Int. J. Oral Maxillofac. Surg. 2017; xxx: xxx–xxx
https://doi.org/10.1016/j.ijom.2017.10.012, available online at https://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Research Paper
TMJ Disorders

Changes in condylar volume and joint spaces after orthognathic surgery

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R. J. da Silva, C. V. Valadares Souza, G. A. Souza, G. M. B. Ambrosano, D. Q. Freitas, E. Sant'Ana, C. de Oliveira-Santos: Changes in condylar volume and joint spaces after orthognathic surgery. Int. J. Oral Maxillofac. Surg. 2017; xxx: xxx–xxx.

Abstract. The aim of this study was to evaluate the changes in condylar volume and joint spaces occurring in patients undergoing bimaxillary orthognathic surgery for the treatment of class II deformities, by means of cone beam computed tomography (CBCT). Initial and follow-up (at least 6 months) CBCT examinations of 114 condyles (57 patients) were studied retrospectively. Linear measurements of the joint space and volumetric analysis of changes in condylar volume were performed using Dolphin 3D Imaging in association with ITK-SNAP 3.0.0 segmentation software. The paired *t*-test and Pearson correlation coefficient were applied, and a descriptive analysis was performed. Mean condyle volumes were significantly smaller at follow-up ($P = 0.0125$). There were significant reductions in superior and medial joint spaces in the follow-up examinations (both $P < 0.05$). Positive correlations were found when comparing the mean changes in anterior, superior, and posterior space values between the right and left sides. No significant correlation was observed between changes in volume and joint spaces. In conclusion, there was a reduction in mean condylar volume after orthognathic surgery in class II patients. However, changes in volume for each condyle may be variable. Such changes in condylar volume may occur independently on the left and right sides, and do not correlate with changes in joint spaces.

Key words: temporomandibular joint; orthognathic surgery; condylar remodelling.

Accepted for publication 24 October 2017

Dentomaxillofacial deformities involve skeletal and dentoalveolar modifications that usually require combined orthodontic and orthognathic surgery treatment[1]. Dental and facial development is affected by genetic and/or environmental factors, facial infections/traumas in childhood, maxillofacial cysts or tumours, condylar hyperplasia, mandibular hypoplasia, or previous surgical procedures. Patients with these deformities usually present problems in mastication, speech, swallowing, and aesthetics, as well as psychological disorders[2].

Orthognathic surgery covers a whole set of techniques used to correct maxillofacial discrepancies. One of the techniques most used for this purpose is the bilateral sagittal split osteotomy (BSSO) established by Obwegeser and Trauner in 1955[3]. This is described as the complete osteotomy of the mandibular ramus superior to the mandibular foramen, allowing advancement or repositioning of the mandible. Over the years, this technique has undergone some modifications, with the main changes being those made by Dal Pont in 1961[4] and

0901-5027/000001+07

Please cite this article in press as: da RJ, et al. Changes in condylar volume and joint spaces after orthognathic surgery, *Int J Oral Maxillofac Surg* (2017), https://doi.org/10.1016/j.ijom.2017.10.012

Epker in 1977[5]. The main advantages offered by these modifications are a greater bone contact area between the segments and easier repositioning of the condyle in the articular fossa. Another technique that is commonly used is the Le Fort I osteotomy, which in association with the BSSO can provide greater occlusal stability[6]. The main indications for orthognathic surgery are to improve function, minimize the treatment time and obtain stability after orthodontic treatment, and improve aesthetics[7].

Condylar remodelling and condylar displacement have been studied as possible side effects after orthognathic surgery[8]. Condylar remodelling is defined as an adaptive physiological process that alters the structure of the temporomandibular joint (TMJ). This irreversible process is based on an interaction between the mechanical forces sustained by the condyle and the adaptive capacities of the TMJ[9]. This effect has idiopathic causes, mainly affects women with class II malocclusions, and is either associated (or not) with open bite and a history of TMJ disorders that date back to the time before the surgical procedure[10–12]. One of the major concerns about condylar remodelling after orthognathic surgery is that it can cause the recurrence of occlusal problems. Open bite may present as one of the first signs of this recurrence[13].

With regard to the evaluation of TMJ bone structures, cone beam computed tomography (CBCT) is the examination that offers the best results in the identification of bone changes[14]. This is mainly because it is a three-dimensional (3D) examination and thus the overlapping image of structures – a problem inherent in two-dimensional (2D) examinations – is eliminated, allowing better assessment of the volume and position of the mandibular condyles.

Several studies have used computed tomography (CT) or CBCT to investigate physiological condylar head remodelling after orthognathic surgery; however, most of these have used volume superimposition methods to evaluate condylar changes[15–21]. These methods allow correct delimitation of the areas that have undergone alterations, but they do not indicate whether these alterations are due to repositioning of the condyle or to a remodelling process. The effect of orthognathic surgery on the volume of the mandibular condyles and its relationship with other parameters is still unclear. The objective of this study was to evaluate the possible changes in condylar volume and their relationships with the joint spaces of the TMJ in patients undergoing bimaxillary orthognathic surgery for the treatment of class II deformities, by means of CBCT.

Materials and methods

This retrospective study was approved by the local ethics committee. The sample was composed of CBCT volumes taken previously for the purposes of planning and follow-up of bimaxillary orthognathic surgery procedures, selected from the institutional diagnostic image database. The images were acquired with an i-CAT Next Generation scanner (Imaging Sciences International, Hatfield, PA, USA) operating with the following parameters: 120 kVp, 5 mA, 23 × 17 cm field of view, 0.4-mm voxel size, and 40 s scanning time.

Inclusion criteria were the availability of CBCT scans obtained at the initial and follow-up examinations, with the follow-up scan obtained at least 6 months after orthognathic surgery, from patients who had undergone orthognathic surgery for the correction of class II deformities. All patients underwent Le Fort I osteotomy and mandibular advancement by BSSO as defined by Trauner and Obwegeser[3] and modified by Epker[5], performed by the same team of surgeons, and using rigid fixation. The exclusion criteria were as follows: presence of syndromes or pathologies in the head and neck region, degenerative joint diseases, or malocclusion such as cross bite or anterior open bite; age younger than 18 years at the time of the surgery; or CBCT examinations of compromised technical quality.

Following the application of the inclusion and exclusion criteria, the sample was composed of 57 patients (17 male and 40 female) aged between 18 and 64 years (mean age 31.4 years). The mean interval between surgery and the follow-up CBCT examination was 18 months (range 6–48 months).

Linear and volumetric measurements were made by a single examiner with previous experience in diagnosis using CBCT images. Linear measurements were obtained using Dolphin 3D Imaging software (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA). Standardized orientation was achieved by rotating the volume to align the Frankfort plane horizontally and both transporionic and midsagittal planes vertically (Fig. 1).

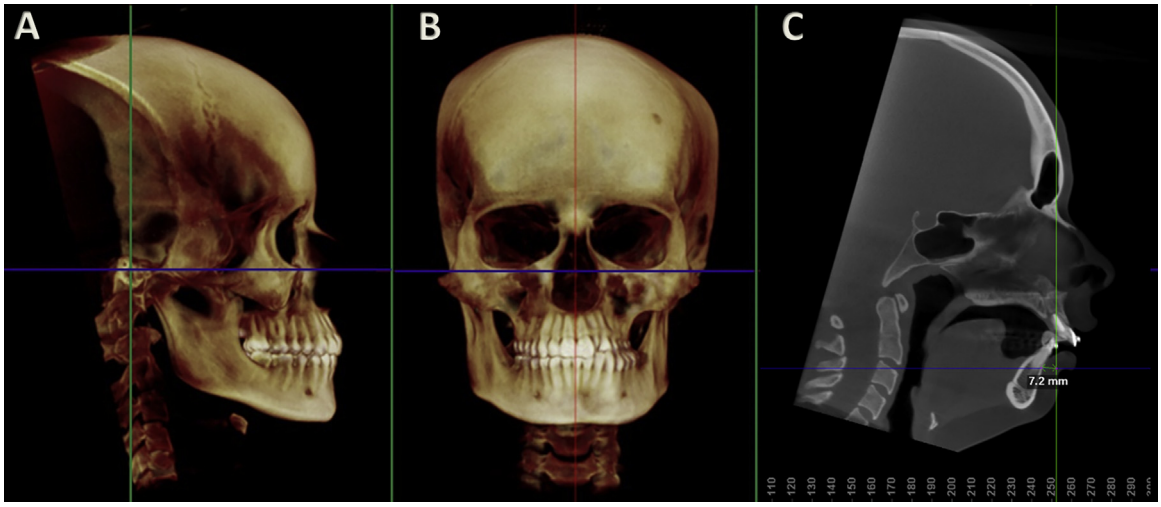

Fig. 1. Orientation of the CBCT scan before linear measurements. (A) Alignment of the Frankfort horizontal plane and transporionic vertical plane on the right view, and (B) alignment of the Frankfort horizontal plane and the midsagittal plane on the front view of the 3D reconstruction. (C) Measurement of the mandibular advancement performed in the sagittal view of the CBCT volume.

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