Robin Sequence

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15.1 Definition

Robin sequence (RS) is a congenital condition characterized by micrognathia, glossoptosis, and upper airway obstruction. Consensus was reached that micrognathia is the primary characteristic of RS. Other mandatory diagnostic characteristics include glossoptosis and airway obstruction. Cleft palate is considered a common and additional feature (Breugem and Evans 2016). The incidence of RS in the general population is 1/8500–1/14000 live births (Bush and Williams 1983; Printzlau and Andersen 2004) (Fig. 15.1).

According to Cohen classification (Cohen 1999), there are three distinct groups of RS: RS as a component of a known syndrome; RS associated with an anomaly but without constituting a specific syndrome; and isolated RS, when not associated with other malformations or syndromes. Several syndromes can

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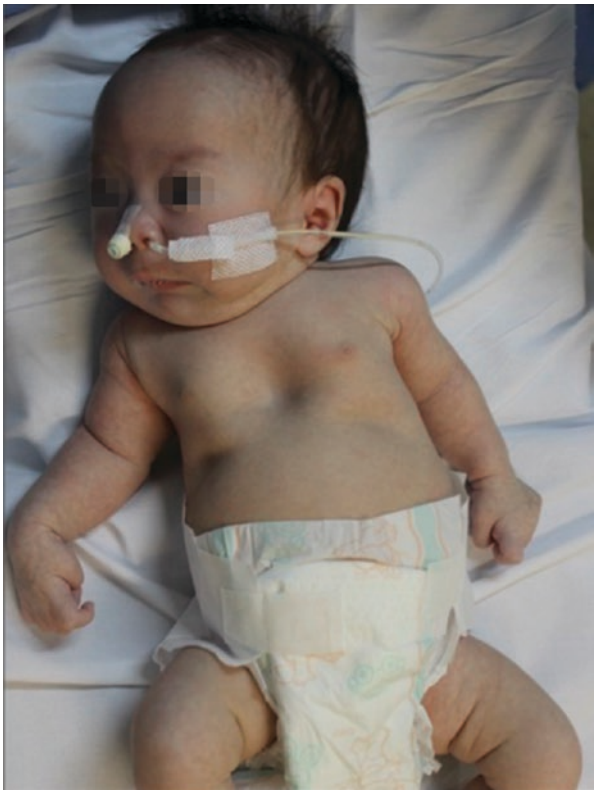

Fig. 15.1 Isolated RS patient (micrognathia and sternal retraction due to respiratory obstruction)

be associated with the RS, the most frequent being Stickler syndrome (Antunes et al. 2012). Other syndromes more frequently associated are velocardiofacial syndrome, fetal alcohol syndrome, Treacher Collins syndrome, and cerebrocostomandibular syndrome (Cohen 1976; Marques et al. 2001; Shprintzen 1992) (Fig. 15.2).

15.2 Etiological Diagnosis

In a sequence, all or most of the anomalies are caused by a primary abnormality. Micrognathia is the hypothesized initiating event in RS and it is a clinical component in several disorders (Breugem and Evans 2016). This way, the great variation of conditions in which the triad appears suggests heterogeneity of the etiological agents (Cohen 1979).

The cause of isolated RS is still unknown; however, patients with isolated RS have a stronger family history of cleft lip and/or palate. Marques et al. (1998) studied 36 infants with isolated RS and found positive family history in 27.7% of cases. In addition, there is an increased incidence in twins when compared to general

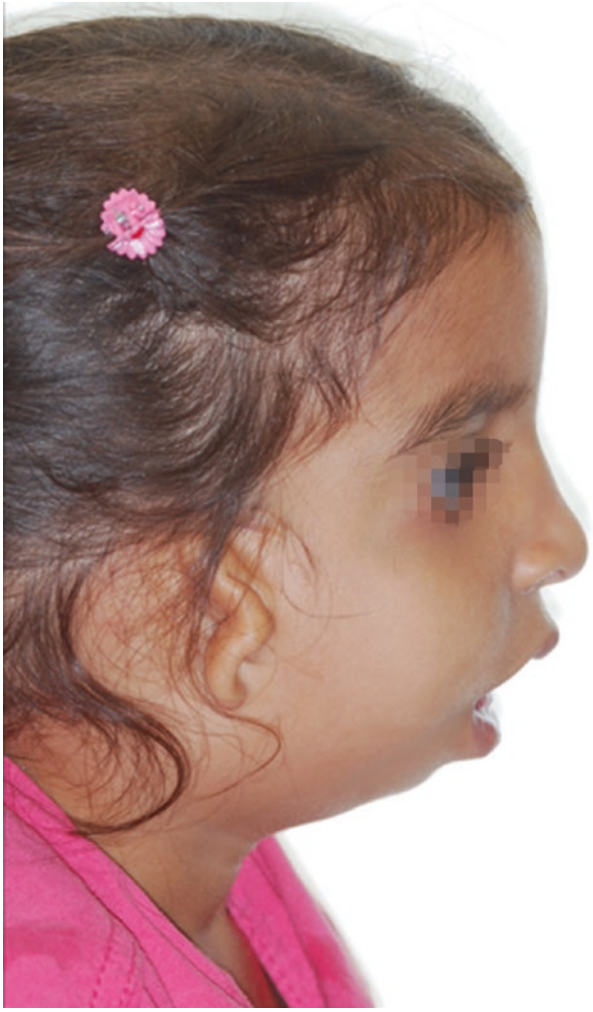

Fig. 15.2 RS associated to Treacher Collins syndrome (severe micrognathia)

population. In the study by Jakobsen et al. (2006), there was a failed attempt to identify causative genes, but it was found that only genes in GAD67 2q31, 11q23-q24 in PVRL1, and SOX9 gene in the 24.3-17q q 25.1 appear to be important. Later in 2007, Jakobsen et al. (2007) studied ten patients with isolated PRS and their findings suggest that this disease can be caused by defect in the SOX9 and KCNJ2 genes, as evidenced by their decreased expressions in the studied patients. The SOX9 gene regulates the growth of collagen during the formation of cartilage and endochondral bone.

For the syndromic patients, the mode of inheritance is particular to each associated syndrome. For example, Stickler syndrome is a connective tissue disorder with autosomal dominant inheritance. The RS plus patient group with associated

nonsyndromic anomalies is even more heterogeneous, some of them with genetic abnormalities. RS has been observed in association with congenital hypotonia and skeletal and connective tissue disorders.

15.3 Clinical Presentation

Clinical expression of RS is very heterogeneous, ranging from discrete respiratory distress and mild feeding problems to suffocation and death. The clinical manifestations are more frequent and more severe in the first months of life (Freeman and Manners 1980). It can be apparent shortly after birth or when feeding is initiated. Symptoms of respiratory obstruction are noisy breathing, intercostal retractions, and apnea. Another clinical manifestation is dyspnea, apnea, or very lengthy feeding time. As several factors can contribute to the upper airway obstruction, there may be no correlation between the severity of micrognathia and the severity of respiratory distress and difficulty feeding. Infants with mild degree of mandibular deficiency may show severe respiratory symptoms and dysphagia (Singer and Sidoti 1992).

Some studies have shown that the respiratory and feeding problems are a result of a combination of the abnormal anatomy and factors associated with neuromotor development of pharyngeal and genioglossus muscles (Souza et al. 2003; Marques et al. 2005a).

Respiratory obstruction is multifactorial. It is related to anatomical jaw abnormalities—micrognathia and consequent glossoptosis, with a decrease in effectiveness of the genioglossus muscle to prevent tongue drop, due to its posterior insertion. The respiratory obstruction observed in these patients can be translated by the high prevalence of obstructive sleep apnea syndrome (OSAS) present in RS. Approximately 85% of these patients with less than 1 year present OSAS, with a clear tendency towards greater severity, the younger the child is (Anderson et al. 2011).

Malnutrition is an important contributing factor to the severity of respiratory obstruction because, in the neonatal period and in early childhood, it is associated with delay in neuromuscular development (Marques et al. 2005a).

Feeding difficulties, aspiration, vomiting, and dysphagia are usually secondary to airway obstruction and are worsened by the presence of cleft palate (Lidsky et al. 2008). The obstruction causes difficulties in coordination of sucking, swallowing, and breathing. Glossoptosis doesn't allow anterior position of the tongue and the cleft palate causes less intraoral negative pressure, which is required to create efficient suctioning as well as prevent nasal reflux (Nassar et al. 2006).

Manometry has been used to study the relationship between airway obstruction and difficulty feeding in PRS infants. The negative pharyngeal pressure during

breastfeeding increases with continuous suctioning and breathing attempts. A negative pressure greater than 60 mm Hg sucks the tongue, closing the lower pharynx, during attempts to inspiration and suction. It was also reported that the frequent vomiting is due to gastric distension secondary to swallowing of air, during inspiration attempts against the blocked airway (Fletcher et al. 1969). Other studies have shown primary motor dysfunction of upper gastrointestinal tract in infants with RS (Baudon et al. 2002).

The high negative intrathoracic pressure generated during obstructive sleep apnea causes worsening reflux and aspiration in children with obstructive sleep apnea syndrome, which tends to improve with treatment of the respiratory problem.

15.4 Cleft Palate

The abnormal jaw embryological development occurs between the 7th and 11th weeks of gestation, resulting in a high position of the tongue in the nasopharynx, while palatal shelves start their growth towards the midline. An explanation for the presence of cleft palate would be the inability of the tongue to descend, due to lack of mandibular growth, preventing the shelves to fuse (Elliot et al. 1995). There are descriptions of a much higher frequency of U-shaped cleft palate, complete and wide, and this was considered a leading cause of delay in the morphogenesis of the swallowing and mastication musculature and impairment of mandibular growth and worst respiratory impairment (Marques et al. 1998) (Fig. 15.3).

Fig. 15.3 "U"-shaped cleft palate and glossoptosis associated in RS newborn

15.5 Diagnosis

The diagnostic process begins with identification of clinical findings present in RS and classification of the severity of symptoms. The anatomy and function of orofacial structures can contribute to making the diagnosis but do not correlate with severity of symptoms.

It is important to consider that the diagnosis of micrognathia, initiating event of RS, is subjective as glossoptosis. It can be difficult to judge the severity of tongue base airway obstruction and a possibility of multilevel obstruction associated. Signs of upper airway obstruction can be intermittent and are more likely to be present when the infant is asleep. The initial assessment of the clinical features and severity of respiratory distress is important and has practical implications (Breugem and Evans 2016). Therefore, a multidisciplinary team must evaluate suspicious cases of RS and thorough investigation should take place.

15.5.1 Prenatal Diagnosis

Prenatal recognition of suspected RS allows planning and immediate intervention at birth and prevention of life-threatening situation. The main ultrasonographic findings are polyhydramnios, micrognathia, and glossoptosis.

Polyhydramnios is considered because it may be associated to swallowing difficulties. It is observed in approximately 65% of fetuses with micrognathia (Bromley and Benacerraf 1994). Since micrognathia is associated with several syndromes and malformations, it should not be the only finding taken into consideration (Bronshtein et al. 2005; Izumi et al. 2012; Luedders et al. 2011). Glossoptosis is more closely associated with prenatal diagnosis. The ultrasonographic analysis should be dynamic and diagnosis is made when the tongue is positioned posteriorly during most of the examination, approximately 20–30 min, and is not observed anterior to the inferior alveolar margin at any time (Bronshtein et al. 2005).

15.5.2 Physical Examination

The observation of the clinical triad of RS is usually made in the first days of life. Gestational age and birth weight are no different from normal patients and do not vary depending on the severity of cases. At birth, the micrognathia is the most evident feature in patients with RS. It is characterized by a small and/or retropositioned jaw, with increased overjet. The facial profile is convex due to lack of projection of the lower third. The nasolabial angle and maxillary position are normal (Fig. 15.7).

Intraoral examination reveals tongue base collapse, especially when the baby is in supine position. Cleft palate is present in 90% of cases, 75% of cases being wide and complete and 25% of them narrow or incomplete, “V” shaped (Marques et al. 1998; Spina et al. 1972).

Some children with RS are robust and strong, while others may present with significant hypotonia (due to associated neurological impairment) or severe cyanosis (due to cardiac structural changes) (Abadie et al. 2002). Newborns may present with minimal

respiratory distress at birth while others have significant airway obstruction, with nasal flaring, cyanosis, stridor, and subcostal retraction. Suspecting the diagnosis of PRS, it is important to identify eventual other associated anomalies and syndromes.

15.5.3 Pulse Oximetry

Continuous pulse oximetry has been used as a tool to assess severity of respiratory distress and sometimes is the only available tool to evaluate pediatric respiratory impairment in settings with limited resources. However, obstruction, central or mixed, and sleep fragmentation are not always associated with decreased oxygen saturation.

Intermittent oxygen desaturation during sleep in children is highly suggestive of the presence of sleep disturbance and it is a good indicative to which of them will require polysomnography. The examination must be continuous for at least 6 h of sleep and a drop of 4% or more is considered desaturation. A set of desaturation happens when there are more desaturation episodes in a period of 10–30 min. The pulse oximetry should be considered positive when there are three or more sets of desaturation and at least three readings below 90% (Brouillette et al. 2000).

15.5.4 Polysomnography

This test allows for evaluation of early respiratory variables, confirming the clinical suspicion of respiratory sleeping disturbances in children, in order to guide any necessary clinical treatment or to justify appropriate surgical intervention (Freed et al. 1988) (Fig. 15.4).

The polysomnogram (PSG) assesses quality of sleep, has excellent reproducibility, and documents the presence of snoring and respiratory events (obstructive sleep apnea, central and mixed, hypopneas, and airflow restriction), oxygen saturation, and patient movements. The PSG distinguishes obstructive from central apnea or epileptic activity in children with neurological diseases (Society 1999). Ideally, the test is performed overnight, but polysomnography during daytime for at least 2 h shows acceptable sensitivity and specificity.

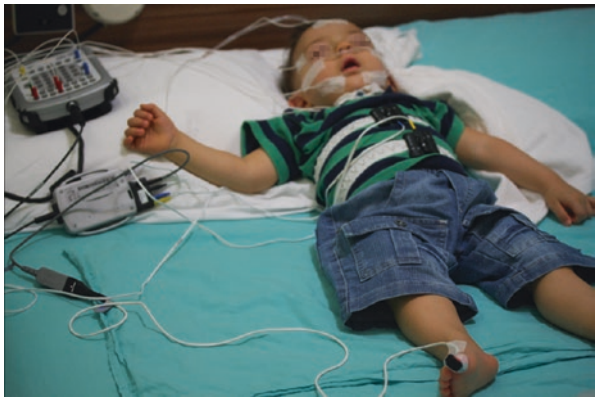

Fig. 15.4 Polysomnography exam in RS to evaluate respiratory disorders

15.5.5 Endoscopic Airway Evaluation

Clinical presentation alone is not sufficient to predict the evolution of airway obstruction in PRS patients. It is important to elucidate the cause to appropriately treat it. The nasopharyngeal endoscopy is the best tool for the visualization of airway in order to detect structural abnormalities (de Sousa et al. 2003).

Glossoptosis is usually the main cause for airway obstruction, but other structures can abnormally function (Fig. 15.5).

The endoscopic examination is subjective and does not evaluate the patient during rest or sleep. Many authors have shown that there is no correlation between clinical severity and isolated glossoptosis. The existence of tonsillar hypertrophy, shape and position of the epiglottis and arytenoids, aspect of the cartilaginous framework, mobility of vocal folds, pharyngeal hypotonia, and nasal atresia must be evaluated. The thorough analysis increases the test sensitivity and specificity. Laryngomalacia is the main cause of stridor in babies.

Respiratory obstruction in PRS is not always caused by glossoptosis. Multilevel obstruction could be associated to glossoptosis and contribute to respiratory distress. Nasopharyngoscopy studies in patients with craniofacial anomalies and obstructive sleep apnea, including RS (Sher et al. 1986; Sher 1992), demonstrated besides laryngomalacia, vocal fold disorder, other types of obstruction. Type 1: the obstruction is due to tongue drop, which rests on posterior pharynx, below the soft palate; type 2: the tongue moves posteriorly and compresses, partially or totally, the soft palate against the posterior wall of the pharynx; type 3: the lateral pharyngeal walls move medially, causing airway obstruction; and type 4: there is a sphincteric constriction of the pharynx in all directions. The tongue doesn't participate in obstruction of types 3 and 4.

The diagnosis of airway obstruction sites is important to direct the treatment modality.

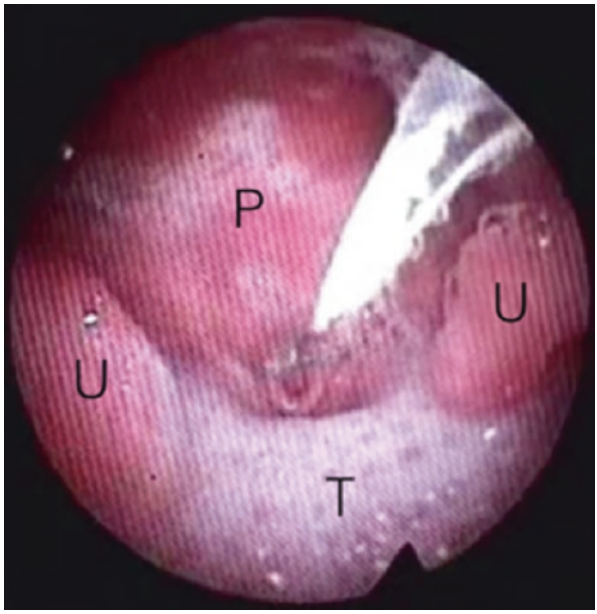

Fig. 15.5 Glossoptosis evaluated by endoscopic superior airway. The base of the tongue is pushing the epiglottis. (T: tongue, U: uvula, P: pharyngeal posterior wall)

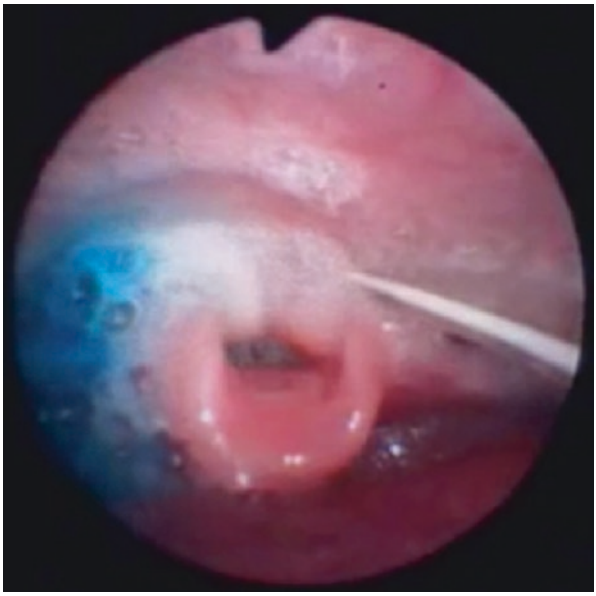

Fig. 15.6 Tracheal aspiration of colored saliva during swallowing endoscopy

15.5.6 Swallowing Studies

Endoscopy is also helpful to evaluate oropharyngeal dysphagia. It is a simple and safe tool, even in infants. It is extremely important before starting diet by mouth, since it evaluates for aspiration risk. When there is reflux of milk through the nasopharyngeal airway and/or delay in swallowing as well as presence of residual milk in the epiglottis, vocal folds or trachea are findings of possible aspiration (Macedo 2000) (Fig. 15.6).

Barium swallow study is another adjunct in evaluating unsynchronized tongue and esophageal movement. It is also considered abnormal when there is evidence of more than 1-s pharyngeal phase of swallowing and penetration of barium in the laryngeal vestibule above the vocal folds or trachea.

All RS patients present some degree of tongue movement abnormality and studies have shown more than 66% presenting penetration of contrast in laryngeal vestibule and 50% presenting residual material in pharyngeal recess during the first months of life (Monasterio et al. 2004).

15.5.7 Genetic Analysis

If there is a suspicion for RS, genetic evaluation should be obtained. Family history of cleft palate may be present in 27% of cases of isolated RS (Marques et al. 1998), but other authors have pointed out that there is no genetic relevant factor in this disease (Edwards and Newall 1985).

There is increased prevalence of prenatal exposure to teratogenic agents and chromosomal abnormalities in patients with RS (Izumi et al. 2012).

It is difficult to make the genetic diagnosis during the neonatal period and usually requires long-term follow-up. The facial features of specific syndromes are usually absent at this early stage and become more obvious with development. Similarly, specific medical characteristics to each syndrome usually develop after the neonatal period.

Stickler syndrome is the genetic diagnosis most commonly associated with PRS, 11 to 18% (Evans et al. 2011). It is an autosomal dominant disease. There is associated hypoplastic midface, flat nasal bridge (Marques et al. 1998), in addition to ocular abnormalities, such as severe myopia, retinal detachment and glaucoma, conductive or neurosensory hearing loss, and joint hypermobility leading to early osteoarthritis (Antunes et al. 2012). Such clinical characteristics are very suggestive of the diagnosis, but molecular analysis is required for confirmation since other syndromes may have similar phenotype. Mutations in the genes COL2A1, COL1A1, COL1A2, or COL9A1 are present in 75% of cases of SS cases. Due to visual and auditory irreversible implications, every child must have an early assessment, no later than 6 months of life (Antunes et al. 2012) (Fig. 15.7).

Fig. 15.7 RS and Stickler syndrome

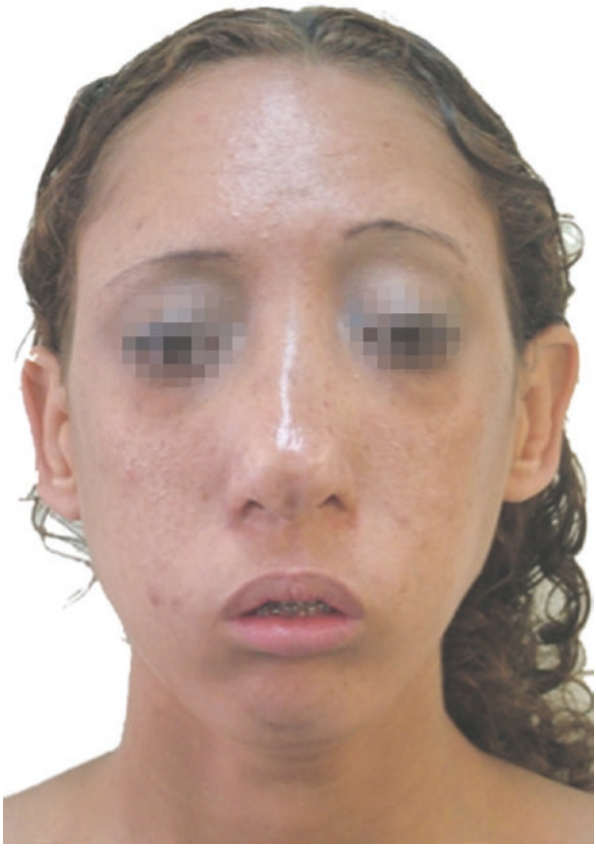

Fig. 15.8 RS and velocardiofacial syndrome

The second most frequent genetic association is velocardiofacial syndrome (Fig. 15.7), present in about 3% of cases (Marques et al. 1998). These patients present with long face due to vertical maxillary excess, prominent nose with wide dorsum and narrow ala base, thin upper lip, narrow palpebral fissures, low-set, malformed ears with long abundance, and microcephaly. Velopharyngeal insufficiency and neuropsychomotor development delay appear in 100% of cases, and cardiac changes in 82%. Deletion of chromosome 22q 11.2 confirms the diagnosis (Izumi et al. 2012) (Fig. 15.8).

15.5.8 Computed Tomography

Computed tomography (CT) is an important asset in difficult differential diagnosis and also for operative planning. The mandible is small and the deficiency is mainly limited to the mandibular body, with an obtuse gonial angle (Rogers et al. 2009). The posterior mandible height is significantly shorter in syndromic PRS patients

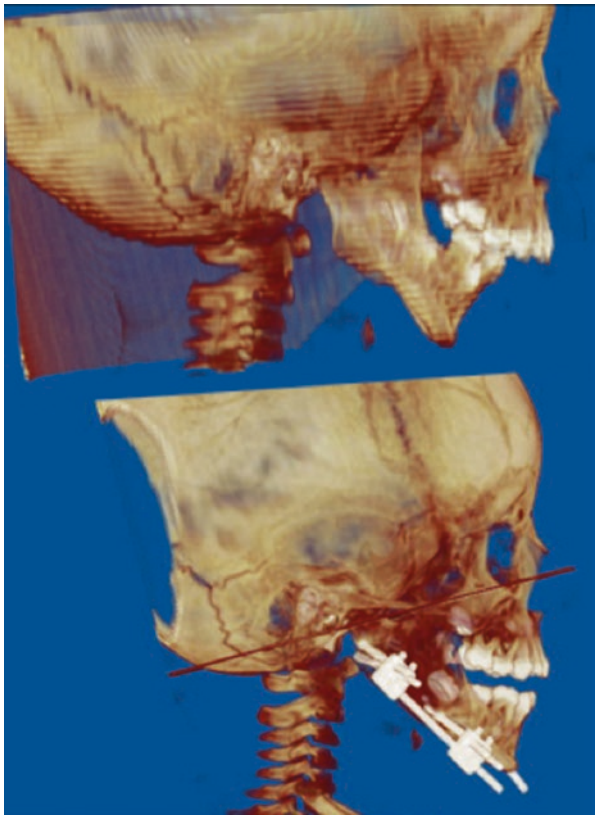

Fig. 15.9 3-dimensional reconstruction of CT scan pre- and postoperatively (MDO)

when compared to isolated cases (Glander and Cisneros 1992). Temporomandibular joint ankylosis or hypoplasia can be the cause of micrognathia. Other malformations, such as mandibular, zygomatic, craniosynostosis, cranial base, and ear, can also be identified with CT use. It is also very helpful in determining the osteotomy and vector for distraction osteogenesis (Chung et al. 2012; Alonso and Freitas 2002) (Fig. 15.9).

15.5.9 24-h Esophageal pH Testing

Gastroesophageal reflux disease (GERD) is present in up to 35% of RS patients and poses increased risk for respiratory events, recurrent pneumonia, ear infections, swallowing problems, and growth delay (Vandenplas et al. 1991). The esophageal pH monitoring should be performed in the inpatient setting after the first month of life and be repeated every 2 months if needed.

15.6 Treatment

The priority in the treatment of RS infants must be the maintenance of a patent airway as early as possible (Breugem and Evans 2016). Maintaining the airway permeability in these patients besides the correction of respiratory impairment and improvement of the alimentary difficulty could be obtained in the same time (Marques et al. 2005).

Airway obstruction in RS does depend not only on the anatomical abnormality of the mandible and/or the position of the tongue, but also on the intrinsic activity of the parapharyngeal muscles. This activity depends on individual maturation during the neonatal period. The degree of neuromuscular dysfunction and the speed of maturation of this function vary among patients and play an important role in the recovery of airway permeability (Marques et al. 2005; Sher 1992).

Another very important aspect to consider is the different evolution observed in patients with isolated SR and the form associated with syndromes.

While conservative treatment of airway obstruction in children with RS is possible and strongly recommended when it is possible, in syndromic conditions these options more frequently fail.

Some modalities of treatment for airway obstruction, surgical and nonsurgical, have been described; however, a consensus about the best approach is still unclear in our current literature.

15.6.1 Prone Position

The prone position could be effective for infants with mild airway obstruction. It facilitates breathing and prevents aspiration of saliva and food due to the cervical hyperextension and gravity position of the tongue. Prone position is not as effective for moderate and severe cases.

15.6.2 Nasopharyngeal Intubation

The nasopharyngeal airway (NPA) is a simple method to provide a patent airway and consists of introduction of a silicone cannula through the nostril showing excellent results specially in isolated RS patients. The cannula diameter measures 3–3.5 mm, and is introduced 7–8 cm passed the nostril, reaching the pharynx. The remaining of the external cannula is trimmed to leave approximately 1 cm outside. The location of the cannula internally remains at the level of the epiglottis (Marques et al. 2001).

NPA prevents the development of high negative pressure, the level of the posterior pharynx during inspiration, suction, and swallowing, improving the airway obstruction caused by the tongue drop. Moreover, the NPA is hollow and allows airflow through it (Fig. 15.10).

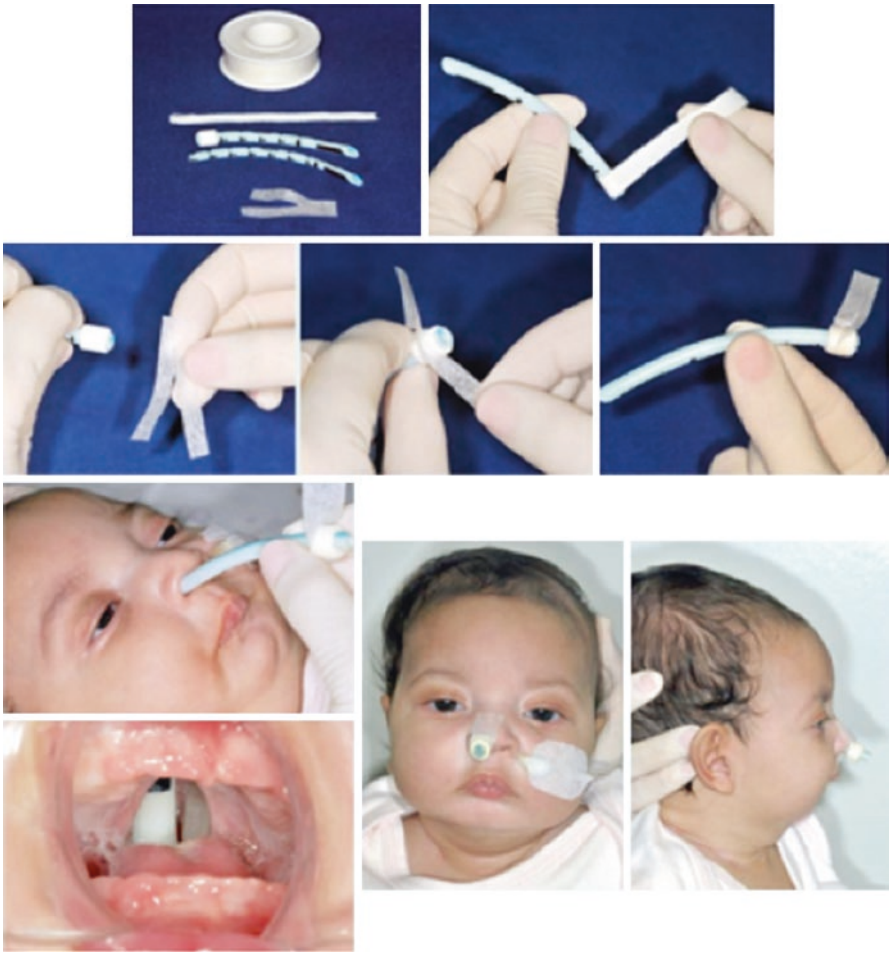

Fig. 15.10 RS patient treated with nasopharyngeal intubation

15.6.3 Glossopexy

In general, glossopexy consists of anchoring the tongue to the lower lip anteriorly and from the base of the tongue to the mandible. This allows the tongue to be anteriorized and respiratory obstruction to be replaced instead of the tracheostomy (Argamaso 1992).

Adhesion is maintained throughout the first year of life and is usually reversed at the time of palatoplasty, which occurs around 12 months of age.

Although the success rate with the use of this technique is high in selected patients, limiting tongue mobility tends to exacerbate the dysphagia, increasing the

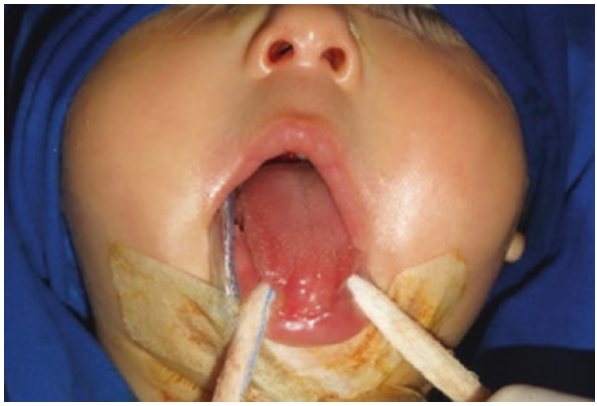

Fig. 15.11 RS patient undergone glossopexy (tongue lip adhesion)

likelihood of requiring a prolonged period of enteral supplementation via the nasogastric tube or gastrostomy (Abramowicz et al. 2012; Scott et al. 2012; Rogers et al. 2011; Evans et al. 2006).

The difficulty in treating dysphagia or even worsening of its symptoms observed after performing the procedure associated with complications such as adhesion dehiscence and pronounced edema of the tongue and oropharynx with a need for postoperative tracheostomy is one of the arguments used by most of the centers that abandoned this technique (Scott et al. 2012; Rogers et al. 2011).

In addition, situations in which the patient presents patterns of respiratory obstruction due to collapse of the pharyngeal walls to nasopharyngoscopy, syndromic diagnosis associated with low birth weight, presence of gastroesophageal reflux, and history of preoperative, among others, presents a high probability of failure with this practice (Marques et al. 2005; Abramowicz et al. 2012; Rogers et al. 2011).

Recent publications, however, have advocated in favor of glossopexy as a treatment of choice for specific groups of patients. The simplicity of the procedure, lower potential for scarring, facial nerve lesion, and dental germs, besides the absence of specialized equipment, are the arguments used by those who advocate their indication, especially when compared to MDO (Abramowicz et al. 2012; Scott et al. 2012; Rogers et al. 2011) (Fig. 15.11).

15.6.4 Mandibular Distraction Osteogenesis

Mandibular distraction osteogenesis (MDO) is characterized as a dynamic process, consisting of the elongation of the facial skeleton and adjacent soft parts, obtained through gradual traction applied to two osteotomized bone surfaces, by means of a mechanical device (Fig. 15.12).

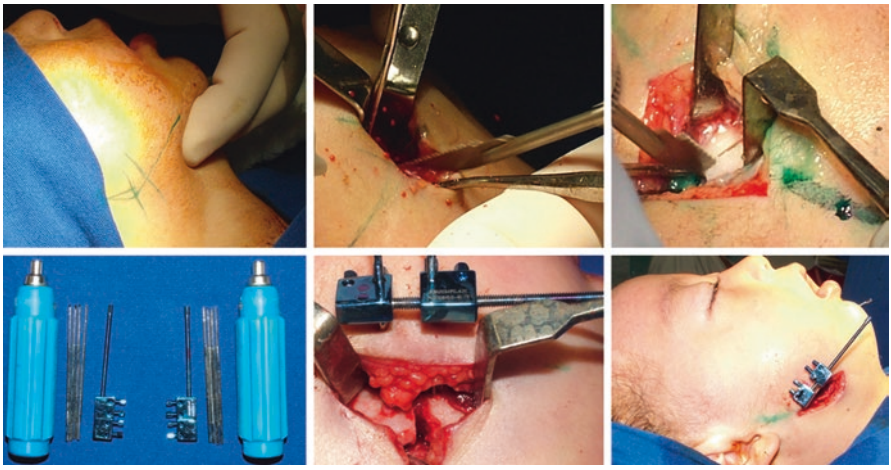

Fig. 15.12 RS patient undergone mandible osteotomy and placement of external devices to mandibular distraction

The MDO represents an alternative method to the traditional upper airway management of RS patients. The mandibular stretching promotes the positioning of the base tongue to a more anterior position, thus allowing the opening of the airway posteriorly. It can be observed that the MDO, when indicated in selected patients, prevents the tracheostomy in patients who did not respond to clinical treatments.

In addition, their results are apparently superior to those obtained with glossopexy, especially with regard to improved swallowing. In this way, this technique allows to avoid, in many cases, the indication of tracheostomy and gastrostomy (Scott et al. 2012; Rogers et al. 2011; Evans et al. 2006).

When compared to tracheostomy, considering the specific indications of each procedure, it presents lower rates of morbidity and mortality in addition to the cost savings of medical and hospital care (Hong et al. 2012).

Success in approximately 90% of cases can be observed when MDO is indicated in selected patients. However, as with other procedures, especially glossopexy, if these patients were adequately treated by specialized teams with gastroesophageal reflux control, use of feeding techniques and use of nasopharyngeal cannula, sometimes surgical indications would be unnecessary (Marques et al. 1998b, 2001, 2005; Scott et al. 2012).

Thus, possibly the best indication for MDO is reserved for cases in which glossoptosis is identified as a main cause of respiratory obstruction in patients with SR, preferably nonsyndromic, who do not respond to the different clinical measures employed and in those situations where we desire decannulation (Fig. 15.13).

Negative points related to MDO are mainly due to complications inherent to the procedure, besides aspects such as the cost of distractors and few services and surgeons being able to perform this procedure. The limitations on the results obtained

Fig. 15.13 RS patient previously MDO to decannulation and 2-year follow-up MDO

in patients with syndromic SR and those with respiratory obstruction due to collapsed upper airways resemble those of glossopexia. In these cases the tracheostomy appears as the technique of choice (Scott et al. 2012; Jarrahy 2012).

15.6.5 Tracheostomy

Upper airway obstruction treatment protocols usually reserve to tracheostomy, the last indication, or those situations in which other clinical or surgical procedures fail. Although this happens relatively frequently, it should be remembered that tracheostomy is considered the definitive technique to ensure a stable airway in patients with upper airway obstruction.

In addition, some cases will rarely improve with another technique, especially if the patient is an SR associated with the syndrome and present respiratory obstruction in which glossoptosis is not the main cause of respiratory impairment (Marques et al. 1998b, 2001, 2005; Rogers et al. 2011).

Neurologically compromised children have a risk of airway involvement regardless of glossoptosis. For this reason, addressing the obstruction of the tongue base with different techniques of tracheostomy in children with syndromic SR frequently is not appropriate. These interventions do not address associated factors such as hypotonia, poor coordination, or chronic aspiration. For patients with these comorbidities, the tracheostomy associated with gastrostomy allows an improvement of the respiratory function and maintenance of adequate nutrition (Scott et al. 2012).

Although tracheostomy could be the best indication in some situations, it presents considerable morbidity and mortality rates and requires specific care from the family and the care team. Thirteen some complications associated with tracheostomy, most of them observed in the first postoperative days, account for a mortality rate of approximately 0.7%. Adverse events related to this procedure include sudden airway obstruction by accidental decannulation and mucus impaction, airway infections, bleeding, stoma maintenance problems, tracheal stenosis, and appropriate speech inhibition and swallowing development (Scott et al. 2012; Rogers et al. 2011).

15.7 Dysphagia Treatment

Respiratory compromise leads to difficulty in coordination between suction, swallowing, and breathing. Therefore, clearing the airway obstruction is essential to improve feeding and nutrition. Besides this lack of coordination, glossoptosis also makes it difficult for the anteriorization of the tongue, necessary for adequate suction. The cleft palate causes a lack of negative pressure resulting in inefficient suction, nasal reflux of food, and higher risk of aspiration. Nutrition is usually managed through feeding tubes.

Facilitator techniques of feeding have been developed to stimulate oral feeding on PRS infants after treatment and clearance of the obstructed airway (Nassar et al. 2006; Marques et al. 2010). Gradual daily implementation of these techniques, in a short period of time, can promote oral feeding, as well as the discontinuity of feeding tubes. It consists of encouragement of non-nutritional suction through the use of pacifiers, massage to relax and anteriorize the tongue, manual support of the jaw, soft and long bottle nipples with a 1 mm puncture whole, nipple accurately place on the tongue, position of the child in a symmetrical global position, rhythmic movements of the nipple in the oral cavity, and thickening of the milk (Nassar et al. 2006; Marques et al. 2010).

Besides these techniques, swallowing endoscopies are frequently performed to monitor the risk of aspiration and decide the timing to initiate oral diet, which happens in approximately 2 weeks (Elliot et al. 1995; Marques et al. 2010).

Another strategy that can be used is the administration of a hypercaloric diet for newborns that allows the use of smaller volumes. It consists of formula or breastmilk boosted with 5–8% of glucose polymers, 3–5% of medium-chain triglycerides, and essential fatty acids (Marques et al. 2004).

If the patient is not able to be fed by mouth and requires extended tube feeds, gastrostomy tube may be indicated; this has been reported in up to 60% of patients (Salmen 2011).

Different publications have shown that in those institutions where glossopexy or even tracheostomy is indicated routinely, the number of patients submitted to gastrostomy is much higher when compared to those in which clinical measures or even MDO were indicated. In addition, a large proportion of patients with SR associated with neurological syndrome or neurological impairment will most often require surgical treatment, whereas in isolated form it is rarely needed (Marques et al. 2001, 2005; Scott et al. 2012).

15.8 Cleft Palate Repair

Palatoplasty is usually performed at 12 months of age. However, some conditions should be considered with palatoplasty in patients with SR.

Patients with SR present an increased risk of respiratory compromise in the postoperative period when compared to palatoplasty in patients with isolated palatine fissures.

The respiratory discomfort immediately installed after the procedure is a manifestation observed in some cases. Symptoms usually appear within the first 2 h after surgery, and most manifest within 48 h. Prolonged surgical time, excessive pressure exerted on the base of the tongue by the oral opener, and palate and tongue edema secondary to surgical manipulation associated with a basal micrognath condition are the main causes (Antony and Sloan 2002).

The respiratory discomfort after palatoplasty observed in some previously asymptomatic children results from a compromised but compensated upper airway. Respiratory obstruction may not manifest until the period of palatoplasty.

However, author's studies in progress have showed that immediate respiratory discomfort is limited. Clinical and PSG parameters improve following 6 months up the procedure (Carpes 2011).

References

Abadie V, Morisseau-Durand MP, Beyler C, Manach Y, Couly G. Brainstem dysfunction: a possible neuroembryological pathogenesis of isolated Pierre Robin sequence. Eur J Pediatr. 2002;161(5):275–80.

Abramowicz S, Bacic JD, Mulliken JB, Rogers GF. Validation of the GILLS score for tongue-lip adhesion in Robin sequence patients. J Craniofac Surg. 2012;23(2):382–6.

Alonso N, Freitas RS. Mandibular distraction: comparison between intraoral and extraoral devices. Braz J Craniomaxillofac Surg. 2002;5(2):15–8.

Anderson IC, Sedaghat AR, McGinley BM, et al. Prevalence and severity of obstructive sleep apnea and snoring in infants with Pierre Robin sequence. Cleft Palate Craniofac J. 2011;48(5):614–8.

Antony AK, Sloan GM. Airway obstruction following palatoplasty: analysis of 247 consecutive operations. Cleft Palate Craniofac J. 2002;39(2):145–8.

Antunes RB, Alonso N, Paula RG. Importance of early diagnosis of Stickler syndrome in newborns. J Plast Reconstr Aesthet Surg. 2012;65(8):1029–34.

Argamaso RV. Glossopexy for upper airway obstruction in Robin sequence. Cleft Palate Craniofac J. 1992;29(3):232–8.

Baudon JJ, Renault F, Goutet JM, Flores Guevara R, Soupre V, Gold F, Vazquez MP. Motor disfunction of the upper digestive tract in Pierre Robin sequence as assessed by sucking-swallowing eletromyography and esophageal manometry. J Pediatr. 2002;140:719–23.

Breugem CC, Evans KN. Best practices for the diagnosis and evaluation of infants with Robin sequence- a clinical consensus report. JAMA Pediatr. 2016;170(9):894–902.

Bromley B, Benacerraf BR. Fetal micrognathia: associated anomalies and outcome. J Ultrasound Med. 1994;13(7):529–33.

Bronshtein M, Blazer S, Zalel Y, Zimmer EZ. Ultrasonographic diagnosis of glossoptosis in fetuses with Pierre Robin sequence in early and mid pregnancy. Am J Obstet Gynecol. 2005;193(4):1561–4.

Brouillette RT, Morielli A, Leimanis A, Waters KA, Luciano R, Ducharme FM. Nocturnal pulse oximetry as an abbreviated testing modality for pediatric obstructive sleep apnea. Pediatrics. 2000;105(2):405–12.

Bush PG, Williams AJ. Incidence of the Robin anomalad (Pierre Robin syndrome). Br J Plast Surg. 1983;36:434–7.

Carpes AF. Avaliação polissonográfica e endoscópica em pacientes com Sequência de Robin isolada submetidas à palatoplastia. [tese]. São Paulo: Hospital das Clínicas da Faculdade de Medicina, Universidade de São Paulo; 2011.

Chung MT, Levi B, Hyun JS, Lo DD, Montoro DT, Lisiecki J. Pierre Robin sequence and Treacher Collins hypoplastic mandible comparison using three-dimensional morphometric analysis. J Craniofac Surg. 2012;23(7 Suppl 1):1959–63.

Cohen MM Jr. The Robin anomalad: its nonspecificity and associated syndromes. J Oral Surg. 1976;34:587–93.

Cohen MM Jr. Syndromology's message for craniofacial biology. J Maxilofac Surg. 1979;7:89–109.

Cohen MM Jr. Robin sequences and complexes: casual heterogeneity and pathogenetic/phenotypic variability. Am J Med Genet. 1999;84(4):311–5.

Edwards JR, Newall DR. The Pierre Robin syndrome reassessed in the light of recent research. Br J Plast Surg. 1985;38(3):339–42.

Elliot MA, Studen-Pevovich DA, Ranalli DN. Prevalence of selected pediatric conditions in children with Pierre Robin sequence. Pediatr Dent. 1995;17(2):106–11.

Evans AK, Rahbar R, Rogers GF, Mulliken JB, Volk MS. Robin sequence: a retrospective review of 115 patients. Int J Pediatr Otorhinolaryngol. 2006;70(6):973–80. Epub 2006 Jan 26

Evans KN, Sie KC, Hopper RA, Glass RP, Hing AV, Cunningham ML. Robin sequence: from diagnosis to development of an effective management plan. Pediatrics. 2011;127(5):936–48.

Fletcher MM, Blum SL, Blanchard CL. Pierre Robin syndrome pathophysiology of obstructive episodes. Laryngoscope. 1969;79:547–59.

Freed G, Pearlman MA, Brown AS, Barot LR. Polysomnographic indications for surgical intervention in Pierre Robin sequence: acute airway management and follow-up studies after repair and take-down of tongue-lip adhesion. Cleft Palate J. 1988;25(2):151–5.

Freeman MK, Manners JM. Cor pulmonale and the Pierre Robin anomaly. Airway management with a nasopharyngeal tube. Anaesthesia. 1980;35(3):282–6.

Glander K 2nd, Cisneros GJ. Comparison of the craniofacial characteristics of two syndromes associated with the Pierre Robin sequence. Cleft Palate Craniofac J. 1992;29(3):210–9.

Hong P, Bezuhly M, Mark Taylor S, Hart RD, Kearns DB, Corsten G. Tracheostomy versus mandibular distraction osteogenesis in Canadian children with Pierre Robin sequence: a comparative cost analysis. J Otolaryngol Head Neck Surg. 2012;41(3):207–14.

Izumi K, Konczal LL, Mitchell AL, Jones MC. Underlying genetic diagnosis of Pierre Robin sequence: retrospective chart review at two children's hospitals and a systematic literature review. J Pediatr. 2012;160(4):645–50 e2.

Jakobsen LP, Knudsen MA, Lespinasse J, García Ayuso C, Ramos C, Fryns JP. The genetic basis of the Pierre Robin sequence. Cleft Palate Craniofac J. 2006;43:155–9.

Jakobsen LP, Ullman R, Christensen SB, Jensen KE, Molsted K, Henriksen KF, Hansen C, Knudsen MA, Larsen LA, Tommerup N, Tümer Z. Pierre Robin sequence may be caused by dysregulation of SOX9 and KCNJ2. J Med Genet. 2007;44:381–6.

Jarrahy R. Controversies in the management of neonatal micrognathia: to distract or not to distract, that is the question. J Craniofac Surg. 2012;23(1):243–9.

Lidsky ME, Lander TA, Sidman JD. Resolving feeding difficulties with early airway intervention in Pierre Robin sequence. Laryngoscope. 2008;118:120–3.

Luedders DW, Bohlmann MK, Germer U, Axt-Fliedner R, Gembruch U, Weichert J. Fetal micrognathia: objective assessment and associated anomalies on prenatal sonogram. Prenat Diagn. 2011;31(2):146–51.

Macedo EF. Avaliação endoscópica da deglutição com nasofaringolaringoscópio (FEESH) na abordagem da disfagia orofaríngea. In: Castro LPS-RP, Melo JCR, Costa MMB, editors. Tópicos em gastroenterologia: deglutição e disfagia. Rio de Janeiro: Medsi; 2000. p. 71–82.

Marques IL, Barbieri MA, Bettiol H. Etiopathogenesis of isolated Robin sequence. Cleft Palate Craniofac J. 1998;35:517–25.

Marques IL, de Sousa TV, Carneiro AF, Barbieri MA, Bettiol H, Gutierrez MR. Clinical experience with infants with Robin sequence: a prospective study. Cleft Palate Craniofac J. 2001;38:171–8.
Marques IL, Peres SP, Bettiol H, Barbieri MA, Andrea M, Souza L. Growth of children with isolated Robin sequence treated by nasopharyngeal intubation: importance of a hypercaloric diet. Cleft Palate Craniofac. 2004;41:53–8.
Marques IL, Souza TV, Carneiro AF, Peres SP, Barbieri MA, Bettiol H. Seqüência de Robin-Protocolo único de tratamento. J Pediatr. 2005;81:14–22.
Marques IL, Prado-Oliveira R, Leirião VH, Jorge JC, Souza L. Clinical and fiberoptic endoscopic evaluation of swallowing in Robin sequence treated with nasopharyngeal intubation. The importance of feeding facilitating techniques. Cleft Palate-Craniofac J. 2010;47(5):523–9.
Monasterio FO, Molina F, Berlanga F, Lopez ME, Ahumada H, Takenaga RH. Swallowing disorders in Pierre Robin sequence: its correction by distraction. J Craniofac Surg. 2004;15(6):934–41.
Nassar E, Marques IL, Trindade AS Jr, Bettiol H. Feeding–facilitating techniques for the nursing infant with Pierre Robin sequence. Cleft Palate Craniofac J. 2006;43:55–60.
Printzlau A, Andersen M. Pierre Robin sequence in Denmark: aretrospective population-based epidemiological study. Cleft Palate Craniofac J. 2004;41(1):47–52.
Rogers GF, Lim AA, Mulliken JB, Padwa BL. Effect of a syndromic diagnosis on mandibular size and sagittal position in Robin sequence. J Oral Maxillofac Surg. 2009;67(11):2323–31.
Rogers GF, Murthy AS, LaBrie RA, Mulliken JB. The GILLS score: part I. Patient selection for tongue-lip adhesion in Robin sequence. Plast Reconstr Surg. 2011;128(1):243–51.
Salmen ICM. Sequencia de Robin: estudo retrospective dos lactentes internados no HRAC-USP [dissertação]. Bauru: Hospital de Reabilitação de Anomalias Craniofaciais, Universidade de São Paulo; 2011.
Scott AR, Tibesar RJ, Sidman JD. Pierre Robin sequence: evaluation, management, indications for surgery, and pitfalls. Otolaryngol Clin N Am. 2012;45(3):695–710.
Sher AE. Mechanisms of airway obstruction in Robin sequence: implications for treatment. Cleft Palate Craniofac J. 1992;29(3):224–31.
Sher AE, Shprintzen RJ, Thorpy MJ. Endoscopic observations of obstructive sleep apnea in children with anomalous upper airways: predictive and therapeutic value. Int J Pediatr Otorhinolaryngol. 1986;11(2):135–46.
Shprintzen RJ. The implications of the diagnosis of Robin sequence. Cleft Palate Craniofac J. 1992;29(3):205–9.
Singer L, Sidoti EG. Pediatric management of Robin sequence. Cleft Palate Craniofac J. 1992;29:220–3.
Society AT. Cardiorespiratory sleep studies in children. Establishment of normative data and polysomnographic predictors of morbidity. American Thoracic Society. Am J Respir Crit Care Med. 1999;160(4):1381–7.
de Sousa TV, Marques IL, Carneiro AF, Bettiol H, Freitas JA. Nasopharyngoscopy in Robin sequence: clinical and predictive value. Cleft Palate Craniofac J. 2003;40(6):618–23.
Souza TV, Marques IL, Carneiro AF, Bettiol H, Freitas JA. Nasopharyngoscopy in Robin sequence: clinical and predictive value. Cleft Palate Craniofac J. 2003;40(6):618–23.
Spina V, Psillakis JM, Lapa FS, Ferreira MC. Classification of cleft lip and cleft palate. Suggested changes. Rev Hosp Clin Fac Med Sao Paulo. 1972;27(1):5–6.
Vandenplas Y, Goyvaerts H, Helven R, Sacre L. Gastroesophageal reflux, as measured by 24-hour pH monitoring, in 509 healthy infants screened for risk of sudden infant death syndrome. Pediatrics. 1991;88(4):834–40.