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Effects of maxillomandibular advancement on the upper airway and surrounding structures in patients with obstructive sleep apnoea: a systematic review

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Abstract

Obstructive sleep apnoea is ideally treated by continuous positive airway pressure, but other options are needed because its clinical effectiveness is limited by poor acceptance and tolerance, which results in suboptimal compliance. Patients often prefer operation, with maxillomandibular advancement (MMA) being the most effective approach. In this systematic review we have assessed its effects on the upper airway and surrounding structures in patients with obstructive sleep apnoea. After a structured search of electronic databases and hand searching, we retrieved 104 publications. After application of inclusion and exclusion criteria, 15 studies remained. From these we extracted data on study design, sample size, patients, methods and measurement, and outcomes. The quality of each study was assessed objectively. The heterogeneity of samples and outcome measures prevented a meta-analysis. MMA was shown to be an effective treatment of sleep apnoea. Primary and secondary MMA resulted in mean reductions in the apnoea–hypopnoea index/respiratory disturbance index of 61–92% and 82–92%, respectively. The operation not only enlarges the upper airway in the anteroposterior and lateral dimensions, but also raises the hyoid. Only 7 studies reported the relations between improvement in sleep apnoea and changes in the upper airway and surrounding structures, and only one correlated it with skeletal advancement. The studies were of low or medium quality. There were insufficient data to support a relation between improvement in sleep apnoea and changes in the upper airway and surrounding structures because of the contradictory results and poor quality of most studies.

Keywords: Maxillomandibular advancement; Obstructive sleep apnoea; Upper airway

Introduction

Obstructive sleep apnoea is a common sleep-related breathing disorder of major public health importance. However, treatment remains challenging.[1] The current gold standard, particularly for moderate to severe cases, is continuous positive airway pressure, but it is often suboptimal because patients dislike it so do not tolerate it.[2,3] They often consider operation to be a more acceptable alternative.Interventions for obstructive sleep apnoea have all been designed to increase the patency of the upper airway at a specific point. Although many techniques have been reported,[4] maxillomandibular advancement (MMA) is the most effective, as it excludes tracheostomy and is successful in 65–100% of cases.[5–11]

MMA traditionally consists of bilateral sagittal split osteotomies of the mandible, and a Le Fort I osteotomy of the

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maxilla. It advances the maxilla and mandible, with the aim of increasing the calibre of the upper airway, thereby preventing its collapse during sleep. Although the technique reduces the severity of the apnoea, it does not necessarily resolve it completely, and its impact varies substantially among patients. The outcome may therefore be more closely linked to factors other than increasing the calibre of the upper airway. MMA does increase the calibre.[5,8,10,12–23] However, its effect on the surrounding structures (such as the facial skeleton, soft palate, tongue, and hyoid), the interaction between the upper airway and the surrounding structures, and the response to treatment, have so far been given little attention.

To evaluate the effects of MMA on the upper airway and surrounding structures we conducted a systematic review the purpose of which was to answer the following questions: What extent of facial skeletal advancement followed MMA? What was the effect of MMA on the upper airway and surrounding structures? What was the extent of improvement of obstructive sleep apnoea after MMA? Was there any relation between improvement in sleep apnoea and changes in the upper airway and surrounding structures? We also analysed the studies reviewed for the adequacy of their design, conduct, and interpretation.

Methods

Search strategy

We used the following criteria to identify all studies that described changes in the upper airway and surrounding structures (maxilla, mandible, soft palate, tongue, and hyoid) and improvement in obstructive sleep apnoea after MMA: we searched PubMed from January 1966 to December 2011 using the medical subject headings "maxillomandibular advancement", "jaw surgery", "obstructive sleep apnoea" and "sleep apnoea", and we searched the reference lists of all relevant publications to identify articles not already found.

Selection criteria

Studies were selected if they were published as full-length articles that reported quantitative data about changes in the upper airway, facial skeleton, or surrounding structures as well as improvement in obstructive sleep apnoea after MMA. Studies were excluded if they were case reports (sample size < 10), abstracts, letters, reviews, and not written in English. Two independent reviewers assessed all articles for the inclusion and exclusion criteria. Inter-examiner conflicts were resolved by discussing each article to reach consensus.

Data collection and analysis

The following data were abstracted: year of publication, study design, sample size, patients, their ages, methods, measurements, and outcomes. The soundness of the method used in each investigation was evaluated using a modified checklist,[24,25] which included 9 characteristics: study design, sample size, method of selection, consecutive recruitment, valid methods, consideration of confounding factors, analysis of errors in methods, "blinding" in measurements, and adequate statistical analysis. The quality of each article was categorised as low (≤3 characteristics fulfilled), medium (4–7 characteristics fulfilled), or high (8 or 9 characteristics fulfilled). The data were extracted from each article by 2 independent evaluators who were aware of the purpose of the investigation. Interexaminer conflicts were resolved by discussing each article to reach consensus.

Results

The search identified 104 papers, all of which were analysed according to the selection criteria, and 15 of which[5,8,10,12–23] qualified for review. The 15 studies are summarised in the Appendix (online only). All studies were case series; 13 were retrospective, and 2[17,22] were prospective. Six studies[12–17] were conducted by the Stanford group, and

Table 1
Mean skeletal movement after MMA in reviewed studies.

First author and reference number	Mean (SD) skeletal movement[a]	
	Maxilla	Mandible
Waite[5]	7.3 (2.6) mm advancement (6.9 mm in success group; 7.9 mm in failure group)	12.4 (3.5) mm advancement (12.9 mm in success group; 11.4 mm in failure group)
Riley[12]	↑ 4.5 (2.1) in SNA	↑ 5.6 (2.1) in SNB
Riley[13]	↑ 3.5 in SNA	↑ 4.5 in SNB (11.9 mm in advancement)
Hochban[8]	↑ 5.6 in SNA	↑ 5.5 in SNB
Prinsell[10]	↑ 7.4 in SNA	↑ 6.9 in SNB
Li[14]	↑ 7.5 (2.9) in SNA	↑ 6.5 (2.1) in SNB
Li[15]	↑ 8.2 (3.4) in SNA	↑ 6.3 (3.2) in SNB
Li[16]	↑ 7.6 in SNA	↑ 6.4 in SNB
Li[17]	↑ 8.0 in SNA	↑ 6.2 in SNB
Ronchi[19]	↑ 6.5 (3.6) in SNA	↑ 6.3 (2.8) in SNB
Abramson[20]	9.2 (2.7) mm advancement	10.1 (2.7) mm advancement
Lin[22]	↑ 2.9 (3.5) in SNA 4.2 (3.0) mm advancement at Point A 5.8 (3.6) mm advancment at PNS	↑ 7.2 (1.8) in SNB 12.6 (3.1) mm advancement at Point B 19.3 (4.4) mm advancment at Pog
Susarla[23]	9.8 (2.0) mm advancement	10.8 (2.2) mm advancement
Brevi[21]	↑ 5.7 (2.4) in SNA	↑ 5.9 (2.4) in SNB

[a] Units in (°) unless otherwise noted, MMA: maxillomandibular advancement; OSA: obstructive sleep apnoea, PNS: posterior nasal spine, Pog: pogonion, SNA: sella-nasion-A point angle, SNB: sella-nasion-B point angle, and ↑ increase.