

# Does the Rate of Distraction or Type of Distractor Affect the Outcome of Mandibular Distraction in Children With Micrognathia?



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**Purpose:** A variety of surgical protocols are available in the literature for performing mandibular distraction. This study aims to determine the ideal rate of distraction and compare outcomes between internal and external distractors in children and infants with upper airway obstruction due to micrognathia.

**Patients and Methods:** A systematic review was performed. The databases searched included PubMed, Embase, Scopus, Web of Knowledge, and gray-literature sources. The intervention was bilateral mandibular distraction for upper airway obstruction in children with clinical evidence of micrognathia or Pierre Robin sequence. The variables for comparison included distraction rates of 1 mm/d and 2 mm/d and external versus internal distractors. The outcome was successful completion of distraction. Complications also were recorded and compared. The data were analyzed by cross tabulation to calculate odds ratios.

**Results:** Overall, 43 studies were included in the surgical outcomes analysis. The overall success rate of distraction was 95.4%. There was no statistically significant difference in success rate with distraction at 1 mm/d or 2 mm/d ( $P = .18$ ). Distraction at 1 mm/d was associated with a higher rate of technical failures. External distractors had a higher failure rate than internal distractors ( $P = .012$ ). Internal distractors had a lower rate of significant scarring ( $P = .006$ ) and had a lower incidence of technical failures ( $P = .039$ ).

**Conclusions:** In children younger than 12 months, distraction at a rate of 2 mm/d is safe and appears to have a similar success rate to distraction at 1 mm/d. Internal distractors have a higher success rate than external distractors and should be used when possible.

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Ilizarov,<sup>1</sup> a Russian orthopaedic surgeon, developed a procedure to lengthen long bones that is based on the “tension-stress” principle. The procedure involves an osteotomy (bony cut) with gradual lengthening of the divided bony segments. Stretching the healing soft tissues between the bony segments induces a constant

state of tension and stress that promotes metabolic activation, angiogenesis, and new bone formation.<sup>2</sup>

Since the mid 1980s to early 1990s, this technique has been adapted in the craniomaxillofacial skeleton to manage various types of reconstructive dilemmas.<sup>3,4</sup> Mandibular distraction osteogenesis

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(MDO) for infants with micrognathia was first reported during this period and was initially used for unilateral mandibular lengthening for cases of hemifacial microsomia<sup>5</sup> and bilateral cases of Treacher Collins syndrome.<sup>6</sup> Since then, it has increasingly been used as the primary surgical option for the management of neonates and infants with upper airway obstruction due to micrognathia.<sup>7</sup> Children with Pierre Robin sequence are undergoing MDO as early as 5 days of age in some reports.

MDO relieves airway obstruction by lengthening the mandible. This stretches the tongue attachments to the mandible (genioglossus muscle), which positions the tongue more anteriorly, relieving the glossoptosis. The surgical procedure involves 4 main phases: osteotomy/corticotomy, latency, distraction, and consolidation. Osteotomy involves bony cuts in the mandible bilaterally, and distraction devices are inserted that span the proximal and distal bony segments. A latency period is applied to allow for the formation of a soft tissue callus before the segments are distracted. The distraction phase soon follows with activation of the distractor to gradually lengthen the mandible. The distraction is gradual and steady; hence the overlying soft tissues also are stretched to accommodate the changes.<sup>8</sup> The final stage is the consolidation phase. Once the ideal length is achieved, the distractors are kept in situ until the bone matures and consolidates, which usually takes 4 to 8 weeks.<sup>1</sup> Most children with upper airway obstruction will show an improvement in their respiratory status within a few days of distraction. For those children who are intubated and mechanically ventilated, this may mean extubation and transfer to a regular hospital ward.

As in all areas of clinical medicine, advances in new technology and experience with the techniques result in modifications to both technique and treatment protocol. Other modifications include use of the corticotomy/osteotomy design, modification of the rate of distraction, use of various latency and consolidation periods, use of resorbable distraction devices, and use of biological adjuncts including bone morphogenetic protein (BMP)<sup>9</sup> to enhance bone regeneration in the distracted segment. Lack of longitudinal comparison between these procedures limits the surgeon's ability to select the appropriate procedure. However, a modification that has been largely adopted is the use of internal distractors over external distractors. The procedure to insert the former has resulted in a reduction of scarring, nerve damage, and infection rate in several studies.<sup>7,10</sup> Another important variable is the rate of daily distraction. The recommendation of 1 mm/d by Ilizarov was initially recommended for the treatment of long bones and adult patients, and thus it may not apply to cases involving the craniofacial skeleton of a neonate. Studies on

mandibular distraction vary from distraction at a rate of 1 mm/d up to 5 mm/d.<sup>11</sup> It is important to determine if there is an ideal daily rate of distraction, as well as to determine if it differs in certain age groups, because this may directly affect the rate of early reoperation and the rate of complications.

The purpose of this study was to determine if there is an ideal surgical protocol in children with upper airway obstruction due to micrognathia, with a focus on the rate of distraction and type of distractor used. The specific aims of the study were 1) to determine if the success rate is affected by the rate of distraction, comparing 1 mm/d, 1.1 to 1.9 mm/d, and 2 mm/d; 2) to compare the rate of complications between different distraction rates; 3) to determine if the success rate is affected by the use of an external or internal distractor; and 4) to compare the rate of complications with different types of distractors. We hypothesized that distraction at a rate of 2 mm/d or greater is safe in neonates and children younger than 12 months. We also hypothesized that the use of internal distractors has reduced the incidence of certain complications such as infections and scarring. This article represents a subset of results from a larger systematic review project evaluating airway and feeding outcomes after MDO in children with upper airway obstruction.

## Patients and Methods

### STUDY DESIGN

To address the research question, we designed and implemented a systematic review. The study population was composed of all studies published on the evaluation and management of upper airway obstruction in children who underwent MDO. A protocol was written, peer reviewed, and accepted before this systematic review was undertaken.<sup>12</sup> The PICO (population, intervention, comparator, outcomes) criteria used for this review are included in [Table 1](#).

### POPULATION

All the studies included children who had clinical evidence of micrognathia and underwent bilateral MDO. All studies in this review included patients who initially underwent trials for conservative treatment options, and were being considered for a tracheostomy. Children with syndromic and nonsyndromic micrognathia were included, but some particular conditions were excluded. These included bilateral temporomandibular joint (TMJ) ankylosis, unilateral hemifacial microsomia, and other conditions that may have contributed to the airway obstruction for reasons other than the micrognathia alone. In addition, children with known lower airway abnormalities before treatment were excluded.

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