

Clinical Paper
Orthognathic Surgery

Do the changes in muscle mass, muscle direction, and rotations of the condyles that occur after sagittal split advancement osteotomies play a role in the aetiology of progressive condylar resorption?

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Abstract. Changes in cross-sectional area (CSA), volume (indicating muscle strength), and direction of the masseter and medial pterygoid muscles after surgical mandibular advancement were measured, along with the rotation of the condyles after bilateral sagittal split osteotomies (BSSOs) to advance the mandible. Measurements were done on magnetic resonance images obtained before and 2 years after surgery. CSA and volume were measured in five short-face and seven long-face patients (five males, seven females). Muscle direction was calculated in eight short-face and eight long-face patients (eight males, eight females). Short-face patients underwent BSSO only; long-face patients underwent combined BSSO and Le Fort I osteotomies. The CSA and volume decreased significantly (mean 18%) in all patients after surgery. The postoperative muscle direction was significantly more vertical (9°) in long-face patients. Rotations of the proximal segments (condyles) were minimal after 2 years. The results of this study showed that, after BSSO advancement surgery, changes in the masseter and medial pterygoid muscles are not likely to cause increased pressure on the condyles and nor are the minimal rotations

of the condyles. It is concluded that neither increased muscle traction nor condylar rotations can be held responsible for progressive condylar resorption after advancement BSSO.

Keywords: Bilateral sagittal split osteotomy; Condylar position; Masseter muscle; Medial pterygoid muscle; Magnetic resonance imaging; Muscle direction; Muscle size; Progressive

condylar resorption; Relapse; Surgical mandibular advancement.

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Introduction

Progressive condylar resorption (PCR) can be defined as a progressive, extreme pathological change in the structure of the condyle leading to a loss of vertical height¹ (Fig. 1). It commonly presents as a bilateral condition, but unilateral presentation does occur. There is a clear predilection for females, as is borne out in several studies.^{1–6} The condition usually occurs after bilateral sagittal split osteotomy (BSSO) to advance the mandible,^{7–12} although it may occur after conventional orthodontic treatment and can even be idiopathic, albeit rarely.^{1,13–15} The authors are not aware of any published case in which PCR has occurred after a BSSO carried out to set the mandible back.

Several theories have been put forward to explain this phenomenon. It is generally accepted, however, that systemic factors may play a role, including conditions such as rheumatoid arthritis, osteodystrophy, autoimmune disease, endocrine disorders, and nutritional and metabolic disorders.^{4,6,14,16} Since in most cases surgery has preceded the presentation of PCR, it is very tempting to blame factors associated with the surgery. One may think of vascular impairment of the condyle because of

the sagittal bone cut being not far from the condylar neck, although little evidence exists that this may be the case,^{17–20} or inflammatory disease because of increased loading of the condyle.^{3,21} This may be due to increased muscle traction or to a change in position of the condyle in relation to the disc and/or capsule. Since PCR predominantly occurs in females, it is thought that oestrogen receptors, which are present in the synovial membrane of the joint, contribute to its occurrence.^{22–24} Last but not least, several studies have shown that patients with a high mandibular plane angle (MPA) are prone to develop PCR, with patients suffering from anterior open bite being the most susceptible.^{5,10,25,26} They are particularly at risk when they have slender, backwards bending condyles.^{10,27}

Whatever the cause may be, the fact remains that a BSSO is almost always the initiating factor and, therefore, it is reasonable to assume that the change in condylar position in relation to the disc and capsule is a determining factor, as well as possible increased loading of the joint because of changed muscle traction. The increased loading and/or changed position of the condyle may cause increased pressure on the disc and/or capsule. Torque or

just a rotational movement may also contribute to this pressure and thus result in an inflammatory reaction within the joint. This may lead to adaptive remodelling or in the worst case scenario to PCR.¹⁰

The aim of this study was to investigate the changes that occur in the main jaw-closing muscles after a BSSO, both in terms of mass and direction. At the same time it was planned to monitor the long-term rotational movement of the condyles. The research hypothesis was that the change in muscle direction and possibly the increase in muscle mass would contribute to increased loading of the joint, which could also be the case because of a persisting rotation of the condyles.

Materials and methods

The patient groups included in this study have been described in two previous articles.^{28,29} In short, 12 patients (five males and seven females) were included to determine changes in cross-sectional area (CSA), and 16 patients (eight males and eight females) were included to measure directional changes in the masseter muscle and medial pterygoid muscle. The average age of the patients at the time of surgery was 27 years (range 16–45 years).

None of the patients showed marked facial asymmetry or had signs or symptoms of temporomandibular joint (TMJ) dysfunction. Of the 16 patients in whom the directional changes were measured, eight had an MPA (sella–nasion (S–N) to gonion–menton (Go–Me)) of $<39^\circ$ (group I). They were considered to be short-face patients. The other eight patients had an MPA of $\geq 39^\circ$ (group II). They were classified as long-face patients. All patients underwent orthodontic treatment before and after surgery. A BSSO with the modifications as suggested by Hunsuck and Dal Pont was carried out to advance the mandible in all patients. Fixation was done with three bicortical position screws on each side. Postoperative intermaxillary fixation was not used at all. All patients were allowed to open and close the jaw immediately after surgery. In group II patients, a Le Fort osteotomy with posterior intrusion was carried out in order to avoid counter-clockwise rotation of the

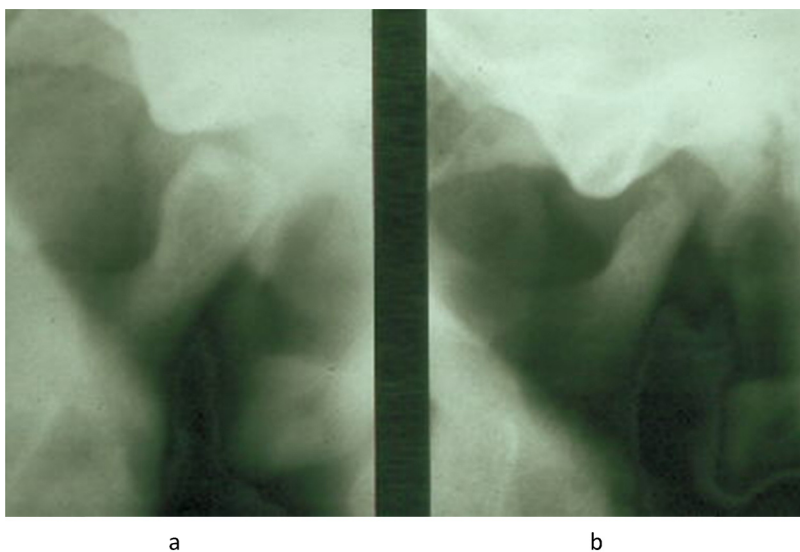


Fig. 1. Example of progressive condylar resorption in a patient who underwent an advancement BSSO: (a) before, and (b) 1 year after surgery. Note the loss of integrity of the cortical bone postoperatively.

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