended that the surgeon pay particular attention to the markings and measurements that have been made over the proximal and distal segments. For example, when SSRO is used to correct mandibular prognathism, it is very likely that the proximal segment be inadvertently rotated or pushed distally as a result of the backward force that the distal segment exerts over the medial pterygoid muscle. This inadvertent distalization of the proximal segment may go unnoticed if the surgeon does not pay attention to the amount of bone strip that should be removed from the anterior part of the proximal segment before fixation. The width of this bone strip should be equal to the amount of mandibular setback. If the width of the strip is less than the amount of setback, this is most probably due to inadvertent distalization of the proximal segment. Therefore, by proper attention to the markings and measurements, manual positioning of the proximal segments become more accurate and reliable.

Conflict of Interest

There is no conflict of interest to declare.

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