Airway management in neonates with Pierre Robin sequence

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Neonates with Pierre Robin sequence (PRs) suffer from varying degrees of airway obstruction and feeding difficulties, the courses of which differ from patient to patient, due to mandibular deficiency. We aimed to evaluate the course and prognosis of upper airway obstruction in 20 newborns with PRs. Among 15 isolated and 5 syndromic cases, 7 patients fell into Group I, 5 into Group II and 8 into Group III, respectively, according to the clinical classification system proposed by Caouette-Laberge. The 12 patients in Groups I and II were treated with positioning and gavage feeding, whereas the 6 patients in Group III underwent bilateral mandibular distraction. Decannulation or avoidance of tracheostomy was achieved in all of them. A patient who had a significant comorbidity was managed with tracheostomy and one patient expired due to pulmonary problems. When conservative measures fail, mandibular distraction osteogenesis should be considered to obviate tracheostomy in newborns with micrognathia.

Key words: Pierre Robin sequence, airway, mandibular distraction.

Pierre Robin sequence (PRs) consists of micrognathia and glossoptosis with or without a cleft palate[1]. It occurs at a rate ranging from 1 in 9,000 to 1 in 14,000 live births[2,3].

The important aspects of embryologic development of the face take place between 4 and 8 weeks of gestation. The mandibular prominence lies between the stomodeum and the first branchial groove, which delineates the caudal limits of the face. The paired, free ends of the mandibular arch enlarge and converge ventrally during the sixth week. The retroposition of the mandible, which develops from this arch, maintains the tongue high in the nasopharynx, thereby impairing medial growth and fusion of the posterior palatal shelves. The mandibular hypoplasia arising before nine weeks of fetal life seems to be the initiating factor in PRs. It can be the result of a malformation (i.e. Treacher-Collins syndrome, hemifacial microsomia), a disruption (i.e. amniotic band), or deformation (i.e. oligohydramnios), and over 40 syndromes have been described in association with PRs[4]. It was also found to be associated with *in utero* tamoxifen exposure[5].

Immediate supportive measures to ensure adequate ventilation and nutrition are required during the neonatal period. The most severe manifestation is life-threatening respiratory

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compromise due to the retroposition of the tongue into the oropharynx. Poor nutrition and failure to thrive, gastroesophageal reflux, hypoxia, hypercapnia, cor pulmonale, neurologic impairment, and death often accompany airway obstruction. Primary oropharyngeal dysmotility has also been noted in some patients. Delay in achieving adequate oral intake can result in a dependence upon nasogastric, orogastric or gastrostomy tube feeding.

The primary management of respiratory compromise in these patients is controversial. While most authors agree that prone positioning is the treatment of choice for minor cases, there is no universally accepted opinion to determine the best treatment modality for patients with severe respiratory compromise. A prospective non-randomized, non-controlled clinical trial was conducted to evaluate the course and prognosis of upper airway obstruction in 20 newborns with PRs, of whom five were syndromic.

Material and Methods

Neonates with a clinical diagnosis of PRs either seen primarily at the Women and Children's Hospital of Bakırköy or referred from other institutions for airway management were included. The institutional review board approved the study, and informed consent was obtained from the parents. Twenty patients managed and followed by the Neonatal Airway Management Team at two tertiary-care teaching hospitals between December 2002 and December 2006 were analyzed (Table I). The treatment strategy for each case was determined by a team, consisting of a neonatologist, pediatric surgeon, otolaryngologist, anesthesiologist, and a plastic surgeon. The classification system proposed by Caouette-Laberge and co-workers[6] was used to rate the severity of symptoms: Group I comprised children with adequate respiration in the prone position and with bottle feeding; Group II had adequate respiration in the prone position but feeding difficulties requiring gavage feeding; and Group III consisted of children with respiratory distress requiring respiratory support and gavage feeding. When clinical signs of severe airway obstruction including retractions, stridor and inability to feed were evident, acute intervention with mandibular distraction was considered. These infants were often intubated shortly after birth and had failed attempts at extubation. The survivors were further evaluated and followed by the clinical geneticist and the orthodontist of the team. Clinical findings, treatment interventions, complications, and outcomes were evaluated.

Results

Among 12 male and 8 female patients, 15 were identified as isolated PRs (75%), whereas five were syndromic (25%), which included Stickler (n=3) and Treacher-Collins syndromes (n=2) (Figs. 1, 2). Seven patients fell into Group I, five into Group II and eight into Group III. All the patients in Groups I and II (60%) demonstrated a successful prone or lateral positional airway with or without gavage

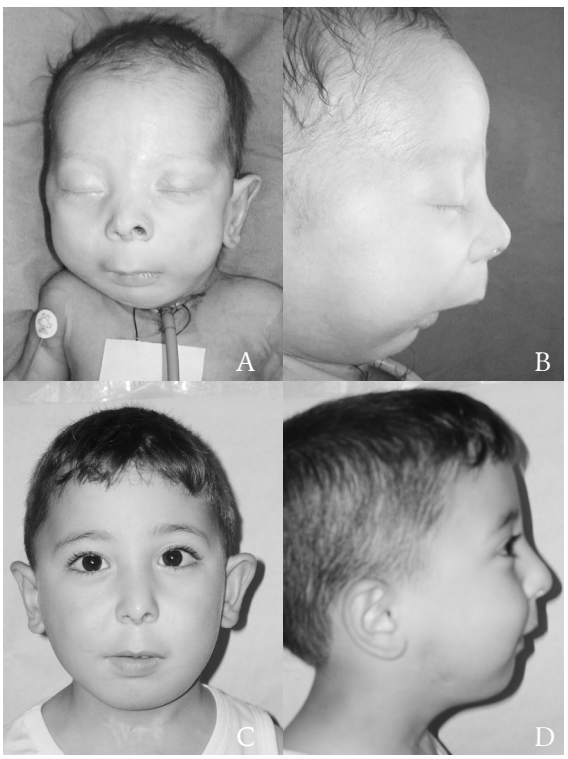
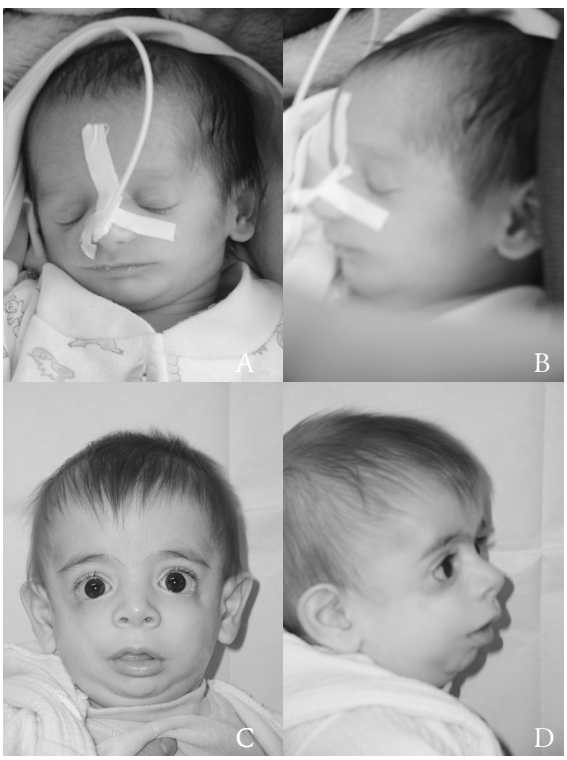


Fig 1. Patient 2 presented with Stickler syndrome. He was operated on the 49th day and a 20 mm mandibular advancement was achieved. **Fig. 1a.** Anteroposterior view of Patient 2, suffering from severe airway obstruction. **Fig. 1b.** Lateral view of Patient 2 indicating severe micrognathia. **Fig. 1c and 1d.** Anteroposterior and lateral views of Patient 2 at five years of age, suffering from predominantly ophthalmic manifestations (high myopia and retinal detachment). Note minimal scarring.

Table I. Clinical Presentations and Outcome Data of 20 Patients

Patient Number	Sex	Group	Diagnosis	Positioning	Additional measures	Outcome
1	M	III	isolated PRs	fail	prolonged int. gavage f.	expired
2	M	III	Stickler s.	fail	prolonged int. gavage f., MDO	survived
3	F	I	isolated PRs	pass	-	survived
4	M	I	isolated PRs	pass	-	survived
5	M	II	isolated PRs	pass	gavage f.	survived
6	M	I	isolated PRs	pass	-	survived
7	F	III	isolated PRs	fail	tracheostomy prolonged gavage f	survived (neurol. imp.)
8	F	II	Stickler s.	fail	prolonged int. MDO	survived
9	M	I	T.-Collins s.	pass	-	survived
10	F	II	isolated PRs	pass	gavage f.	survived
11	F	I	Stickler s.	pass	-	survived
12	M	III	isolated PRs	fail	referred with tracheostomy, MDO	survived
13	M	II	isolated PRs	pass	prolonged gavage f.	survived
14	M	II	isolated PRs	pass	prolonged gavage f.	survived
15	F	I	isolated PRs	pass	-	survived
16	F	II	isolated PRs	pass	gavage f.	survived
17	M	III	isolated PRs	fail	prolonged int., gavage f., MDO	survived
18	M	I	T.-Collins s.	pass	-	survived
19	F	III	isolated PRS	fail	prolonged int. gavage f., MDO	survived
20	M	III	isolated PRs	fail	prolonged int. gavage f., MDO	survived

PRs: Pierre Robin sequence. int: Intubation. f: Feeding. s: Syndrome.
MDO: Mandibular distraction osteogenesis. neurol. imp: Neurologic impairment.
T.-Collins: Treacher-Collins. Group I: Adequate respiration in the prone position and with bottle feeding. Group II: Adequate respiration in the prone position but feeding difficulties requiring gavage feeding. Group III: Respiratory distress requiring respiratory support and gavage feeding.



feeding. The patient referred with tracheostomy and seven other patients who suffered from severe airway obstruction (40%) were evaluated for mandibular distraction osteogenesis (MDO). The first case could not be operated due to an unresolved aspiration pneumonia and expired at the sixth week. The seventh case was excluded because of significant comorbidity (massive hemorrhage due to necrotizing enterocolitis and neurologic impairment) and underwent tracheostomy. The remaining six patients underwent bilateral MDO. Bronchoscopic examination was performed under sedation in the operating room, and the diagnosis was determined as severe tongue base obstruction of the hypopharynx and supraglottic compression

Fig. 2. Patient 18 presented with Treacher-Collins syndrome. **Fig. 2a.** Anteroposterior view of Patient 18, suffering from mild airway obstruction. **Fig. 2b.** Lateral view of Patient 18, indicating micrognathia. **Fig. 2c and 2d.** Anteroposterior and lateral views of patient 18 at 1.5 years of age, followed with conservative measures.

due to mandibular retroposition both on inspiration and expiration. Their intermittent resting oxygen saturation levels were less than 70% before operation. Those findings were supported with jaw thrust maneuver, which has been an accurate predictor of the potential success of MDO[7]. An external incision was used to expose the mandibular angle and ramus and an oblique osteotomy was made on the ramus, taking care to preserve the site of the tooth buds. External unidirectional (n=1) or multidirectional (n=5) distractors were used and a 12 to 20 mm lengthening (mean 15 mm) was achieved. The healing was uneventful in all patients. In the 2nd case, the tracheal intubation cannula was removed on the third postoperative day; the 12th case was successfully decannulated on the seventh day of distractor activation; and tracheostomy was avoided in four patients. Feeding difficulties were also improved following distraction procedures, whereas the patient followed with tracheostomy and two patients in Group II required prolonged tube feeding.

Palatoplasties were performed successfully at 14-16 months. With a mean follow-up period of 3.7 years (range: 1.5 to 5.5 years), growth was noted to be above the 50th percentile in all but one patient (7th case) with no symptoms of sleep apnea. A proportionate growth of the mandible was observed in all patients.

Discussion

The distribution of PRs patients within isolated and syndromic subgroups varies between institutions depending on referral patterns, the presence of multidisciplinary teams and the availability of clinical geneticists. The literature includes controversial results regarding the risk and severity of airway compromise and feeding difficulties between these diagnostic subgroups[8-10]. Isolated PRs was more commonly encountered in the present study, with 33% displaying feeding difficulty as an isolated finding, whereas patients requiring surgical management were equally distributed in each subgroup (40%). Stickler syndrome, which is the most common syndrome associated with PRs, constituted 15% of cases in this series.

Most newborns with PRs can be managed conservatively with positioning or temporary nasopharyngeal airways with home monitoring. These methods are reserved for infants with minor airway obstruction requiring short-term treatment, ranging between 40.3% to 74.5% of patients in the literature[11,12]. In the present study, they were effective in 60% of cases. Among other non-operative treatment modalities, including laryngeal mask and prolonged intubation, which have been reported with variable success, the latter was also used as a temporizing measure by our team.

More severe obstruction has been managed traditionally with tongue-lip adhesion or tracheostomy. The former, despite a high initial success rate, has been associated with a high incidence of secondary procedures for ultimate management of the airway, feeding and orthognathic relationship. While some authors have proposed to use certain modified techniques in selected cases to reverse unfavorable results[9,13-15], others have tended to consider it as a temporizing procedure[12,16-20]. As conservative measures were sufficient for Group II patients and we were concerned regarding the safety and efficacy of this procedure in Group III patients, it was not used in this series. The latter is the standard definitive procedure to achieve a long-term airway management. However, it necessitates a specialized nursing care and education of family members[21] and imparts significant risks of airway complications (hemorrhage, pneumothorax, tube obstruction, accidental decannulation, and tracheal stenosis). To avoid problems that often accompany a tracheostomy, mandibular advancement with distraction osteogenesis has been offered in selected patients[7-9,15,19,20,22,23]. Our attempt to perform MDO in this patient population was based on our experience with the technique in older children with various craniofacial deformities. All the patients we operated fell into Group III. Three-dimensional computed tomography (CT) and sleep and gastrointestinal studies are of questionable value in this patient population[19]. Because the physical signs of obstruction were quite evident, to eliminate the risk of anesthesia, such studies are not routinely included in our practice. Possible complications, including infection, malalignment, nonunion, or facial palsy, were not observed in this study. We have been using multidirectional external devices to achieve a more precise correction of the mandibular deformity compared to

that achieved with unidirectional external or internal systems.

Feeding difficulty and failure to thrive in PRs is most commonly due to upper airway obstruction. However, a subset of patients with adequate positional airway also display feeding difficulty. Some of them likely have a marginal airway that is unable to tolerate the additional stress of an oral diet. Others may have an intrinsic anomaly due to abnormal oral, pharyngeal, or esophageal motility or a neurologic disorder. In a longitudinal study of the growth of infants with isolated PRs considered as severe cases[24], the authors found impaired weight and length growth from birth to six months of age, despite a number of feeding facilitating techniques and a hypercaloric diet. Early airway intervention with mandibular distraction has been found effective in relieving feeding difficulties and accelerating growth of isolated PRs patients, whereas syndromic patients may need feeding assistance with gastrostomy tubes regardless of airway intervention[10,23,25]. In two isolated cases requiring prolonged gavage feeding in the present study, oral feeding was achieved at the fourth and sixth months, respectively, and an average weight gain continues with the longest follow-up (2 to 3 years), whereas the neurologically impaired case has severe growth retardation.

The death rate in PRs ranges between 0% and 13.6%, which reflects differences in the follow-up period and referral patterns to each center[6,8,9,23,26]. In their series of 125 patients, Caouette-Laberge et al.[6] found 12 of the 17 deaths in Group III patients (41.3%) and among survivors, 23% presented psychomotor impairment. The expired one (5%) constituted 12.5% of Group III patients in the present study.

In a subgroup of patients with PRs, airway management does not respond to conservative measures. A multidisciplinary team with expertise in distraction osteogenesis is essential in the treatment, and proper patient selection is the most critical factor predicting success.

REFERENCES

1. Robin P. A fall of the base of the tongue considered as a new cause of nasopharyngeal respiratory impairment: Pierre Robin sequence, a translation. 1923. Plast Reconstr Surg 1994; 93: 1301-1303.
2. St-Hilaire H, Buchbinder D. Maxillofacial pathology and management of Pierre Robin sequence. Otolaryngol Clin North Am 2000; 33: 1241-1256.
3. Printzlau A, Andersen M. Pierre Robin sequence in Denmark: a retrospective population-based epidemiological study. Cleft Palate Craniofac J 2004; 41: 47-52.
4. Spranger JW, Benirschke K, Hall JG, et al. Errors in morphogenesis: concepts and terms. J Pediatr 1982; 100: 160-165.
5. Berger JC, Clericuzio CL. Pierre Robin sequence associated with first trimester fetal tamoxifen exposure. Am J Med Genet A 2008; 146A: 2141-2144.
6. Caouette-Laberge L, Bayet B, Larocque Y. The Pierre Robin sequence: review of 125 cases and evolution of treatment modalities. Plast Reconstr Surg 1994; 93: 934-942.
7. Sidman JD, Sampson D, Templeton B. Distraction osteogenesis of the mandible for airway obstruction in children. Laryngoscope 2001; 111: 1137-1146.
8. Smith MC, Senders CW. Prognosis of airway obstruction and feeding difficulty in the Robin sequence. Int J Pediatr Otorhinolaryngol 2006; 70: 319-324.
9. Evans AK, Rahbar R, Rogers GF, Mulliken JB, Volk MS. Robin sequence: a retrospective review of 115 patients. Int J Pediatr Otorhinolaryngol 2006; 70: 973-980.
10. Lidsky ME, Lander TA, Sidman JD. Resolving feeding difficulties with early airway intervention in Pierre Robin sequence. Laryngoscope 2008; 118: 120-123.
11. 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: 171-178.
12. Li HY, Lo LJ, Chen KS, Wong KS, Chang KP. Robin sequence: review of treatment modalities for airway obstruction in 110 cases. Int J Pediatr Otorhinolaryngol 2002; 65: 45-51.
13. Argamaso RV. Glossopexy for upper airway obstruction in Robin sequence. Cleft Palate Craniofac J 1992; 29: 232-238.
14. Kirschner RE, Low DW, Randall P, et al. Surgical airway management in Pierre Robin sequence: is there a role for tongue-lip adhesion? Cleft Palate Craniofac J 2003; 40: 13-18.
15. Schaefer RB, Stadler JA 3rd, Gosain AK. To distract or not to distract: an algorithm for airway management in isolated Pierre Robin sequence. Plast Reconstr Surg 2004; 113: 1113-1125.
16. Hoffman W. Outcome of tongue-lip plication in patients with severe Pierre Robin sequence. J Craniofac Surg 2003; 14: 602-608.
17. Siddique S, Haupert M, Rozelle A. Subperiosteal release of the floor of the mouth musculature in two cases of Pierre Robin sequence. Ear Nose Throat 2000; 79: 816-819.
18. Denny AD, Amm CA, Schafer RB. Outcomes of tongue-lip adhesion for neonatal respiratory distress caused by Pierre Robin sequence. J Craniofac Surg 2004; 15: 819-823.

19. Fritz MA, Sidman JD. Distraction osteogenesis of the mandible. Curr Opin Otolaryngol Head Neck Surg 2004; 12: 513-518.

20. Burstein FD, Williams JK. Mandibular distraction osteogenesis in Pierre Robin sequence: application of a new internal single-stage resorbable device. Plast Reconstr Surg 2005; 115: 61-67.

21. Demke J, Bassim M, Patel MR, et al. Parental perceptions and morbidity: tracheostomy and Pierre Robin sequence. Int J Pediatr Otorhinolaryngol 2008; 72: 1509-1516.

22. Izadi K, Yellon R, Mandell DL, et al. Correction of upper airway obstruction in the newborn with internal mandibular distraction osteogenesis. J Craniofac Surg 2003; 14: 493-499.

23. Denny A, Amm C. New technique for airway correction in neonates with severe Pierre Robin sequence. J Pediatr 2005; 147: 97-101.

24. Marques IL, Bettiol H, de Souza L, Barbieri MA, Bachega MI. Longitudinal study of the growth of infants with isolated Robin sequence considered being severe cases. Acta Paediatr 2008; 97: 371-375.

25. Spring MA, Mount DL. Pediatric feeding disorder and growth decline following mandibular distraction osteogenesis. Plast Reconstr Surg 2006; 118: 476-482.

26. Holder-Espinasse M, Abadie V, Cormier-Daire V, et al. Pierre Robin sequence: a series of 117 consecutive cases. J Pediatr 2001; 139: 588-590.