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Systematic Review
Orthognathic Surgery

Mandible-first sequence in bimaxillary orthognathic surgery: a systematic review

A. M. Borba[1,2,3], A. H. Borges[1], P. S. Cé[1], B. A. Venturi[4], M. G. Naclério-Homem[2], M. Miloro[3]

[1]Master of Science Program on Integrated Dental Sciences, Faculty of Dentistry of the University of Cuiabá – UNIC, Cuiabá, Brazil; [2]Department of Oral and Maxillofacial Surgery, Traumatology and Prosthesis, Faculty of Dentistry of the University of São Paulo – USP, São Paulo, Brazil; [3]Department of Oral and Maxillofacial Surgery, University of Illinois at Chicago, Chicago, IL, USA; [4]Master of Science Program on Orthodontics, São Leopoldo Mandic Research Center, Campinas, Brazil

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Abstract. The sequencing of bimaxillary orthognathic surgery remains controversial, although the traditional maxilla-first approach is performed routinely. The goal of this study was to present a systematic review of the mandible-first sequence in bimaxillary orthognathic surgery, to provide data that may assist in the decision as to which jaw should undergo osteotomy first in bimaxillary orthognathic surgery cases. A literature search was conducted for articles published in the English language, reporting the use of the altered sequence for bimaxillary orthognathic surgery (mandible-first), using the following descriptors: 'orthognathic' and 'double-jaw', 'orthognathic' and 'two-jaw', 'orthognathic' and 'mandible-first', 'orthognathic' and 'bimaxillary'. Eight hundred eighty-seven abstracts were initially identified and were evaluated for inclusion according to the proposed inclusion criteria. After evaluation of these abstracts and relevant references, six publications met the criteria for consideration. Performing mandible-first surgery in bimaxillary orthognathic cases dates back to the 1970s; however the decision regarding the jaw to be operated on first seems to rely on accurate preoperative planning based upon the surgeon's experience and preference. While there appear to be significant theoretical advantages to support the use of the altered orthognathic sequence (mandible-first), future prospective studies on its reliability, accuracy, and short- and long-term outcomes are required.

Key words: orthognathic surgery; bimaxillary; double-jaw; two-jaw; altered sequence.

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Dentofacial deformities are defined as skeletal abnormalities affecting the maxilla, mandible, or both jaws. The teeth located in the alveolar process of the affected bone(s) will frequently present with malocclusion, crowding, dental compensations, rotations, and misalignments. Orthodontic treatment may be sufficient to manage mild dentoskeletal discrepancies, but as the magnitude and severity of the discrepancy increases, treatment with combined orthodontics and orthognathic surgery will be required.

Orthognathic surgery may be performed as a single-jaw procedure in which only the maxilla or the mandible is operated on, but when the diagnostic records and presurgical planning indicate that both jaws need to be osteotomized, bimaxillary (or double-jaw) orthognathic surgery must be planned. The sequencing of bimaxillary orthognathic surgery has been the subject of debate for decades.[1–4] Recently, several articles have addressed aspects related to

the sequence in bimaxillary surgery, comparing the 'traditional' maxilla-first to the 'altered' mandible-first sequence, and have highlighted the debate regarding whether the sequencing choice in bimaxillary surgery might influence post-surgical outcomes.[2,3,5]

The aim of the present systematic review was to examine the existing literature regarding the development of and scientific evidence related to the mandible-first sequence in bimaxillary orthognathic surgery, in order to provide data that may assist surgeons in determining the jaw that should be operated on first in bimaxillary orthognathic cases.

Materials and methods

A systematic review was conducted, based on the PRISMA guidelines (http://www.prisma-statement.org). The PubMed, Cochrane Library, and Scopus databases were searched for publications in the English language, without any restriction on the type of study (all searched up to 3 June 2015). The search strategy was defined by the following terms: 'orthognathic' and 'double-jaw', 'orthognathic' and 'two-jaw', 'orthognathic' and 'mandible-first', 'orthognathic' and 'bimaxillary'.

Inclusion criteria encompassed any mention of the mandible-first sequence within the abstract of any article generated by the search, without any restriction on the type of study. The exclusion criterion was the absence of any reference to the mandible-first sequence within the abstract.

The systematic search was conducted by one author (A.M.B.), and two authors (A.M.B., P.S.C.) independently performed the screening of titles and abstracts. Once an article abstract was selected according to the eligibility criteria (inclusion and exclusion), the full-text article was read, including the references. Any reference that could contribute to the purpose of the systematic review was retrieved. The two authors then presented their list of eligible studies and any difference was discussed until consensus was reached.

Results

With the application of the search criteria, the initial search identified a total of 887 abstracts from the different databases (Fig. 1). After reading the full-text versions of the corresponding articles and relevant references, six articles were selected (Table 1). The contents of these six articles addressed the topic of mandible-first bimaxillary orthognathic surgery.

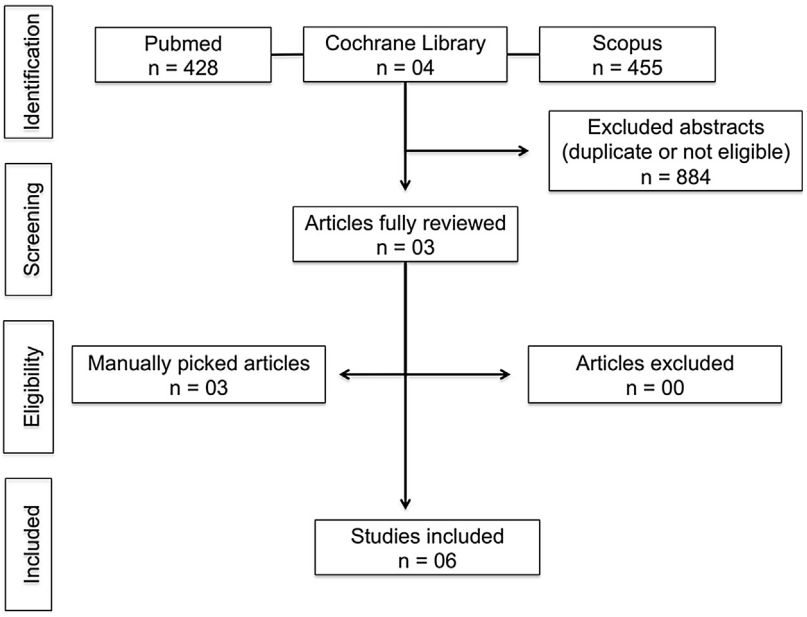

Fig. 1. Flow diagram (PRISMA format) of the screening and selection process.

The 884 articles excluded following the review of abstracts were either duplicates or did not mention the mandible-first sequence.

The first mention of the altered sequence for bimaxillary orthognathic surgery was provided by Lindorf and Steinhäuser in 1978.[6] They stated that bimaxillary orthognathic surgery should start with the mandible, since a stable reference (the maxilla) is needed to accurately reproduce the surgical movements predicted during model surgery to correspond to the actual surgery. The authors performed model surgery starting with the maxilla, then assembling the mandible in the desired final position for the construction of the final inter-occlusal splint; later, the maxilla was returned to its original position, and an intermediate splint fabricated.

In the 1980s, Buckley et al. highlighted the disadvantages of starting bimaxillary orthognathic surgery with the maxilla, due to the instability of an already operated maxilla that could be displaced during mandibular manipulation and fixation.[7] With two maxillary cast models and one mandibular cast model mounted on a semi-adjustable articulator, the authors also proposed model surgery to begin with the maxilla, since surgery itself would start with the mandible having the uncut maxilla as a stable reference for the operated mandible. The need for rigid fixation instead of wire osteosynthesis for this technique was emphasized.

In the following decade, Cottrell and Wolford published their experience of commencing bimaxillary orthognathic surgery with the mandible first.[1] The authors proposed model surgery to start with the mandible based upon the prediction of its position on the final occlusion, thus eliminating errors related to achieving centric relation for model surgery. Moreover, they suggested that even in segmental maxillary surgery, the use of a final splint would be an option; however, their preference was for direct dental interdigitation to achieve the final planned occlusion, in order to eliminate interferences from the splint. It was suggested that these modifications would reduce the time and materials required for this planning step and also result in improved accuracy. Surgery was started with the mandible as long as rigid fixation was used, and

Table 1. Selected publications on the mandible-first orthognathic sequence.

Year	Authors, Ref.	Source	Type of study
1978	Lindorf and Steinhäuser[6]	Manual search	Case report
1987	Buckley et al.[7]	Manual search	Case report
1994	Cottrell and Wolford[1]	Manual search	Case report
2006	Posnick et al.[4]	PubMed, Scopus	Case report
2011	Perez and Ellis[2]	PubMed, Scopus	Case report
2014	Ritto et al.[5]	PubMed, Scopus	Research article