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Systematic Review Paper
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Complications of mandibular distraction osteogenesis for developmental deformities: a systematic review of the literature

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Abstract. A systematic review of English and non-English articles on the complications of mandibular distraction osteogenesis (MDO) for patients with developmental deformities was performed, in accordance with the PRISMA statement. Search terms expressing distraction osteogenesis were used in 'AND' combination with search terms comprising 'mandible' and terms for complication, failure, and morbidity. A search using PubMed (National Library of Medicine, NCBI), EMBASE, and Cochrane Controlled Trials Register yielded 644 articles published between 1966 and mid October 2013. Clinical articles that reported complications related to MDO in developmental deformities were included. Two hundred and fifty articles were eligible and were screened in detail. A total of 32 articles reporting the cases of 565 patients were finally included. Patients underwent mandibular lengthening and transverse widening. A total of 211 complications were reported (37.4%); these were classified according to an index that indicates the clinical impact. Inferior alveolar nerve (IAN) neurosensory disturbances, minor infection, device failure, anterior open bite, permanent dental damage, and skeletal relapse were most represented. Complications that resolved spontaneously (type I) were seen in 11.0%, medically or technically manageable complications, without hospitalization, were seen in 10.8% (type II), and permanent complications (type VI) were seen in 9.6%.

Keywords: distraction; distraction osteogenesis; lengthening; complication; complicated; failure; morbidity; mandible; mandibular hypoplasia; retrognathia; orthognathic surgery; systematic review.

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More than two decades after its introduction by McCarthy et al.,[1] mandibular distraction osteogenesis (MDO) has become an established technique alongside orthognathic surgery for the correction of non-syndromic mandibular hypoplasia. Corpus lengthening using MDO transcends the believed limitations of 10 mm lengthening of the bilateral sagittal split osteotomy.[2]

Clinical experience and improvements in the technique have led to an evolution in surgical planning and devices. A spectrum of external, unidirectional, and semi-buried/hybrid devices, progressing to miniaturized internal, multidirectional, and custom-made devices has been employed. Multidirectional MDO requires more detailed presurgical planning directed at the individual anatomical needs.[3] The increased use of this technique and development of devices has given rise to a wide variety of complications.[2,4,5] Several reviews on clinical parameters (including complications) in MDO for varying indications have been published.[4–6] At the same time, several different systematic reviews on the clinical application of craniomaxillofacial DO[5–7] have been published. Nevertheless, evidence-based reports on the long-term results, relapse, and complications of MDO are limited.

The aims of this study were (1) to perform a systematic review of the literature on complications of MDO for developmental deformities, in accordance with the PRISMA statement, and (2) to classify all complications using a recently devised classification.[8]

Materials and methods

Literature search

A comprehensive systematic review of the literature was performed in the bibliographic databases PubMed (National Library of Medicine, NCBI), EMBASE, and the Cochrane Central Register of Controlled Trials from inception to 15 October 2013; the review was performed in accordance with the PRISMA statement.[9] Search terms included controlled terms from medical subject headings (MeSH) in PubMed and Emtree in EMBASE, as well as free text terms. We used free text terms only in The Cochrane Library. Search terms expressing distraction osteogenesis were used in 'AND' combination with search terms comprising 'mandible' and terms for complication, failure, and morbidity. The references of the articles identified were searched for additional relevant publications.

Table 1. Inclusion and exclusion criteria.

Condition	Article types	Number of papers (*n*)
Excluded from the systematic review	Non-developmental deformities	185
	Insufficient or no information on complications and/or methods	20
	Non-clinical articles (experimental, scientific, synopsis)	9
	No translation available	3
	Publication type, e.g. discussion	1
Included in the systematic review	Clinical articles on complications in mandibular distraction osteogenesis for developmental deformities	32

Study selection and inclusion criteria

Two reviewers independently screened all potentially relevant titles and abstracts for pre-specified eligibility criteria.[9] If necessary, the full text article was checked for the eligibility criteria. Differences in judgement were resolved through a consensus procedure. Full text articles were then obtained for further review.[9]

Articles were included if the following eligibility criteria were met: (1) clinical article, (2) mandibular distraction osteogenesis (MDO), (3) developmental deformities, and (4) a report on complications. Studies were excluded if data on complications were insufficient, no translation was available, or the publication was a non-clinical article (Table 1).

The remaining clinically relevant articles were included in this systematic review. According to their emphasis, these relevant papers were included if they described MDO in developmental deformities. The articles were screened for the following data: type of deformity, number of patients, type of DO, distraction device, vector, and type and number of complications. The latter were classified according to the proposed classification index shown in Fig. 1.

The initial literature search yielded a total of 973 references: 521 in PubMed, 437 in EMBASE, and 15 in The Cochrane Library. After removing duplicate references ($n = 329$) that were selected from more than one database, 644 papers remained. Titles and abstracts were screened according to the eligibility criteria; 394 articles were excluded from the review based on the abstract. The full text was obtained for 250 papers and analyzed thoroughly. The following groups were identified (Table 1): (1) 185 articles reported non-developmental mandibular deformities, (2) 20 articles contained insufficient or no information on complications and/or methods; (3) nine papers were non-clinical (seven scientific, one cephalometric, one synopsis); (4) three papers had no available translation (two Chinese, one Hungarian); (5) one article had an edited publication type (discussion). These five groups were excluded from further evaluation. In the case of a paper that reported on complications in a mixed population in which the complications could not be traced back to the exact patient subgroup, the article was excluded on the basis of insufficient data. A total of 32 articles on MDO for developmental deformities met the inclusion criteria.

Type 1	Spontaneously resolving complication (within 6 months after the retention period)
Type 2	Medically or technically manageable complication, without hospitalization
Type 3	Surgically manageable complication requiring local anaesthesia only, without hospitalization
Type 4	Technical complication, necessitating general anaesthesia for correction
Type 5	Medically or surgically manageable complication with hospitalization or general anaesthesia
Type 6	Permanent sequelae, functionally and/or psychosocially disabling, and unachieved goal or unsatisfactory result

Fig. 1. Distraction osteogenesis complication classification.[8]