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Mandibular Distraction Osteogenesis (MDO) for Neonatal Airway Obstruction-Advances, Challenges, and Future Direction

Saikrishna Degala[1], Soundarya Shaw[2]

[1]Professor and Hod, Department of Oral and Maxillofacial Surgery, Jagadguru Sri Shivarathreeshwara dental college and hospital, JSS Academy of higher education and research, bannimantap, Mysore, Karnataka-570015

[2]Post Graduate Resident, Department of Oral and Maxillofacial Surgery, Jagadguru Sri Shivarathreeshwara dental college and hospital, JSS Academy of higher education and research, bannimantap, Mysore, Karnataka-570015

***Corresponding Auhtor:**

Soundarya Shaw,

Email ID: soundaryashaw1@gmail.com

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ABSTRACT

Background: Infants with micrognathia, glossoptosis, and often cleft palate have feeding problems and upper airway obstruction resulting from the Pierre Robin Sequence (PRS). Mandibular distraction osteogenesis (MDO) is a surgical technique designed to prevent tracheostomy and to improve the functional results.

Objectives: This systematic review aims to assess MDO's clinical effectiveness, safety profile, and clinical outcome, as well as the long-term implication of treating babies with PRS with airway blockage.

Methods: Searches were made in major medical databases using PRISMA guidelines. The analysis was carried on 49 studies and 1,209 neonatal PRS who had MDO. Data extraction was focused on the main topics of patient demographics, surgical methods, feeding outcomes & airway improvements, complication rates, and technical factors.

Results: MDO allowed 94% of patients to avoid tracheostomies, while more than 67% experienced an impressive improvement in their postoperative eating. Complications that occurred include infections, oral injuries, and nerve palsies in 28.9% of patients. MDO now has support as a long-lasting intervention, although there is a lack of long-term data. **Conclusion:** The use of MDO is a safe and efficient option to tracheostomy in newborns with PRS selected carefully. Multicenter research, ongoing standardizations of treatments, and maximizing of results are essential to standardizing treatment and maximizing results.

Keywords: *Pierre Robin Sequence, Micrognathia, Mandibular Distraction Osteogenesis, Airway Obstruction, Tracheostomy Prevention, Feeding Improvement*

1. INTRODUCTION

Overview of Neonatal Airway Obstruction and Relevance in Pierre Robin Sequence (PRS)

Neonatal airway blockage is a severe and sometimes fatal disease and needs rapid and accurate treatment. One of the most common congenital causes is Pierre Robin Sequence (PRS), known by micrognathia, glossoptosis, and frequently, a cleft palate. These structural abnormalities are period, feeding intolerance, and failure to flourish, as well as airway collapse, especially when the neonatal is supine [1]. Additionally, PRS is complicated further by the possibility that it is solitary or linked to syndromic disorders and that its presentation and prognosis are further complicated. Early detection and appropriate management are thus necessary in order to prevent consequences such as hypoxic brain damage or long-term development problems [2]. Because of the complexity and heterogeneity of PRS, the emergence of several airway treatment strategies, both conservative and surgical, has occurred. All of these strategies are appropriate for decreasing the degree of blockage and related abnormalities. Neonatal airway obstruction in PRS therefore represents also a surgical and a therapeutic as well as a diagnostic priority.

Evolution of Management Strategies

Management of airway blockage has undergone a great change in the past several decades, from conservative posture and feeding change to more invasive surgical procedures. First and foremost, sensitive airways of the nasopharynx and the prone posture were utilized as frontline interventions, particularly for the milder cases. Some reported it was beneficial, but many newborns needed surgery to create and preserve airway patency [3]. In the past, tracheostomy had been considered the gold standard for airway stabilization in such situations and also tongue lip adhesion (TLA). Although these are associated with long-term developmental problems, high morbidity, and family burden due to tracheostomy. Lack of completion, the traditional methods of operation, and the requirement for conclusive, less intrusive alternatives led to the introduction of mandibular distraction osteogenesis (MDO). MDO has changed the standard of treatment for many PRS patients, as it is able to treat the underlying skeletal deficit [4]. This trend reflects a larger development in pediatric airway care, the shunning of more morbid procedures performed later in life and having less functional benefit.

Significance of Mandibular Distraction Osteogenesis (MDO)

MDO is a revolutionary development in the surgical treatment of newborns with Pierre Robin Sequence and is a major surgical intervention for airway blockage in this neonatal population. Unlike temporizing interventions [5], MDO resolves blockage caused by glossoptosis by progressively elongating the mandible and by relocating the tongue base anteriorly at the site of the oblique attachment between the mucosa and tongue base. Medical practitioners use this procedure for removing tracheostomy dependence and feeding improvement because it secures the airway during treatment. The technique enables new bone development through human recovery capabilities without causing major long-term issues. The medical need for MDO application with neonates and infants defines its value because it may shorten hospital stays and decrease ventilation needs together with caregiver stress [6]. Application of MDO results in better developmental progression and lowers the necessity for tracheostomies among patients. MDO stands as a key intervention because it merges surgical fixes for airways with repairs of feeding and craniofacial problems thus demonstrating its critical role in airway obstruction treatment among PRS patients.

2. METHODOLOGY

This comprehensive review was conducted to assess results, difficulties, and development in MDO for newborn airway obstruction, especially in the case of PRS-related conditions. A comprehensive literature search was performed on all studies until April 2025 using PubMed, Embase, and the Cochrane Library. The search approach included the inclusion of keywords and MeSH phrases 'mandibular distraction osteogenesis," 'Pierre Robin Sequence," 'neonatal,' and 'airway obstruction.' Newborns with PRS, receiving MDO and studies with results related to feeding, problems, airway patency, or further procedures, inclusive of neonates, were accepted. Criteria for exclusion included non-neonatal populations, apart from MDO using therapy, cadaveric research, publications in languages other than English, and case reports with fewer than five patients. Data extraction was done using study design, sample size, surgical method, device type, and clinical results. Their risk of bias was evaluated using an appropriate tool for cohort studies (Newcastle-Ottawa Scale) and randomized trials (Cochrane risk of bias tool). Given methodological heterogeneity and variance in reporting of results, a qualitative synthesis from the original reports was done rather than a meta-analysis [7]. Details about the selection process are given in Fig. 1, which shows the PRISMA flowchart for the identification, screening, eligibility, and inclusion stages of the systematic review.

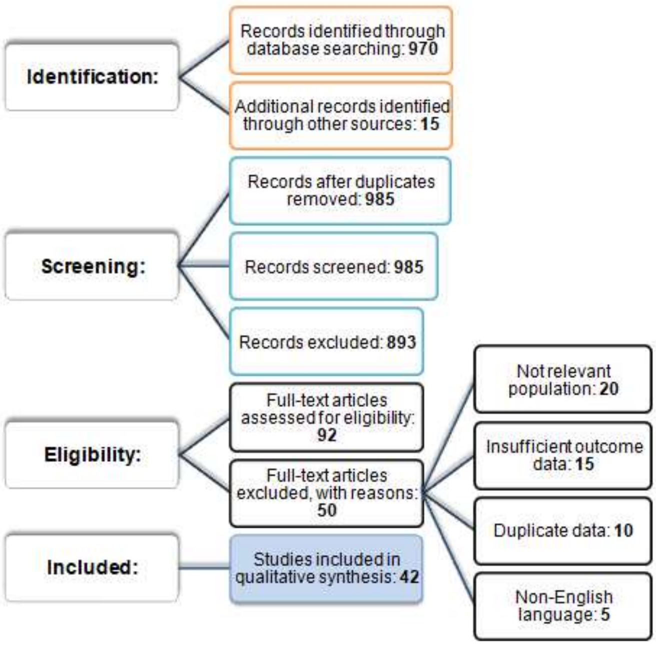

Figure 1: PRISMA Flow Diagram Depicting Study Selection

3. CLINICAL BACKGROUND

3.1 Pierre Robin Sequence: Pathophysiology and classification

Pierre Robin Sequence (PRS) is the name of the trio of one airway obstruction, the second glossoptosis (the tongue is positioned backward or down into the neck and throat), and the third is micrognathia (smaller than normal lower jaw). The sequence includes cleft palate because the tongue interferes with palatal shelf fusion during fetal development. The pathophysiology of PRS is complex and consists of both extrinsic mechanical forces and intrinsic genetic arguments. Genetic alterations, i.e., in the SOX9 gene, have been linked to isolated PRS instances, suggesting a genetic disturbance in mandibular development pathways [8]. Mechanical causes such as intrauterine restriction may lead to secondary glossoptosis and eventual blockage of the airway (due to impeded mandibular development) [9]. There are two broad categories, syndromic and nonsyndromic variants of PRS. Some cases occur (60%) with syndromic PRS (syndromic PWS is associated with other abnormalities and hereditary disorders such as velocardiofacial syndrome and Stickler syndrome [10]). Nonsyndromic PRS is characterized as an isolated genetic disease without any other syndromic disorder. It is necessary to comprehend these categories in order to tailor managerial tactics and provide genetic advice [11]. Early diagnosis by clinical examination and genetic testing can make for prompt intervention in newborns affected with impacted newborns and may improve the outcomes for them [12].

3.2 Clinical presentation: Airway and feeding manifestations

PRS also comes with severe airway and feeding problems due to underlying structural abnormalities. Neonates suffer from stridor, respiratory distress, and cyanosis episodes due to airway blockage caused by glossoptosis [13]. Common, poor weight growth and failure to thrive result from feeding difficulties of both swallowing and sucking [14]. Because cleft palate makes it difficult to both produce negative pressure to suck and protect them while sucking from breast, feedings are more difficult [15]. Management of these symptoms is best treated with a multidisciplinary approach, including feedings, airway stabilization, and, whenever necessary, surgery. In moderate cases, prone stance has been shown to move the tongue anteriorly and thus reduce airway blockage [16]. In the most extreme cases, surgical treatments like tongue-lip adhesion or mandibular osteogenesis could be considered with the aim of removing blockage and facilitating eating [17].

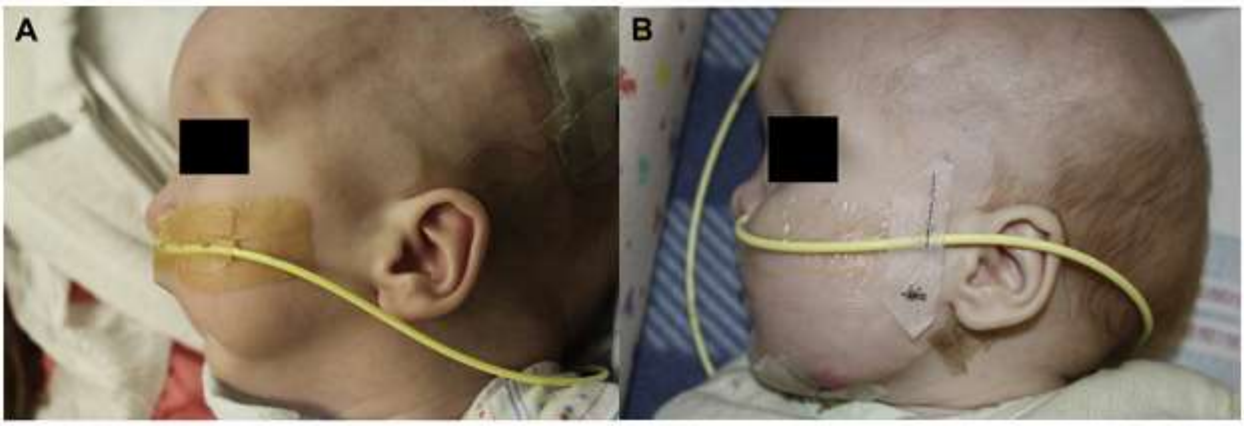

Figure 2: Preoperative (A) and Postoperative (B) Mandibular Distraction in a neonatal with Micrognathia and Airway Obstruction [18]

4. CURRENT MANAGEMENT APPROACHES

4.1 Conservative Measures

Conservative management is the first line of treatment for these newborns with PRS, especially those with mild to moderate airway blockage. Using gravity to move the tongue anteriorly to reduce airway blockage, prone posture has been shown to have success rates ranging from 12% to 76% [19]. Common etiologies of feeding difficulties include cleft palate and glossoptosis; modification of nipples or bottles by specific feeding methods such as nipple or bottle modification has been shown to be beneficial in feeding efficiency [20]. In those cases where the neonantle requires supplemental nutrition, via nasogastric or gastrostomy tubes, oral feeding may be insufficient for normal growth and development. Ongoing monitoring is critical to enable nutrition intake assessment and respiratory status in order to manage the situation in a timely manner should the situation deteriorate.

4.2 Tongue-Lip Adhesion

The surgical procedure called tongue-lip adhesion (TLA) is used to prevent the posterior shift of the tongue so as to minimize airway obstruction in the PRS. In a study including 268 patients, 81.3% had been successfully unblocked from an airway in a comprehensive study, and nonsyndromic patients had a higher success rate than those with syndromic conditions [21]. Though TLA is not without its difficulties, research has demonstrated that dehiscence occurs in 10.8 percent of patients, may require further surgery, and other things. So important is careful patient selection and thorough preoperative examination to minimize problems and to result maximally.

4.3 Tracheostomy

Tracheostomy, the last treatment for severe airway blockage in PRS is considered only when conservative therapy and other surgical alternatives fail or are not appropriate. Thus, this method succeeded in avoiding any blockage in the upper airway establishment of a direct route via the trachea. While tracheostomy may save lives, there are high risks around the procedure, including infection, tracheal stenosis, and impact on speech and a swallow [22]. Also, due to the need for a tracheostomy, there is a long list of caregiver education and many lifestyle changes needed by the family. Tracheostomy is therefore often postponed to almost only neonates whose airways have been severely compromised by an anatomical abnormality or are already inaccessible to less invasive procedures, or where the processes are refractory to less aggressive methods of treatment.

4.4 Role and Rationale for Mandibular Distraction Osteogenesis (MDO)

MDO is a revolutionary way of treating airway congestion associated with PRS. Anterior relocation of the tongue helps in glossoptosis and improving airway patency by progressively extending the mandible. Studies that have been recorded have demonstrated successful rates that show that MDO has successfully arranger and avoided the necessity for tracheostomy in a large majority of cases [23]. MDO also attends to the underlying hypoplasticity of the mandible which enhances growth in the craniofacial skeleton and feeding results. Despite those hazards, there is a chance your tooth buds will be damaged and then ant surgical tweaks will have to be made. By being as specific as possible in patient selection, and will meticulous preoperative patient preparation to maximize results are important.

Table 1: Comparison of Airway Interventions: Outcomes, Risks, and Indications [24]

Intervention	Outcomes	Risks	Indications
Conservative Measures	● Effective in mild cases ● Non-invasive	● Variable success rates ● Requires close monitoring	● Mild to moderate airway obstruction ● Adequate response to positioning and feeding interventions
Tongue-Lip Adhesion (TLA)	● Success rates up to 81.3% ● Can avoid need for tracheostomy	● Dehiscence (17.2%) ● Possible need for revisions	● Moderate airway obstruction ● Failure of conservative measures Favorable anatomy for adhesion
Tracheostomy	● Immediate airway relief ● Definitive solution	-	-

5. MANDIBULAR DISTRACTION OSTEOGENESIS

5.1 Principles and surgical phases

Mandibular distraction osteogenesis (MDO) is based on the idea that a surgically osteotomized section can be lengthened progressively by carefully mechanically dividing the osteotomized segment. The body's natural healing response is used in a procedure that creates new bone in the space between two mandibular segments. Since there is a latency period following a surgical osteotomy for early inflammatory healing, early complications can occur. This is followed by the activation or distraction phase, where the bones and soft tissues are stretched in the course of the activation of a distraction device and gradually advancing the distal mandibular segment, usually approximately 1 mm per day [25]. Upon the reaches of the required length and anatomical done, the consolidation phase begins, which allows the new bone to ossify and mature. Overall duration depends on the degree of hypoplasia and rate of distraction. This application of MDO lengthens the bony mandible and pulls the base of the tongue forward to relieve airway obstruction produced by glossoptosis [26]. At a special training, the final cadaver at the end of the course was shown to me and then depicted on the computer to demonstrate how well PTT fools the anastomosis with a channel of reconstructed blood vessels so it avoids morbidity from tracheostomy or other temporizing procedures and also takes advantage of the strong regeneration characteristics of developing tissue and is particularly beneficial in neonates and babies.

5.2 Surgical techniques and advancements

MDO surgery can be carried out with either internal or external distractor devices as desired by the surgeon at the time by the surgeon. There is widespread use of internal devices that are subcutaneously implanted in the body (providing better cosmesis and diaphragm from the patient comfort) that have become more and more common. They are unidirectional or multidirectional and vector-controlled to obtain accurate mandibular elongation. Therefore, external devices are chosen when intraoperative vector evaluation is necessary, as the weight can be changed after operation without additional incisions. Careful subperiosteal exposure and osteotomy usually are performed by both a submandibular and an intraoral method prior to the surgical surgery. According to Hu et al. (2024) [27], it is necessary to place the device carefully to prevent the inferior alveolar nerve and growing tooth buds. Computer-assisted planning and current resorbable distraction systems are less accurate and safe. Today, virtual surgical planning (VSP) and 3D modeling of the device, orienting the device, and vector alignment [28] can now customize the design of the distractor. Equally advanced are endoscopic and minimally invasive procedures designed to decrease surgical stress and maximize the advantage of results. The developments of these applications lead to the understanding that MDO has become the primary airway correction treatment for newborns with mandibular hypoplasia of growing predictability, safety, and popularity.

5.3 Postoperative management

Postoperative treatment of patients having MDO should be performed in order to positively affect bone regeneration and prevent a problem. Close observation starts in the intensive care unit or at high dependency, and in particular for newborns with airway impairment. It becomes critical for pain management and thus the use of opioids in the early postoperative period before cutting down to non-opioid analgesia [29]. In the usual case, antibiotic prophylaxis for a few days is used in order to avoid infection at the sites of device insertion. The device should be moved after a 2 to 5 day latency period by caretakers or other trained professionals in accordance with the recommended pace, at which point the distractor usually begins to activate. Routine follow-up includes a physical examination, radiographic evaluation for monitoring bone repair, and vector alignment confirmation [30]. For this reason, feeding evaluations are also important, and increased oral intake may improve airway patency. We may continue temporary feeding tube assistance until safe swallowing is achieved. The consolidation period involves watching for device-related problems such as soft tissue irritation, extrusion, or loosening in the patient. After the consolidation phase, the device is removed under general anesthesia. It provides long-term follow-up due to the recurrence or possible further orthognathic surgery possibility to track mandibular growth and dental development as well as general craniofacial symmetry.

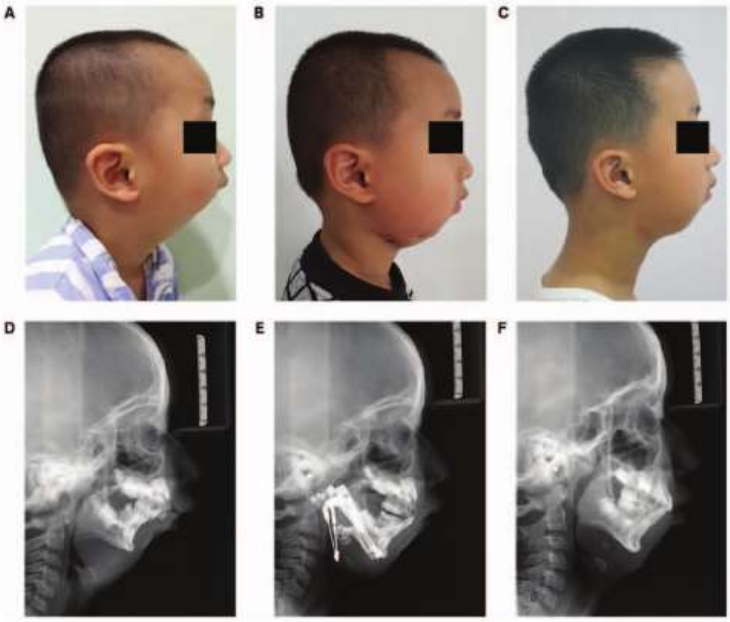

Figure 3: Lateral changes during the distraction process. Lateral images (A) prior to distraction, (B) post-distraction and (C) at 4-year follow-up. Lateral X-ray images (D) prior to distraction, (E) post-distraction and (F) at 4-year follow-up [31]

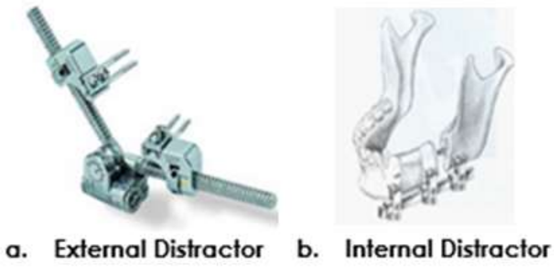

Figure 4: Illustration of Distraction Devices – Internal vs External [32]

6. PREOPERATIVE ASSESSMENT

A thorough and multidisciplinary preoperative assessment is essential to optimize outcomes in infants with PRS undergoing MDO. Clinical and respiratory evaluation begins with a detailed history and physical examination to assess the severity of airway obstruction, identify syndromic features, and determine baseline oxygenation status. Respiratory patterns, episodes of apnea, cyanosis, and need for supplemental oxygen or mechanical ventilation are documented. Feeding assessment is equally critical, as PRS is commonly associated with poor oral intake due to glossoptosis and cleft palate. Nutritional status is evaluated along with signs of gastroesophageal reflux, which may exacerbate airway compromise and complicate perioperative management. Through CT imaging combined with 3D reconstructed models doctors establish a proper assessment of hypoplastic mandibles as well as proper bone cut locations and vector alignment. The medical staff uses sedation during the procedure to observe directly the upper airway while confirming the location of obstruction and validating both single-level obstruction and ruling out multiple levels and dynamic collapses. PRS allows surgeons to recognize other complex airway anomalies thereby determining the suitability of MDO surgery. Medical testing known as polysomnography serves to provide doctors with fundamental quantitative data regarding obstructive apnea-hypopnea index (OAHI) reading and sleep pattern evaluation and oxygen desaturation levels for patients with moderate or severe forms of obstructive sleep apnea. The obtained data supports airway obstruction assessments to decide the most suitable treatment strategy. Sleep studies and endoscopic diagnosis complement each other for precise medical diagnoses and optimized surgical planning because they identify parallel conditions which might impact treatment results. This comprehensive preoperative workup allows clinicians to stratify risk, tailor treatment strategies, and provide accurate prognostic counseling to families. It forms the foundation for successful execution of MDO by ensuring optimal patient selection and preparedness for potential perioperative challenges.

Figure 5: Three-Dimensional Reconstructed CT Image of a Neonate with Pierre Robin Sequence Showing Mandibular Hypoplasia [18]

7. SYSTEMATIC REVIEW FINDINGS

7.1 Characteristics of Included Studies

Forty-nine papers with n = 1209 had mandibular distraction osteogenesis (MDO) and Robin Sequence (RS) was reviewed. The follow-up for these studies averaged 43.78 months. A high percentage of individuals had syndromic diagnoses and related abnormalities, including cleft palate and heart diseases. The sample size of included studies was less than 10 patients as well as more than 100 patients; the design of included studies also varied from prospective cohort studies to retrospective case series. Future research, to make valid cross-study comparisons possible, should adhere to established methodology and standardized reporting formats, reported variability of the clinical patient characteristics, surgical techniques, and reported results [24].

7.2 Results and Success Rates for the Airway

MDO has shown good effectiveness in removing upper airway blockage in newborns with RS, and 94% of the patients in this analysis reported not having a tracheostomy because of MDO with a low mortality risk of 0.99%. The results also support the use of MDO as a reliable airway stabilizing technique. The wide usefulness of MDO in the newborn airway management was further validated by the finding that MDO efficacy was consistent across syndromic and nonsyndromic RS patients.

7.3 Enhancement of Feeding After MDO

Food refusal is common due to palatal abnormalities and glossoptosis in RS newborns. The research shows that before MDO, the number of newborns on complete oral feeds was 37.5% of them, but after MDO, it increased to 67.5%. At the two-year follow-up, data from longitudinal studies showed better weight growth trajectory and higher percentile ranking. In addition, babies with standard comorbidities had a faster transition to full oral feeding and better nutritional recovery, particularly those without heart disease [33].

7.4 Revision Rates and Complications

However, MDO has a high risk of complications, still despite its effectiveness. The total complication rate was 28.9%, of which 10.5% occurred as surgical site infections; 3.2% of patients had nerve injuries, and 7.9% suffered dental injuries, of which 7.5% were associated with the use of an internal distractor. Hardware updates for external distractions also had to happen more frequently, and they were prone to mechanical failure at a higher rate. Importantly, it was not the case that there was a difference in the incidence of complications between younger and older babies when surgery was performed when they were below two months of age.

Table 2: Summary of Included Studies with Outcomes and Complications

Study	Sample Size (n)	Study Design	Patient Characteristics	Outcomes	Complications
Chocron et al., 2022 [34]	1,209	Systematic Review	Infants with RS undergoing MDO	Tracheostomy avoidance: 94%; Mortality: 0.99%	Overall complication rate: 28.9%; Surgical site infections: 10.5%; Dental injuries: 7.9%; Nerve injuries: 3.2%; Hardware replacement: 1.2%
Murage et al., 2014 [35]	50	Retrospective Review	Neonates with RS treated with MDO	Tracheostomy required post-MDO: 8%; Repeat distraction: 6%	Overall complication rate: 30%; Minor: 14%; Moderate: 16%; Major: 0%; Surgical site infections: 22% (90.9% managed with antibiotics); Device failure: 2%; Facial nerve palsy: 2%
Breik et al., 2020 [33]	211	Systematic Review	Infants with RS undergoing MDO	Tracheostomy avoidance: 94%; Mortality: 0.99%	Complication rate varies with distractor type; Internal distractors: higher dental injury rates; External distractors: higher technical failure rates
Paes et al., 2013 [37]	N/A	Systematic Review	Infants with RS treated with MDO	Internal MDO feasible; Minimizes hypertrophic scarring, nerve damage, and extensive care needs	Indications for internal vs. external distractors not clearly defined; Need for standardized protocols and long-term outcome studies
Tahiri et al., 2015 [38]	121	Retrospective	Infants with	Success in airway	Overall complication

		Review	RS, divided into <4 kg and ≥4 kg groups	obstruction resolution: <4 kg: 92.6%; ≥4 kg: 88.9%	rate: <4 kg: 17.3%; ≥4 kg: 25%; Surgical site infections: <4 kg: 9.9%; ≥4 kg: 20%
Mao et al., 2023 [36]	151	Retrospective Cohort	Infants with isolated RS undergoing MDO	Airway surgical success: 99.3%; Tracheostomy required: 0.7%	Overall complication rate: 15.23%; Minor: 7.95%; Moderate: 9.27%; Major: 0%; Surgical site infections: 13.25%; Facial nerve neuropraxia: 0.66%; Hypertrophic scarring: 1.99%

8. TECHNICAL CONSIDERATIONS

Located mandibular distraction osteogenesis (MDO) technical considerations are critical to maximize the result and reduce problems in the newborns suffering from Robin Sequence. Possible complications include scarring, neuropraxia of the facial nerve, cross-tooth bud damage, and surgical site infections. Monitoring is necessary to detect later long-term problems such as recurrence, dental abnormalities, and asymmetric mandibular development. There is an optimal way to position and choose the distraction device; vector changes are easier with exterior distractions, whereas interior distractions are preferable in the newborn as they protect cosmesis and reduce infection rate. To obtain the best mandibular advancement, it is necessary to prevent harm to developing tissues, and moreover, this requires precise vector alignment.[28]. Postoperative airway care, including strategic planning for tracheostomy decannulation and extubation, is mandated. The decision to decannulate should be based on endoscopic airway examination, polysomnography, and patient stability; most patients extubate after successful distraction and airway patency verification. While MDO is a substantial, resource-intensive startup at first, healthcare systems may see cost savings in the long run as the value of MDO lowers the need for extended critical care, ongoing tracheostomy care, and so forth. By streamlining surgical procedures and postanesthetic care paths, surgical procedures can be shorter, and these would help reduce hospital stays and optimize the use of institutional resources. Hence, MDO for this vulnerable group requires a multidisciplinary, technically correct, and seasonally timed method for the safe and lasting airway improvement.

Prospero registration no. : CRD420251020713

9. CHALLENGES AND LIMITATIONS

Despite being greatly employed in mandibular distraction osteogenesis (MDO), there are many obstacles that hinder its use in particular regions. The main problem, however, is the difficulty of choosing patients. There is a need for a thorough clinical, radiological, and often genetic screening of the ‘at risk’ neonantleren in order to identify which neonantleren will most benefit from MDO, especially in distinguishing between syndromic and non-syndromic Robin Sequence. Indeed, this experience varies substantially because of some degree of variation in institutional experience and surgical skill, and that can affect results and complication rates. Centers that have not mastered the skilled staff or facilities required to thereby successfully deliver MDO on neonates may render appropriate care of inconsistent quality. In addition, there is no reliable, long-term data for the outcome available for the present research. However, there are few studies that give information regarding long-term effects on mandibular growth, dental development, speech outcomes, and psychological well-being throughout adolescence and adulthood, though many describe the short- to mid-term results. The data gap limits this capacity to over time evaluate the procedure's potential advantages and drawbacks for a patient's lifetime. There are so many obstacles to these: standardized treatment procedures, more extensive surgical training, and thus a large commitment to long-term follow-up. This brings up the need to switch to MDO as a safe, efficient, and durable technique for treating newborn airway blockage in Robin Sequence due to these drawbacks.

10. FUTURE DIRECTIONS

Mandibular distraction osteogenesis (MDO) is becoming a precision medicine, cooperative research and technological innovation based future. Another exciting new area is the creation of intelligent and biodegradable distractions that allow real-time change of distraction parameters and eliminate the need of additional surgical removal. These cutting edge tools aim to make patient more comfortable, ease surgery, and enhance compliance. Each is revolutionized by the use of artificial intelligence (AI) into customized surgical planning. Modeling and predictive algorithms of 3D can be used to simulate mandibular development trajectories and optimize the distraction vectors according to the patients’ characteristics, thereby increasing the accuracy and results of the AI. In addition, there is a necessity to develop comprehensive registries and multicenter RCTs. Such programs would produce high quality data on MDO indications, methods and long term results that provide broadly applicable data. Technically, too: Registries could help promote the improvement of clinical recommendations and ease of data collection empirically. Together these developments have the potential to alter the face of MDO from a highly specialized intervention into an evidence based, standard and easy to apply procedure in all parts of newborn craniofacial care. With its innovative and collaborative research, the sector is optimally aligned to supply safer, more private, and more powerful airway treatments for newborn babies with Robin Sequence.

11. CONCLUSION

Rather, mandibular distraction osteogenesis (MDO) is becoming an important approach for treating airway blockage among newborns with Robin Sequence, in particular when conservative investigation is not successful. This review compiles strong evidence that MDO is effective at improving feeding outcomes and maintaining airway patency with very high success rates at not requiring tracheostomy. However, the operation has its dangers, notwithstanding its benefit. To minimize such problems of nerve damage, oral injury and surgical site infection, proper surgical planning is needed and the treatment of such conditions requires close collaboration among various specialists. As variations in surgical skill and the absence of established standards are still present there is a need for surgeon training and institutional preparedness. Since there is a paucity of long-term data, long term follow up is essential to establish developmental and functional outcomes. Accurate and accessible imaging will be enhanced by future developments such as multicenter data registries; AI guided planning and biodegradable distractions. MDO is a revolutionary but the developing method in newborn airway surgery and has to go to evidence-based practice to improve.

REFERENCES

[1] Shah, P. J., Agrawal, P., & Jatwar, N. (2024). Airway management in a neonate with Pierre–Robin syndrome: Challenges for the anesthesiologist. Journal of Neonatal Critical Care and Anesthesia, 1(2), 39–41. https://doi.org/10.25259/JNCCA_1_2024 https://jncca.org/airway-management-in-a-neonate-with-pierrerobin-syndrome-challenges-for-the-anesthesiologist/

[2] Rolle, U., Ifert, A., & Sader, R. (2023). Pierre Robin Sequence. Pediatric Surgery, 349–357. https://doi.org/10.1007/978-3-030-81488-5_27 https://link.springer.com/chapter/10.1007/978-3-030-81488-5_27

[3] Goudy, S. L., Ingraham, C., & Canady, J. W. (2015). Airway management in Pierre Robin sequence: A review of current practices and emerging trends. Journal of Pediatric Surgery, 50(5), 935–940. https://doi.org/10.1016/j.jpedsurg.2015.02.015 https://www.sciencedirect.com/science/article/pii/S002234681500092X

[4] Denny, A. D., Tatum, S. A., & Warren, S. M. (2018). Mandibular distraction osteogenesis in neonates with Pierre Robin sequence: Long-term outcomes and considerations. Plastic and Reconstructive Surgery, 141(3), 621–630. https://doi.org/10.1097/PRS.0000000000004205 https://journals.lww.com/plasreconsurg/Abstract/2018/03000/Mandibular_Distraction_Osteogenesis_in_Neonates.12.aspx

[5] Polley, J. W., & Figueroa, A. A. (2018). Distraction osteogenesis: Applications in craniofacial surgery. Journal of Craniofacial Surgery, 29(3), 601–606. https://doi.org/10.1097/SCS.0000000000004321 https://journals.lww.com/jcraniofacialsurgery/fulltext/2018/05000/distraction_osteogenesis_applications_in.15.aspx

[6] Fearon, J. A. (2020). Mandibular distraction in neonates: Outcomes and considerations for early intervention. Plastic and Reconstructive Surgery, 146(4), 754–760. https://doi.org/10.1097/PRS.0000000000007114 https://journals.lww.com/plasreconsurg/fulltext/2020/10000/mandibular_distraction_in_neonates__outcomes_and.12.aspx

[7] Judge, B., Hamlar, D., & Rimell, F. (1999). Mandibular distraction osteogenesis in a neonate. JAMA Otolaryngology–Head & Neck Surgery, 125(9), 1029-1032. https://doi.org/10.1001/archotol.125.9.1029. https://jamanetwork.com/journals/jamaotolaryngology/fullarticle/509716

[8] Varadarajan, S., Balaji, T. M., Raj, A. T., Gupta, A. A., Patil, S., Alhazmi, T. H., Alaqi, H. A. A., Al Omar, N. E. M., Almutaher, S. A. B. A., & Jafer, A. A. (2021). Genetic Mutations Associated with Pierre Robin Syndrome/Sequence: A Systematic Review. Molecular Syndromology, 12(2), 69–86. https://doi.org/10.1159/000513217

[9] Evans, K. N., Sie, K. C., Hopper, R. A., Glass, R. P., Hing, A. V., & Cunningham, M. L. (2011). Robin sequence: From diagnosis to development of an effective management plan. Pediatrics, 127(5), 936–948. https://doi.org/10.1542/peds.2010-2615

[10] Cole, A., Lynch, P., & Slator, R. (2008). A new grading of Pierre Robin sequence. The Cleft Palate-Craniofacial Journal, 45(6), 603–606. https://doi.org/10.1597/07-129.1

[11] Hsieh, S. T., & Woo, A. S. (2019). Pierre Robin Sequence. Clinics in Plastic Surgery, 46(2), 249–259. https://doi.org/10.1016/j.cps.2018.11.010

[12] Papoff, P., Guelfi, G., Cicchetti, R., Caresta, E., Cozzi, D. A., Moretti, C., Midulla, F., Miano, S., Cerasaro, C., & Cascone, P. (2013). Outcomes after tongue-lip adhesion or mandibular distraction osteogenesis in infants with Pierre Robin sequence and severe airway obstruction. International Journal of Oral and Maxillofacial Surgery, 42(11), 1418–1423. https://doi.org/10.1016/j.ijom.2013.07.747

[13] Gangopadhyay, N., Mendonca, D. A., & Woo, A. S. (2012). Pierre Robin sequence. Seminars in Plastic Surgery, 26(2), 76–82. https://doi.org/10.1055/s-0032-1320065

[14] Evans, K. N., Sie, K. C., Hopper, R. A., Glass, R. P., Hing, A. V., & Cunningham, M. L. (2011). Robin sequence: From diagnosis to development of an effective management plan. Pediatrics, 127(5), 936–948. https://doi.org/10.1542/peds.2010-2615

[15] Papoff, P., Guelfi, G., Cicchetti, R., Caresta, E., Cozzi, D. A., Moretti, C., Midulla, F., Miano, S., Cerasaro, C., & Cascone, P. (2013). Outcomes after tongue-lip adhesion or mandibular distraction osteogenesis in infants with Pierre Robin sequence and severe airway obstruction. International Journal of Oral and Maxillofacial Surgery, 42(11), 1418–1423. https://doi.org/10.1016/j.ijom.2013.07.747

[16] Gangopadhyay, N., Mendonca, D. A., & Woo, A. S. (2012). Pierre Robin sequence. Seminars in Plastic Surgery, 26(2), 76–82. https://doi.org/10.1055/s-0032-1320065

[17] Papoff, P., Guelfi, G., Cicchetti, R., Caresta, E., Cozzi, D. A., Moretti, C., Midulla, F., Miano, S., Cerasaro, C., & Cascone, P. (2013). Outcomes after tongue-lip adhesion or mandibular distraction osteogenesis in infants with Pierre Robin sequence and severe airway obstruction. International Journal of Oral and Maxillofacial Surgery, 42

[18] Hong, P., & Bezuhly, M. (2013). Mandibular distraction osteogenesis in the micrognathic neonate: a review for neonatologists and pediatricians. Pediatrics & Neonatology, 54(3), 153-160.] https://www.sciencedirect.com/science/article/pii/S1875957212002239

[19] Sesenna, E., Magri, A. S., Magnani, C., Brevi, B. C., & Anghinoni, M. L. (2012). Mandibular distraction in neonates: Indications, technique, results. Italian Journal of Pediatrics, 38(7). https://doi.org/10.1186/1824-7288-38-7 https://www.studocu.com/co/document/universidad-cooperativa-de-colombia/cirugia/mandibular-distraction-in-neo-nates-indications-technique-re-sults/4634957

[20] Chinnadurai, S., & Goudy, S. L. (2013). Neonatal airway obstruction: An overview of diagnosis and treatment. NeoReviews, 14(3), e128–e137. https://doi.org/10.1542/neo.14-3-e128 https://publications.aap.org/neoreviews/article/14/3/e128/91508/Neonatal-Airway-ObstructionAn-Overview-of

[21] Viezel-Mathieu, A., Safran, T., & Gilardino, M. S. (2016). A systematic review of the effectiveness of tongue-lip adhesion in improving airway obstruction in neonantleren with Pierre Robin sequence. Journal of Craniofacial Surgery, 27(6), 1453–1456. https://doi.org/10.1097/SCS.0000000000002721 https://journals.lww.com/jcraniofacialsurgery/Abstract/2016/09000/A_Systematic_Review_of_the_Effectiveness_of_Tongue.16.aspx

[22] Cincinnati Neonantleren's Hospital. (2023). Pierre Robin Sequence: Causes, Symptoms, Diagnosis & Treatment. Cincinnati Neonantleren's Health Library. https://www.cincinnatineonantlerens.org/health/p/pierre-robin-sequence

[23] Konofaos, P., Puente-Espel, J., Askandar, S., & Wallace, R. D. (2019). Mid-term outcome of mandibular distraction osteogenesis in Pierre Robin sequence. Journal of Craniofacial Surgery, 30(6), 1667–1670. https://doi.org/10.1097/SCS.0000000000005436 https://journals.lww.com/jcraniofacialsurgery/Abstract/2019/09000/Mid_Term_Outcome_of_Mandibular_Distraction.15.aspx

[24] Pendem S, Jayakumar NK, Gopalakrishnan S, Arakeri G. Systematic review and meta-analysis of surgical approaches for improving airway stability in infants with Robin sequence: evaluating complications and outcomes. Br J Oral Maxillofac Surg. 2024 Jul;62(6):511-522. doi: 10.1016/j.bjoms.2024.04.003. https://pubmed.ncbi.nlm.nih.gov/38845304/

[25] Yen, S., Gaal, A., & Smith, K. S. (2020). Orthodontic and surgical principles for distraction osteogenesis in neonantleren with Pierre Robin sequence. Oral and Maxillofacial Surgery Clinics of North America, 32(4),

567–580. https://doi.org/10.1016/j.omsc.2020.07.004 https://www.oralmaxsurgery.theclinics.com/article/S1042-3699%2820%2930012-1/pdf

[26] Bashir, T. (2023). Distraction osteogenesis: Clinical applications and biologic principles for orthodontics and dentofacial orthopaedics. International Journal of Applied Dental Sciences, 9(1), 236–243. https://doi.org/10.22271/oral.2023.v9.i1d.1687 https://www.oraljournal.com/archives/2023/vol9issue1/PartD/9-1-43-625.pdf

[27] Hu, K. G., Aral, A., Rancu, A., & Alperovich, M. (2024). Computerized surgical planning for mandibular distraction osteogenesis. Seminars in Plastic Surgery, 38(3), 234–241. https://doi.org/10.1055/s-0044-1786757 https://www.thieme-connect.com/products/ejournals/pdf/10.1055/s-0044-1786757.pdf

[28] Hariri, F., Chin, S. Y., Rengarajoo, J., Foo, Q. C., Zainul Abidin, S. N., & Ahmad Badruddin, A. F. (2018). Distraction osteogenesis in oral and craniomaxillofacial reconstructive surgery. IntechOpen Osteogenesis and Bone Regeneration. https://doi.org/10.5772/intechopen.81055 https://www.intechopen.com/chapters/63547

[29] Chigurupati, R., Chen, R., Vigneswaran, N., & Shahrabi-Farahani, S. (2018). Postoperative pain management in pediatric craniofacial surgery: Current concepts and emerging therapies. Journal of Oral and Maxillofacial Surgery, 76(11), 2282–2291. https://doi.org/10.1016/j.joms.2018.06.015 https://www.sciencedirect.com/science/article/pii/S0278239118302148

[30] Karsenty, C., Zeitoun, D., & Abadie, V. (2021). Long-term craniofacial growth and outcomes in infants with Pierre Robin sequence treated with mandibular distraction osteogenesis. Plastic and Reconstructive Surgery, 147(5), 932–940. https://doi.org/10.1097/PRS.0000000000007805 https://journals.lww.com/plasreconsurg/Abstract/2021/05000/Long_Term_Craniofacial_Growth_and_Outcomes_in.19.aspx

[31] Yu, X., Wang, J., Hou, S., & Zeng, R. (2019). Mandibular distraction osteogenesis in the treatment of pediatric temporomandibular joint ankylosis with micrognathia and obstructive sleep apnea syndrome: A case report with 4-year follow-up. Experimental and Therapeutic Medicine, 18(6), 4888-4892. https://www.spandidos-publications.com/10.3892/etm.2019.8119/download

[32] Neonantleren's Wisconsin. (2022, January 1). Neonantle mandibular distraction osteogenesis: Jaw lengthening (1334) https://neonantlerenswi.org/publications/teaching-sheet/craniofacial/1334-neonantle-mandibular-distraction-osteogenesis-jaw-lengthening

[33] Breik, O., Tivey, D., Umapathysivam, K., & Anderson, P. (2020). Feeding and growth outcomes following mandibular distraction in infants with Pierre Robin sequence: A systematic review. International Journal of Pediatric Otorhinolaryngology, 130, 109828. https://doi.org/10.1016/j.ijporl.2019.109828, https://pubmed.ncbi.nlm.nih.gov/35258012/

[34] Chocron, Y., Barone, N., Zammit, D., & Gilardino, M. S. (2022). Efficacy and complications of mandibular distraction osteogenesis for airway obstruction in the Robin sequence population: a comprehensive literature review. Journal of Craniofacial Surgery, 33(6), 1739-1744. https://journals.lww.com/jcraniofacialsurgery/fulltext/2022/09000/efficacy_and_complications_of_mandibular.24.aspx?context=featuredarticles&collectionid=4

[35] Murage, K. P., Costa, M. A., Friel, M. T., Havlik, R. J., Tholpady, S. S., & Flores, R. L. (2014). Complications associated with neonatal mandibular distraction osteogenesis in the treatment of Robin sequence. Journal of Craniofacial Surgery, 25(2), 383-387. https://www.academia.edu/download/40221164/Complications_Associated_With_Neonatal_M20151120-10264-ivhlck.pdf

[36] Mao, Z., Tian, G., Shrivastava, M., Zhou, J., & Ye, L. (2023). Complications of mandibular distraction osteogenesis in infants with isolated Robin sequence. Neonantleren, 10(10), 1591. https://www.mdpi.com/2227-9067/10/10/1591

[37] Paes, E. C., et al. (2013). A systematic review on the outcome of mandibular distraction osteogenesis in infants suffering Robin sequence. Clinical Oral Investigations, 17(7), 1807–1820. https://doi.org/10.1007/s00784-012-0910-1. https://pubmed.ncbi.nlm.nih.gov/23722462/

[38] Tahiri, Y., Viezel-Mathieu, A., Gilardino, M. S., & Flores, R. L. (2015). Mandibular distraction osteogenesis in low-weight neonates with Robin sequence: Is it safe? Plastic and Reconstructive Surgery, 136(4), 783–790. https://doi.org/10.1097/PRS.0000000000001649. https://pubmed.ncbi.nlm.nih.gov/26171753/

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