Pierre Robin Sequence: An Evidence-Based Treatment Proposal

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Background: The Pierre Robin sequence (PRS) has been defined as the presence of micrognathia, glossoptosis, and respiratory obstruction in the neonatal period. Since its original description, different therapeutic approaches have been proposed obtaining different success rates, but there is no consensus about its management.

Methods: A literature review was conducted in PubMed, Embase, and Cochrane databases, for the period of January,1985 to November, 2016. A number of 23 articles resulting from clinical studies, discussing diagnostic tests or therapeutic approaches, and directly or indirectly comparing diagnostic or treatment modalities were selected and assessed using the GRADE methodology.

Results: After reviewing and analyzing the selected articles, an evidence-based algorithm for diagnosis and integral management of PRS patients was designed.

Conclusion: Based on the anatomical principles and natural evolution of PRS, the clinical scenario must be evaluated thoroughly as a dynamic event to develop a management sequence that minimizes morbidity and mortality and accelerates patients' reinsertion to normal life.

Key Words: Distraction osteogenesis, maxillomandibular discrepancy, micrognathia, Pierre Robin sequence, tongue–lip adhesion

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INTRODUCTION

The Pierre Robin sequence is defined by micrognatia, glossoptosis, and respiratory difficulty in neonatal period. Since its original description, many terapeutical approaches have been proposed with variable success rates; however, because of the wide clinical spectrum of this entity, there is no treatment consensus. A literature review from 1985 to 2016 was performed. The most relevant clinical trials were selected and analyzed using GRADE methodology (Grading of Recommendations Assessment Development and Evaluation). An evidence-based management algorithm is proposed.

The Pierre Robin sequence (PRS), named after the French stomatologist who described it in 1923, is characterized by the clinical triad of glossoptosis, micrognathia, and respiratory difficulty. Although cleft palate is frequent, its presence is not considered essential for diagnosis. PRS incidence has been calculated in 1 in 8500 newborns[1] and can appear in isolation or associated with different syndromes. Since its initial description, numerous techniques for diagnosis and treatment have been used with several results, but so far there is no agreement on the criteria for an optimal management of this condition.

Upper airway obstruction in newborns owing to PRS occurs generally in the first hours after birth; however, it is not always possible to determine the severity of the obstruction nor predict clinical deterioration with the pass of time.[2] Natural evolution of PRS patients shows a gradual airway clearance and a solution of eating difficulties as the mandible grows and the neuromotor system of the newborn develops, improving parapharyngeal muscle coordination and tongue voluntary control.[3] Nonetheless, in syndromic patients, PRS is frequently associated with anatomic alterations in the upper airway or in the central nervous system; this causes complex clinical situations that may require aggressive measures to avoid fatal outcomes.

The primary objectives of the PRS treatment are to maintain airway permeability, to normalize the alimentary tract, and to facilitate adequate weight gain.[2,4,5] If these goals are not achieved, infants may suffer chronic hypoxia with CO_2 retention, increased pulmonary vascular resistance, cor pulmonale, heart failure, and malnutrition. Cerebral hypoxia episodes can be fatal.[4]

Although mortality rates for PRS patients have decreased, morbidity rates and treatment complications are still considerable. Based on an extensive literature review and using the GRADE methodology,[6–21] some recommendations are made and a treatment algorithm is proposed, which considers the diagnostic and therapeutic options that report better success rates at present.

MATERIALS AND METHODS

A literature review was conducted introducing the term "Pierre Robin" in PubMed, Embase, and Cochrane databases, for the period of January 1985 to November, 2016. A total of 1438 articles were found. After filtering the results using "English Language" and "Studies in Human Beings" as selection criteria, 736 articles were reviewed independently. For the purpose of this study, articles resulting from clinical studies, discussing diagnostic tests or therapeutic approaches, and directly or indirectly comparing diagnostic or treatment modalities were taken into account. Case reports, review articles, and basic science experimental studies were excluded. These criteria were fulfilled by 23 articles, from which only 5 compared >1 diagnostic or therapeutic modality (Fig. 1).

RESULTS

The quality of each selected article was measured using the GRADE methodology, seeking to clarify the most frequently used diagnostic and therapeutic strategies. After analyzing the articles, an algorithm for diagnosis and comprehensive management was designed and proposed with recommendations based on the evidence for patients with PRS.

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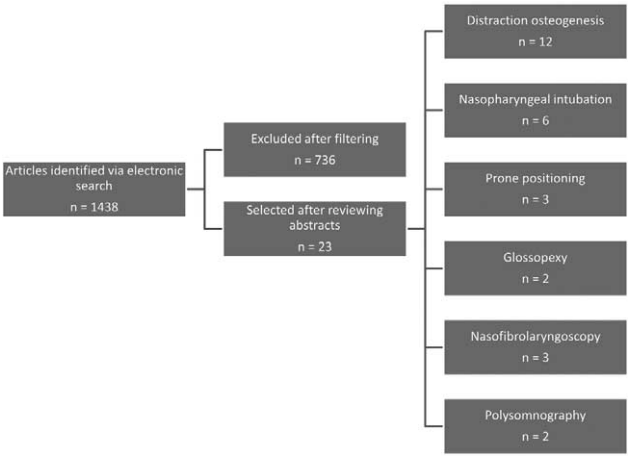

FIGURE 1. Literature search and selection.

Diagnostic Strategies

Micrognathia

Although the concept of micrognathia originated long time ago, there was no consensus on its objective determination yet. In a study conducted by the authors of this article,[22] 600 healthy children were examined to establish normal values of maxillary and mandibular arch lengths as well as of overjet. The latter was validated as an effective innocuous clinical tool to determine the presence of micrognathia. According to this study, an overjet >4 mm should be considered as micrognathia whose severity will be specified along with facial thirds measures. There was no evidence of mandibular catch-up growth, defined as the mandibular growth that allows reduction in the maxillomandibular discrepancy (MMD). In fact, statistical evidence showed that maxilla, mandible, and cranial base grow simultaneously and proportionally, without dominance of one over the others. This growth is logarithmic during the first year of life and linear afterwards. This growth during the first year allows an effective increase of airway diameter, which explains the improvement in respiratory and feeding difficulties in this period.[22]

Based on this, it is strongly recommended to use overjet measurement to diagnose micrognathia when it is >4 mm

Polysomnography

This technique is considered the criterion standard for the diagnosis of obstructive sleep apnea/hypopnea syndrome (OSAHS). It allows to establish severity of this syndrome by calculating the obstructive respiratory disturbance index (ORDI). For the diagnosis in children, it is necessary to observe >1 episode of obstructive apnea, mixed apnea, or hypopnea in 1 hour. OSAHS is classified as mild when ORDI is 1 to 5, moderate if it is 5 to 10, and severe if it is >10.[23,24] Polysomnography can enhance diagnosis accuracy by analyzing the severity of upper airway obstruction and establishing differences among the monitored infants.

Some studies[3,5] do not recommend polysomnography for PRS patients. Instead, they suggest a continuous monitoring of oxygen saturation by using pulse oximetry associated to clinical evaluation. According to them, this method is sufficient to estimate airway obstruction severity and to monitor clinical evolution. Likewise, de Buys Roessingh et al[25] demonstrated that close clinical follow-up allows an adequate correlation among hypoxic episodes resulting from nasopharyngeal intubation misplacement or primary pharyngeal obstruction. Therefore, to them, polysomnography is only necessary if there is any alteration in arterial blood gases, pulse oximetry, or cardiac monitoring.

Nonetheless, polysomnography allows to diagnose the type and severity of obstruction, evaluate treatment response, and detect late obstruction cases. For this reason, it is highly recommended to use this method in an early stage and as part of the follow-up, regardless of the implemented treatment.

Nasofibrolaryngoscopy

This procedure allows to directly examine the upper aerodigestive tract and identify anatomical anomalies in the airway as well as the obstruction specific location. It has proved to have a proper correlation with the polysomnography findings on airway obstruction processes,[23] though its interpretation is operator-dependent.

In 1986, Sher et al[26] proposed a classification of 4 types for the findings of nasofibrolaryngoscopies on PRS patients and their treatment implications (Table 1, Fig. 2).

Different studies emphasize the importance of nasofibrolaryngoscopy (NFL) to orient the treatment based on anatomical factors. It is therefore strongly recommended to implement this tool for the diagnosis and follow-up of PRS patients..[23,27,28]

Video Swallowing Study

This technique allows to analyze the swallowing process to detect disorders and risk of secondary pulmonary aspiration. It is considered a predictor for the continuous use of nasogastric tube (NGT), and hence, for the need of gastrostomy.

For patients with PRS and low weight gain, it is advised to implement NGT and hypercaloric diet consisting of a milk formula supplemented with 5% to 7% of glucose polymers and 3% to 5% of medium-chain triglycerides and essential fatty acids.[3] Once the weight gain is satisfactory, constant NGT feeding is replaced first by intermittent bolus administration and then by oral feeding. Infants are stimulated to suck a pacifier or a finger since their hospitalization. Lingual stimulation must be promoted by parents and caregivers with support of phonoaudiologists, to improve neuromuscular coordination.[5]

It is highly recommended to use video swallowing studies in PRS patients who do not report adequate weight gain despite nutritional supplementation.

TABLE 1. Sher Classification of Nasofibrolaryngoscopy Findings

Type	Description
Type I	Most frequent. Obstruction caused by posterior displacement of the tongue abutting the posterior pharyngeal wall.
Type II	Obstruction following posterior/upward displacement of the tongue abutting the soft palate and the upper portion of the oropharynx.
Type III	Pharyngeal obstruction resulting from prolapse of the pharynx middle wall.
Type IV	Obstruction owing to circular constriction of the pharynx caused by tongue and lateral pharyngeal wall movement.

Source: Elaboration based on.[26]

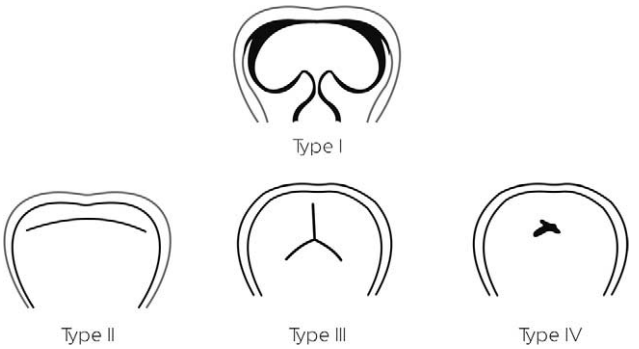

FIGURE 2. Sher' classification of nasofibrolaryngoscopy findings.

TABLE 2. GILLS Score System

Variable*	Score	Intervention
Gastroesophageal reflux disease	0.002	Antireflux medication. Nissen fundoplication.
Preoperative intubation	0.002	Early tongue-lip adhesion. Nasopharyngeal tube.
Late appearance	0.001	Early tongue-lip adhesion, nasopharyngeal tube in case of weight gain fail.
Low weight at birth	0.01	Nonmodifiable variable
Syndromic patient	<0.001	Nonmodifiable variable

Source: Elaboration based on.[32]
*Each variable equals 1 point for a total of 5 points.

Therapeutic Strategies

Prone Positioning

Different studies have suggested this intervention as an initial measure for PRS patients' management reporting 41% to 69% of success for respiratory obstruction treatment. This technique improves breathing by moving the tongue forward, thus avoiding its descent to the hypopharynx. However, in severe cases, it is usually insufficient,[25] and if successful, it may be required till 6 months of age;[2] not to mention that some signs of respiratory difficulty such as supraclavicular, substernal, and intercostal retractions may occur unnoticed or not detected as the patient is in prone position.

Prone positioning in patients with mild and intermittent respiratory difficulty has showed to be a useful measure without additional morbidity. Despite the lack of studies comparing this technique with others, based on its reported success, it is highly recommendable as the initial and in some cases only measure for PRS patients with respiratory obstruction who show favorable response to treatment. This procedure must be conducted with strict clinical follow-up.

Nasopharyngeal Tube

This is one of the contemporary strategies to manage respiratory difficulty in PRS patients. This device causes the tongue to move forward, liberating the airway and allowing the patient to breathe through it.[3] In 2015, Drago Marquezini Salmen and Lazarini Marques[3] conducted a study with 223 PRS patients (73% isolated, 27% syndromic), 107 of whom were diagnosed with severe respiratory difficulty, reported Type I and Type II nasofibrolaryngoscopies according to Sher classification, and received nasopharyngeal intubation. The average time of tube use was 57 days and the average length of hospital stay was 18 days. In all patients, tracheostomy was avoided or achieved decannulation, 15% required gastrostomy and mortality rate was naught. In addition, some studies have proved that this strategy is more effective in children under 1 month.[4] The benefits of nasopharyngeal tubes include minimal morbidity, low cost, adequate parents-child contact, and early hospital discharge once the patient is stable and the parents educated.[5]

In short, this device solves airway obstruction while allowing natural growth and avoiding a possible surgical intervention. It reduces length of hospital stay, promotes adequate weight gain, and has minimal morbidity. For those reasons, it is highly recommendable for PRS patients who do not respond to initial prone positioning.

Tongue–Lip Adhesion

Before the appearance of distraction osteogenesis, tongue–lip adhesion (TLA) was considered the most accurate measure to correct glossoptosis and respiratory obstruction in PRS patients.[29,30] This technique is usually successful in patients with <2 in the GILLS Score (gastroesophageal reflux disease, intubation preoperatively, late operation, low birth weight, and syndromic diagnosis),[31,32] a scoring system validated to predict outcomes of TLA in PRS patients (Table 2). However, TLA has been associated to multiple complications such as wound dehiscence, speech anomalies, tongue coordination problems, and need for reintervention[29,33]

However, in a recent systematic review, Viezel-Mathieu et al identified 268 patients with PRS (35.1% PRS isolated, 35.1% PRS syndromatic, and 29.8% PRS unspecified) in whom TLA was successful in relieving airway in 81.3% of cases (218 patients), with lower complication rates (13.8%) compared to mandibular distraction osteogenesis (MDO) (23.8%) and tracheostomy (37.5%). Although some patients treated with TLA required tracheostomy (n = 27) or MDO (n = 5) as additional measure to treat the obstruction, in most cases TLA was successful to resolve airway obstruction.[34]

The absence of baseline and postintervention ORDI records did not allow to know the real impact on OSAHS, until the most recent publication of a prospective study by Khansa et al[33] on 28 patients with PRS (all with polysomnography before treatment), 3 management modalities were implemented, obtaining clinical and baseline ORDI improvement. In patients submitted to TLA, the improvement was 81.6% (15.1–2.8), in MDO was 94.6% (27.7–1.5) and conservative management in prono was 9.8% (6.1–5.5). This evidence shows a different facet of TLA, showing it as an effective and less morbid[29] measure for patients with SPR in whom the MMD is <8 mm[30]

Considering all this, it is highly recommended to use TLA in patients with lower MMD of 8 mm, Type I and II Sher classification and a <2 in the GILLS, that do not respond to conservative management in prone or nasopharyngeal tubes, or as a rescue measure in patients with a MMD >8 mm in whom the MDO failed.[28,30,33,34]

MDO

It has been reported that 12.2% to 23% of PRS patients require tracheostomy[35] when other measures have not succeeded. To avoid this outcome, MDO has been proposed as an effective treatment to ameliorate respiratory difficulty and relieve feeding problems in PRS patients. Mandibular elongation causes a forward displacement of the tongue and a pharyngeal space widening. However, this procedure has potential risks such as inferior alveolar nerve damage, facial nerve damage, mandible malunion or nonunion, temporomandibular joint ankylosis, tooth-germ damage, pin site infections, osteomyelitis, and mandibular growth abnormalities.[29]

Flores et al compared the effects of MDO versus TLA standing out that patients who underwent MDO reported oxygen saturation levels significantly higher than those of patients who underwent

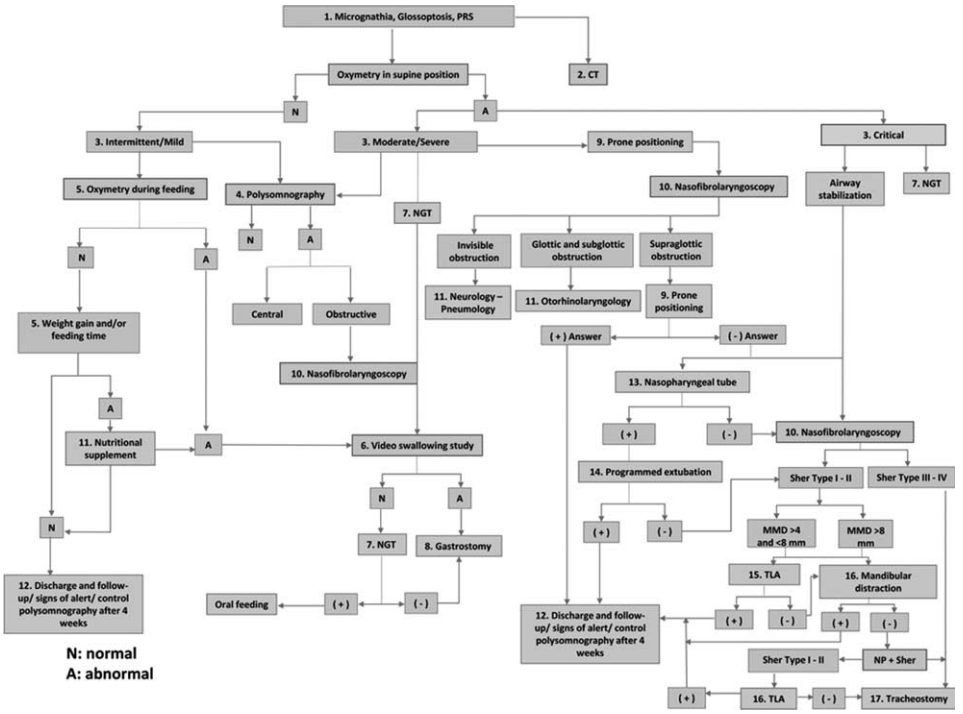

FIGURE 3. Evidence-based algorithm for Pierre Robin sequence management.

TLA at 1 month (98.3% versus 87.5%; $P < 0.05$) and at 12 months (98.5% versus 89.2%; $P < 0.05$) of comparison. Similarly, the MDO group had a lower apnea-hypopnea index than the TLA group at 1 month (10.9 versus 21.6; $P < 0.05$) and at 12 months (2.5 versus 22.1; $P < 0.05$) following the surgical procedure. Tracheostomy was not necessary in the MDO group, whereas it was required in 4 patients of the TLA group.[29]

The literature that proposes MDO as the first line for these patients is numerous.[29] Importantly, when comparing results of MDO to solve airway obstruction in PRS patients, the data vary depending on whether the condition is syndromic or isolated. It has been reported a failure risk of MDO 4 times higher in the first ones; therefore, syndromic patients must be examined deeply before MDO intervention. Among the factors causing failure in this group are congenital cardiac anomalies, nondiagnosed central apneas, and pulmonary hypertension, and others.[34]

Shen and Jie[36] found as indications for MDO: oxygen saturation <40% in the prone position, distance from the posterior pharyngeal wall to the root of the tongue <3 mm in a lateral projection of cephalometry, and even mentioned a distance >5 mm as a contraindication to MDO

Considering all this, it is highly recommended to use MDO in PRS patients with Sher I or II classification, who do not respond to conservative treatment in prone positioning or nasopharyngeal tube or those with a MMD ≥8, a distance from the posterior pharyngeal wall to the root of the tongue <3 mm, or as a rescue measure in those in whom TLA has failed.

Evidence-based Treatment Algorithm

Resulting from the analysis of the available evidence, a management sequence to minimize PRS patients' morbidity and mortality is proposed as follows (Fig. 3):

(1) The presence of the clinical triad, micrognathia (MMD >4 mm),[22,37–39] glossoptosis (tongue verticalization with forward movement limitation), and respiratory difficulty, allows for a PRS diagnosis.[22,35–37] However, patients with isolated micrognathia may present clinical signs of airway obstruction with normal oxymetries in supine position and an increased risk of apparent life-threatening events (ALTE). Oxymetry in supine position (oxygen saturation for ≥12 hours) is a reliable examination to determine the oxygenation degree in a newborn. When it is abnormal, it can be classified as significant (oxygen saturation <90% and >5% of the total time) or critical (episode of saturation <80%, respiratory failure or CO_2 retention signs with a base excess >6.5).[1,5,25,39,40]

(2) A computerized tomography (CT) with 3-dimensional reconstruction (axial and sagittal planes) and measure of airway anteroposterior dimension[41] must be taken from the posterior pharyngeal wall to the base of tongue at C1. The CT allows to plan the treatment, orient surgery, and evaluate response to treatment. Mahrous Mohamed et al[41] proved that pre and postoperative CT increase the anteroposterior dimension of the airway caliber in 141% average in patients who undergo MDO.

(3) Airway obstruction is defined as degree of respiratory difficulty caused by mechanical obstruction. In PRS patients, it can be classified as:[5,40]

Intermittent: It is hard to diagnose during the day as its clinical signs are barely evident or inexistent. There may be noisy respiration, oral respiration, chapped upper-lip, and delayed growth that may worsen between the 1st and 8th week of life.[4,27,38,42,43]

Mild: It is diagnosed when oxygen desaturation occurs during feeding and is improved with oxygen supply.[27] Then, an oximetry during feeding must be conducted in patients with normal oxymetries in supine position (intermittent or mild respiratory difficulty).[1,5,39,44]

Moderate: It is characterized by desaturation episodes in supine positions >5% of the measured time, which require

continuous prone positioning or nasopharyngeal intubation. They also present feeding difficulty that requires NGT.[27]
Severe: It is marked by continuous desaturation that may require airway intervention during hospital admission or afterwards according to evolution and response to prone positioning.
Critical: It requires urgent intervention to stabilize airway (orotracheal intubation or laryngeal mask).[25,27,40,42]

(4) For all patients with micrognathia, besides oximetry in supine position, it is recommended to conduct a polysomnography, given that airway obstruction in these patients worsens during sleep.[24,42,44–46.] Polysomnography makes possible to differentiate the central or obstructive origin of apneas and supervise response to treatment.[5] OSAHS may be diagnosed with occurrence of saturation <85% and an apnea-hypopnea index >5.[23,42,44]
For all patients with abnormal oxymetries in supine position or polysomnography results showing obstructive or mixed pattern, it is recommended to carry out NFL to evaluate the degree of obstruction. Supraglottic obstructions should be classified according to Sher typology.[23,27,28,47] Cruz et al[47] reported that 23% of patients have a degree of obstruction additional to the base of tongue, it can be laryngomalacia, tracheomalacia, or subglottic stenosis (468). The latter may occur in 33% of PRS patients in comparison to normal population rates of 0% to 2%.[43]

(5) When a patient exhibits normal oxymetry during feeding, weight gain and feeding time must be surveilled.[1,49] If weight gain is poor and saturation control is satisfactory, nutritional supplements with high caloric content should be administered.[5,49,50]

(6) Video swallowing study is suggested when the patient exhibits normal oxymetry during feeding, abnormal weight gain that does not improve with nutritional supplementation (<20–30 g/day), abnormal feeding time (>30 mins), and moderate or severe respiratory difficulty.[1,24,44,51]

(7) Nasogastric intubation should be applied when the video swallowing study reports normality and weight gain is scant or inexistent.[52–55]

(8) When the video swallowing study shows severe deglutition disorders, it is a predictor for the continuous use of NGT and, hence, gastrostomy.[47] Once the weight gain is satisfactory, constant NGT feeding is replaced by feeding bolus and finally oral feeding. Infants must be examined by phonoaudiologists and encouraged to suck. Initially, bottle must be administered twice a day during 10 minutes; then, this frequency can be increased gradually if the oxygen saturation and the weight gain continue to be satisfactory.

(9) If airway obstruction is caused by the tongue, prone positioning procedure must be implemented immediately, even in patients with moderate or severe respiratory difficulty.[1,38,40,46,50,54,56,57] However, when respiratory difficulty is critical, the airway must be stabilized immediately using nasopharyngeal tube, laryngeal mask, or orotracheal intubation and the patient must be transferred to the intensive care unit.[1,5,40]

(10) Once the patient is stabilized, NFL should be conducted.

(11) If it shows nonvisible obstruction, a neurological development disorder or bronchopulmonary abnormalities should be suspected, and they may require pneumology and neurology consultancy. If, oppositely, the NFL reports glottis and subglottic obstruction, the patient should be treated in the otorhinolaryngology service.[39,46]

(12) In case of supraglottic obstruction, response to initial prone positioning must be evaluated. If it is favorable and is joint by adequate weight gain, the patient will be discharged and followed-up.[43,46,50,56–58]

(13) When premature patients, with mild to moderate obstruction, pharynx-tongue distance >4 mm[36] and Type I and II classification, do not respond adequately to initial prone positioning, nasopharyngeal intubation must be implemented.

(14) If there is clinical improvement with nasopharyngeal tube, programmed extubation will be conducted. First, the tube must be retired for 4 hours a day whereas weight gain and airway are surveilled during 4 to 5 days. Then, the time without tube is increased in 4 hours every 4 to 5 days until it is no longer necessary. For patient discharge, the following criteria will be considered: no need for tube during 4 days, satisfactory weight gain, adequate adherence, and education of parents and caregivers to feed the child.[1,3–5,25,36,59]

(15) In case of programmed extubation is not tolerated or nasopharyngeal tube treatment failure is presented, TLA is indicated in patients with Sher I and II classification, GILLS score ≤2, weight >2 kg, and MMD <8 mm. Whether MOD fails, TLA is implemented as a rescue maneuver when the following criteria are satisfied: Sher I or II, GILLS score ≤2, and weight ≥2 kg[4,29,31,32,46,54,60,61]

(16) MDO must be determined in patients with NFL reported with Sher I or II, who are not candidates for primary management with nasopharyngeal tube: MMD >8 mm, pharynx-tongue distance <3 mm,[36] Sher I or II classification, failed decannulation, and primary failure of nasopharyngeal tube or failed programmed extubation[29,30,35–37,39,44,46,48,62–65]

(17) Tracheostomy must be conducted in patients with failed MDO, GILLS score ≥3, failed TLA, and Type III and IV in Sher classification.[28,29,31,32,50,54]
If patients exhibit weight gain, normal feeding times, and improvement of airway obstruction, they will be discharged and followed-up without dismissing the risk of ALTE.

Significant obstruction may appear between the 1st and 8th week of life or may deteriorate progressively. Wilson et al[43] found that 70% of 10 PRS patients showed signs of late obstruction between 24 and 51 days of age. For that reason, control polysomnography is recommended at 4 weeks of age. For parents to manage PRS patients at home, it is recommended to avoid neck flexion, to keep the mouth free of secretions, to look out for signs such as noisy breathing, open mouth while breathing, chapped upper lip and delay in growth.[5,40,58] Figure 3 illustrates the treatment algorithm proposed in this study.

DISCUSSION

There is no consensus in literature about the treatment of PRS patients nor are there multicenter studies that compare different management modalities. To classify the available evidence regarding this issue, it implies defined instruments already probed for it. Therefore, a literature review was conducted to compare different types of treatment (conservative and surgical) and their outcomes in achieving decannulation and avoiding tracheostomy and gastrostomy. Results were analyzed using the GRADE methodology to assess literature quality and the PICO strategy (Patients, Intervention, Comparison, Outcomes) to frame questions[6–21]

Owing to the nature of PRS, it is not possible to randomize the patients in groups for a specific treatment. It is not ethically permissible to conduct surgical procedures for comparison of effectiveness in patients who have an adequate response to prone positioning; for that reason and because of their methodological design, most of the studies had a low and very low quality of evidence in the GRADE scale and some of them could not be assessed in this scale.

Natural evolution of PRS patients is characterized by improvement of airway obstruction and feeding difficulties during the first year of life. As the mandible grows, the pharyngeal space widens and coordination of parapharyngeal and tongue muscles improves, according to the neurodevelopment..

PRS patients are clinically diagnosed. However, NFL allows to identify the site and pattern of the respiratory obstruction with high sensibility and specificity in comparison to polysomnography, in addition to low complication rates.

Sher classification, described in 1986, helps to establish anatomic, morphologic, and dynamic relations among the base of tongue, the soft palate and the pharyngeal walls. Sher Types III and IV, which exhibit pharyngeal wall prolapse, are generally found in syndromic PRS patients. Conservative treatments or mandibular distraction do not modify this pattern, so tracheostomy is recommended to secure airway.

Unlike conventional CT, a helical CT provides sufficient data to create 3D images in less scanning time and radiation exposure. It allows to measure MMD, anteroposterior and transversal caliber of airway, mandibular body and ramus lengths, and the distance from the posterior pharyngeal wall to the hyoid bone. It also offers a 3D reconstruction of the facial skeleton and the airway. Although the anteroposterior diameter of the airway caliber can be measured in a lateral cephalometric radiograph, a CT allows to measure both axes and calculate the increase in mandibular size, providing better information for presurgical planning and postoperative follow-up[41,36]

Nasopharyngeal tube is one of the most revolutionary options to manage respiratory difficulty in PRS patients. Surprisingly, its use is not widespread yet and, in fact, other strategies such as MDO are still first-line management in many institutions around the world, despite of the probed efficacy and the minimal or null impact on the morbidity and mortality that has nasopharyngeal tube.

Recently, other procedures have been tested to manage respiratory difficulty in PRS patients. Continuous positive airway pressure has called many health professionals' attention for being a noninvasive therapeutic strategy. It has showed interesting results in avoiding tracheostomy for children with moderate and severe respiratory difficulty.[66] However, these published series were conducted with few patients, so randomized studies with a greater number of children are necessary to draw decisive conclusions.

The studies reviewed show favorable success rates and minimal morbidity in cases of moderate to severe airway obstruction when conservative measures are implemented. Therefore, these strategies are recommended as first-line treatment for PRS patients[3,33,34] Reviewed articles comparing different modalities of conservative treatment (prone positioning, nasopharyngeal tube) among them and with TLA were not found.

Viezel-Mathieu et al founded that TLA ameliorated respiratory obstruction in most cases, with better results in nonsyndromic than in syndromic patients, in addition to low complications rate when compared with tracheostomy and MDO. Nevertheless, taking into account the TLA was released at 17.9 months in average, other outcomes as speaking, feeding route, or gastrostomy needing were not evaluated.[34] Accordingly, in our opinion, the MMD and Sher classification are the main determinants to select the treatment modality. Indeed, as MMD increases, a more severe OSAHS and prolonged nasopharyngeal tube use can be expected. At this time, TLA or MDO should be considered as management alternatives.[33,34]

It is well documented that respiratory difficulty along with feeding problems derived from it, from tongue retroposition and cleft palate, may cause growth failure.[4] Promoting exclusive oral feeding and early removal of tube must be primary objectives of PRS treatment, considering the risk of developing gastroesophageal reflux that prolonged use of NGT entails, especially when is associated with respiratory difficulty.[4]

CONCLUSION

Based on the anatomical principles and natural evolution of PRS, the clinical scenario must be evaluated thoroughly as a dynamic event and professionals of each discipline must articulate their expertise timely. Only then a management sequence can be designed to minimize inherent morbidity and mortality and accelerate patients' reinsertion to normal life with all of the potentials of a healthy child.

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