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Systematic Review
Orthognathic Surgery

Effects of mandibular advancement surgery on the temporomandibular joint and muscular and articular adaptive changes—a systematic review

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Abstract. The objective of this study was to assess the anatomical changes to the condyle and articular disc following mandibular advancement surgery, the adaptation of the masticatory muscles, and the improvement or worsening of temporomandibular disorders (TMD) in patients with pre-existing disorders and those who developed them following surgery. Four databases were searched systematically: PubMed, Scopus, Embase, and Cochrane Library. Of the 544 articles initially selected, 219 were duplicates and a further 165 were excluded on the basis of their titles and abstracts. On reading the full text, 89 were excluded because they were of no interest and 43 because they did not meet the inclusion criteria. Of the remaining 28 articles, six were excluded because they were considered of low quality and 22 articles were reviewed. Mandibular advancement surgery with condyle repositioning is associated with less TMD. Condylar resorption is a physiological process with a multifactorial aetiology. It is accelerated following mandibular advancement surgery but is not a contraindication to this procedure. Despite the large number of studies on the effects of mandibular advancement surgery on the temporomandibular joint (TMJ), this surgery can neither be said to improve nor to worsen TMJ health.

Key words: BSSO; orthognathic surgery; mandibular advancement surgery; temporomandibular joint disorders; mandibular osteotomy.

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Temporomandibular joint (TMJ) health is of prime importance for stable results in orthognathic surgery. If the TMJ is not in good condition, the outcome of the surgical procedure could be unsatisfactory in terms of function, aesthetics, stability, and pain.[1] Consequently, any type of pain and/or dysfunction in the head, neck, or TMJ must be assessed before performing orthognathic surgery. The most frequent temporomandibular disorders (TMDs) are disc displacements, with or without

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reduction. They affect young adult women to a greater extent,[2] and often occur in patients with mandibular retrognathia.[3] The bilateral sagittal split osteotomy (BSSO) is the surgical procedure of choice to correct the most complex cases.[3] Mandibular advancement surgery not only improves aesthetics and function, but also brings an improvement in the airways.[4,5]

Orthognathic surgery to advance the mandible entails adaptive muscular changes, but the results are not always stable.[6] Degenerative changes in the condyle play an important part in relapses, but the biomechanical changes that influence the length of the oral muscles following mandibular advancement are also a significant factor.[7,8]

Some authors consider that changes in condyle position during surgery can increase the risk of an early relapse and encourage the development of TMDs or worsen existing ones.[6,9] Opinions differ on whether repositioning the condyle prior to surgery occasions greater or lesser relapses and/or recovery times.[1,9,10]

The greater prevalence of TMD following orthodontic and surgical treatment of retrognathic patients continues to be a subject of debate.[1,11,12] Some have stated that patients present early discomfort following surgery but adapt within a period of between 6 months and 2 years,[13] and that this adaptation is greater or lesser depending on the advancement attained during surgery.[2] In contrast, others consider that the symptoms worsen,[3] so there is a clear division of opinions, making it difficult to draw reliable conclusions.[12,14–17]

The objective of this systematic review was to evaluate muscular and articular adaptive changes following orthognathic mandibular advancement surgery and assess the prevalence of TMD signs and symptoms before and after this surgical procedure. A further aim was to evaluate the anatomical changes in the condyle and the adaptation of the masticatory muscles following surgery.

Materials and methods

A systematic review of the literature was carried out in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations[18] and CONSORT criteria.[19]

Study selection criteria

The selection criteria for the articles to be included in the review encompassed articles, articles in press, and reviews of studies conducted in adults. Only the following types of study were accepted: systematic reviews and meta-analyses, randomized controlled trials (RCTs), and cohort studies and case–control studies, both prospective and retrospective. All those that investigated adaptation and muscular and anatomical changes in the TMJ following mandibular advancement surgery were accepted. Several articles comparing the effects of different surgical advancement techniques on the TMJ were also included.

Search strategy and screening of articles

To identify the relevant studies, irrespective of language, a detailed electronic search was carried out in the PubMed, Scopus, Embase, and Cochrane Library databases. All studies published between 2002 and 2014 were included. The search was updated on 1 December 2014.

The data search included a combination of nine primary terms concerning mandibular advancement surgery: ''orthognathic surgery'', ''maxillofacial surgery'', ''jaw surgery'', ''mandibular advancement surgery'', ''mandibular advancement'', ''mandibular retrognathism'', ''BSSO'', ''bilateral sagittal split osteotomies'', and ''malocclusion, Angle class II''. A further six secondary terms referring to the TMJ and articular and muscular problems were also included: ''temporomandibular disorders'', ''TMD'', ''temporomandibular effect'', ''temporomandibular joint'', ''TMJ'', and ''muscular changes''. All the possible combinations between these words were explored.

Two reviewers independently assessed the titles and abstracts of all the articles. In the event of disagreement, discussions were held until consensus was reached; however, if the reviewers continued to disagree, a third reviewer was consulted. If the abstract did not provide sufficient information for a definite decision on inclusion or exclusion, the full article was obtained and reviewed before the final decision was made.

Data extraction

The variables selected for comparison between the studies were the following: demographic variables (sex and age), sample size, type of study, follow-up time, diagnostic method, and conclusions (Table 1). Lastly, the articles were classified as being of high, medium, or low quality according to the CONSORT criteria,[19] as adapted by Mattos et al.[20]

Results

The first stage of the search identified 219 articles in PubMed, 203 in Scopus, 110 in Embase, and 12 in Cochrane Library Plus, making a total of 544 articles. Of these, 219 were duplicates and were excluded. On critical reading of the title and abstract, 165 articles were excluded because they did not answer the research question, leaving a total of 160 articles. On reading the full text of these articles, 89 were excluded because they were of no interest and 43 because they did not meet the inclusion criteria. Of the remaining 28 articles, six were excluded because they were considered of low quality (Fig. 1).

Of the resulting 22 articles, four were systematic reviews (Table 2) and 18 were studies: five prospective and 13 retrospective (Table 1). As regards the quality of the studies, seven were of high quality and 11 of medium quality. The 18 studies included five case–control studies. As regards the diagnostic methods, pre- and postoperative clinical examinations were performed in all studies. Radiographic methods were employed in 14 studies: seven used lateral teleradiology of the cranium, three used cone beam computed tomography (CBCT), three used computed tomography (CT), and three used magnetic resonance imaging (MRI). One study used three-dimensional (3D) photography as a complementary diagnostic method. Di Palma et al. used electromyography, and Van den Braber et al. studied masticatory performance. As regards the objectives of the studies, 13 analysed TMD and oral function following surgery, two investigated the effect of advancement surgery on muscle length, one focused on muscle activity after surgery, and five studied the stability of mandibular advancement surgery. Table 3 shows the distribution of the studies by their main observations.

Discussion

Articular changes

Several authors observed that the position and morphology of the disc are closely related to the stress suffered by the joint.[9]

As regards the condyle–disc relationship, Saka et al.[10] and Gonçalves et al.[1] found that patients with preoperative displacement of the disc who underwent mandibular advancement surgery without previous repositioning of the joint could experience a greater relapse and take significantly longer to recover than those with a repositioned TMJ, in agreement with Ueki et al.[9] In relation to disc position, Ueki et al. indicated that fixing the