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Relation between soft tissue and skeletal changes after mandibular setback surgery: A systematic review and meta-analysis

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ABSTRACT

Accurate prediction of hard and soft tissue changes is essential in orthognathic surgery. The aim of the present study was to systematically investigate the relation between soft and hard tissue relocation after mandibular setback surgery. A systematic search was performed, correlation coefficients and ratios were retrieved from the eligible studies, and the risk of bias was assessed. The random effects method was used to combine data. The five eligible studies showed that sagittal changes in pogonion, point B, and incision inferius incisalis are highly correlated with respective soft tissue movements and exhibit ratios ranging from 0.915 to 1.051. Only two studies were classified as having a moderate risk of bias. Although the characteristics of the included data limit the formation of definite conclusions, the soft to hard tissue movement ratios produced constitute initial clinically relevant guidance. Further long-term standardized and well-conducted trials are needed.

1. Introduction

Facial esthetic problems associated with severe mandibular prognathism often affect the social and psychological status of the individual, causing social handicap and psychological disorders (Nurminen et al., 1999). As management of such patients often requires combined surgical and orthodontic approach to achieve optimal functional and esthetic results, it is of paramount importance for the clinician to be able to predict the final soft tissue profile (Nurminen et al., 1999, Eckhardt and Cunningham, 2004). Consequently, the accurate prediction of the hard and soft tissue changes constitutes an essential part of diagnosis and treatment planning in orthognathic surgery cases, in order to assess treatment feasibility, optimize case management, and most importantly enhance patient understanding and increase acceptance of the recommended approach (Miguel et al., 2014).

Cephalometric prediction in orthognathic surgery can be performed manually or by computer, using several currently available software programs, alone or in combination with video images. Moreover, three-dimensional prediction methods are also available (Kolokitha and Topouzelis, 2011). Manual prediction is based on presumed changes (Wolford et al., 1985, Proffit et al., 2003), whereas computer programs rely on databases derived from studies with reported mean ratios of soft to hard tissue movements that give an idea of how much a certain soft tissue landmark will move in relation to the respective movement of a hard tissue landmark (Kolokitha and Chatzistavrou, 2012). Consequently, the accuracy of the simulation relies on the validity and precision of the ratios in the individual databases (Eckhardt and Cunningham, 2004, Chew et al., 2008).

Furthermore, the manual and most of the computer methods usually presuppose that soft tissue response is linear regardless the amount and direction of skeletal repositioning (Wolford et al., 1985, Proffit et al., 2003, Smith et al., 2004). Not only the validity of this assumption has been questioned (Chew et al., 2008), but also, little consistency has been seen across studies on specific ratios' values. For example, regarding pogonion soft tissue to pogonion reported ratios after solely mandibular setback surgery exhibit a range from 59% (Enacar et al., 1999) to 104% (Mobarak et al., 2001). In addition, relevant observations have not been summarized quantitatively; thus their usefulness for clinical practice remains uncertain.

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Orthognathic treatment of Class III problems may involve isolated or combined maxillary and mandibular procedures and/or genioplasty (Kobayashi et al., 1990; Landes et al., 2002, de Lir Ade et al., 2013, Park et al., 2013). The aim of this study is to systematically investigate the available literature regarding the relation between soft and hard tissue changes after mandibular setback surgery that could be used as an aid in cephalometric prediction.

2. Material and methods

The present review was conducted according to the guidelines outlined in the PRISMA statement (Moher et al., 2009) and the Cochrane Handbook for Systematic Reviews of Interventions (version 5.1.0) (Higgins and Green, 2011).

2.1. Selection criteria applied for the review

Studies eligible for consideration in the present review would be clinical trials investigating the relation between soft tissue and osseous changes in patients with Class III deformity treated with mandibular setback surgery only, and fulfilling certain criteria regarding participants' characteristics, intervention characteristics, and outcome measures.

- Types of participants: No restrictions were placed on the ethnic origin or age of the patients. Studies involving patients with craniofacial syndromes or compromised medical history were excluded.
- Types of intervention: Studies involving any kind of mandibular setback surgery were included. Studies involving a combination of mandibular setback surgery with other kinds of interventions, such as maxillary surgery or genioplasty, were excluded. Studies not involving presurgical orthodontics were excluded, as it has been shown that it affects the outcome of orthognathic surgery procedures (Fish and Epker, 1986).
- Outcome measures: Outcome measures were correlation coefficients and/or ratios (together with the respective standard deviations or other measures used to quantify the amount of dispersion of a set of data values) between soft tissue changes and osseous surgical relocation, measured from conventional cephalometric points (Viteporn and Athanasiou, 1995) at pre- and postsurgery cephalograms. The mean follow-up of the sample should be at the earliest 12 months postoperatively or at least 11.5 months for each individual patient (demonstrated by the relevant descriptive statistics), as research data has suggested that a significant decrease in soft tissue swelling still occurs between 6 and 12 months after surgery (Van der Vlis et al., 2014) and that mandibular setback surgery patients experience minimal soft tissue changes after the first year (Bailey et al., 1996, 2007), contrary to earlier time periods (Proffit et al., 1996, Bailey et al., 2004).

From the present review, case reports, case series, opinion articles, reviews, systematic reviews and meta-analyses were excluded.

2.2. Search strategy for identification of studies

For the identification of studies to be considered for this review, detailed search strategies were developed for each database searched (up to December 31, 2014). They were based on the search strategy developed for MEDLINE but revised appropriately for each database to take account of differences in controlled vocabulary and syntax rules. The following electronic databases were searched: MEDLINE (via PubMed), Scopus, ISI Web of Science, the Cochrane Library, and LILACS. Unpublished literature was searched on ClinicalTrials.gov and Pro-Quest Dissertation Abstracts and Theses database (specific strategy together with hits per database presented in the Appendix A).

The search attempted to identify all relevant studies irrespective of language and date of publication, as well as publication status. The reference lists of all eligible studies were hand searched for additional studies. In case of additional information needed, the authors were contacted.

2.3. Selection of studies and data extraction

Assessment of the retrieved records for inclusion, against the predefined criteria, was performed independently and in duplicate by the reviewers. The full report of publications considered by either reviewer to meet the inclusion criteria was obtained and assessed independently. Disagreements were resolved by discussion. A record of all decisions on study identification was kept.

The authors performed data extraction, using specially designed and pretested forms, independently and in duplicate, and any disagreements were again resolved by discussion. Data collection forms were used to record the desired information, such as bibliographic details, details on study design, verification of study eligibility, participants' characteristics and the trials, inclusion and exclusion criteria, interventions' characteristics, outcomes assessed, and details on assessment procedures. Where possible the terms used for each cephalometric point were changed to follow the Viteporn and Athanasiou (1995) terminology. For ratios between soft tissue changes and osseous surgical relocation, the mean values together with the respective standard deviations or other measures used to quantify the amount of dispersion of a set of data values were extracted, to enable a meta-analysis to be performed. If clarifications of the published data or additional material was needed, then the corresponding authors were to be contacted.

The retrieved data were divided in two categories: (1) correlation coefficients and (2) ratios between soft and hard tissue changes.

2.4. Data synthesis and assessment of publication bias

The random effects method for meta-analysis was used to combine correlation coefficients and ratios across studies (Der Simonian and Laird, 1986, Borenstein et al., 2007), since they were expected to differ across studies due to clinical diversity, in terms of participant (i.e., race/ethnicity, gender, lip morphology, etc.) and intervention characteristics (i.e., type of surgery and fixation, etc.). The summary correlation coefficients were interpreted as very high positive (or negative) correlation (±0.90 to ±1.00), high positive (or negative) correlation (±0.70 to ±0.90), moderate positive (or negative) correlation (±0.50 to ±0.70), low positive (or negative) correlation (±0.30 to ±0.50) and negligible correlation (±0.30 to 0.00) (Hinkle et al., 2003).

To identify the presence and extent of between-study heterogeneity, the overlap of the 95% CI for the results of individual studies was inspected graphically, and Cochrane's test for homogeneity and the I^2 statistic were calculated (Higgins and Green, 2011). If deemed possible, exploratory subgroup analyses were planned according to participant and intervention characteristics. In addition, if a sufficient number of trials were identified, analyses were planned for “small-study effects” and publication bias (Higgins and Green, 2011).

All analyses were done with Comprehensive Meta-analysis software 2.2.046 (©2007 Biostat Inc.). Significance (α) was set at 0.05, except for 0.10 used for the heterogeneity tests (Ioannidis, 2008).