Objective: To analyze the outcome of transnasal endoscopic repair of choanal atresia (CA) in children without prolonged nasal stenting after surgery.

Design: Retrospective study.

Setting: Academic tertiary care children’s hospital.

Patients: Forty children aged 3 days to 15 years (mean age, 41 months) who presented with unilateral (n = 26) or bilateral (n = 14) CA and underwent surgery between August 1996 and December 1999.

Intervention: All children underwent transnasal endoscopy with telescopes, endoscopic instruments, and a microdebrider. Nasal tubes in neonates or infants and nasal packing in older children were always removed after 2 days. Systematic revision endoscopy was performed with the patients under local or general anesthesia on days 6 to 10. All patients were then clinically and endoscopically monitored for nasal obstruction and healing during a mean follow-up period of 18 months.

Results: There were 16 patients with associated malformations, including 6 cases of CHARGE association (a malformative syndrome that includes coloboma, heart disease, CA, retarded development, genital hypoplasia, and ear anomalies, including hypoplasia of the external ear and hearing loss), and 14 patients (9 with bilateral CA) with a history of previous choanal surgery (4 transnasal, 4 laser, and 6 transpalatine). Postoperatively, 32 patients (80%) had normal nasal patency and a satisfactory choanal diameter, and 8 (20%) had restenosis or complete choanal closure. Six underwent a second procedure, with success. The results in all children who had been previously treated with laser or transpalatine surgery were successful. The last patient, who presented with severe Treacher Collins syndrome, is still tracheotomized. There were no significant postoperative complications. One patient died of congenital cardiopathy 6 months after surgery.

Conclusions: Transnasal endoscopic repair of CA is a safe and successful technique. The use of powered instrumentation and routine postoperative revision endoscopy seems to avoid prolonged nasal stenting.


Congenital choanal atresia (CA) is a rare malformation that causes airway obstruction in newborns and infants, with an incidence of 1 in 7000 to 8000 births. It seems to occur more commonly in females than males and to be more frequently unilateral and right-sided than bilateral. The nature of the obstructing atretic plate has often been described as 90% bony and 10% membranous. More recent studies using modern imaging techniques have revealed that 30% of the malformations are composed of a purely bony obstruction, and 70% of a mixed bony-membranous anomaly. Most cases of CA are isolated malformations, but association with other congenital deformities is not exceptional, as in the CHARGE association (a malformative syndrome that includes coloboma, heart disease, CA, retarded development, genital hypoplasia, and ear anomalies, including hypoplasia of the external ear and hearing loss). Many approaches have been used to repair CA, including transpalatal and transnasal routes. Until recently, the transpalatal technique was the method preferred by most surgeons for reasons of excellent visualization and success rates of around 80% to 90%. Transnasal techniques, including laser vaporization, are less effective and often require prolonged stenting, with higher failure rates requiring revision surgery. However, the recent development of rigid endoscopes and powered instrumentation has led to a reconsideration of transnasal techniques, although most authors are still using post-
PATIENTS AND METHODS

Forty children (24 girls and 16 boys) aged 3 days to 15 years (mean age, 41 months) were treated between August 1996 and December 1999. Ten children were neonates, and 8 others were younger than 12 months. Fourteen children (35%) had bilateral CA and 26 (65%) had unilateral CA (18 right-sided and 8 left-sided).

Sixteen children (40%) had associated deformities, including isolated cardiac malformations (n = 2), CHARGE association (n = 6), Treacher Collins syndrome (n = 1), and other undiagnosed polymalformative associations (n = 7). The average follow-up period was 18 ± 9 (mean ± SD) months. Preoperative computed tomographic scans with axial, coronal, and sagittal reconstructions were obtained in all cases (Figure 1). Twenty-one children (52%) had a mixed bony-membranous atretic plate, and 19 children (48%) had a pure bony atretic plate.

Fourteen (33%) of the patients had previously undergone surgery using transnasal (n = 4), laser (n = 4), or transpalatal (n = 6) techniques. All but 2 of the 14 procedures were performed at another institution; a transpalatal technique was used in both cases. The mean age of the patients with bilateral CA at the time of primary surgery was 9 days (age range, 3-25 days; n = 5). The other patients with bilateral CA were referred to our department after other transnasal and/or transpalatine techniques failed, and they underwent surgery at a mean age of 42 months (age range, 16 days to 4 years; n = 9). The mean age of patients with unilateral CA at the time of the initial surgery was 40 months (age range, 22 days to 9 years; n = 19). The other patients with unilateral CA were referred for a secondary procedure at a mean age of 67 months (n = 6). The surgical procedures, which were identical in all cases, used 4.0-mm 0° and 30° and 2.7-mm 0° nasal telescopes (Karl Storz, Tutlingen, Germany). Traditional sinus instrumentation was used together with powered instrumentation with 2- and 4-mm blades (Karl Storz). The mucosa covering the atretic bone was gently removed using the soft tissue blades. The cutting burr of the powered instrument was then used to remove the posterior part of the vomer, the lateral wall of the choana, and the upper part of the septum and its attachment to the sphenoid bone. Backbiting forceps were often used to complete the resection of the posterior part of the vomer. In some cases, the soft tissue shaver was also used to remove hypertrophic adenoid pads or to reduce hypertrophic inferior turbinates. Figure 2 shows the major steps of this procedure. The mean ± SD operating time was 50 ± 8 minutes for unilateral CA and 84 ± 20 minutes for bilateral CA. Polyethylene tracheal tubes (size 3.0, 3.5, or 4.0, according to the size of the nasal fossa; Mallincrodt Inc, St Louis, Mo) were used to prevent immediate postoperative nasal obstruction in children younger than 12 months and were removed after 24 to 48 hours. A soft (calcium alginate) nasal packing (Algosterr; Laboratoires Brother, Nanterre, France) was used in the older children after surgery. No prolonged nasal stenting was used. Postoperative drainage of secretions and crusts was performed by the nurses and the parents using an absorbent isotonic sodium chloride wash. Revision endoscopy was systematically performed 1 week after surgery with the patient under local anesthesia (topical 1% lidocaine) or, if necessary, under general anesthesia in the case of granulomas. Gastroesophageal reflux (GER) was diagnosed on the basis of clinical gastrointestinal symptoms or 24-hour pH recording when possible (in unilateral CA cases or before revision procedures). After surgery, airway patency and the choanal size were checked regularly in all cases using a 3.5-mm flexible nasal endoscope (Figure 3).

RESULTS

Thirty-two (80%) of the children who underwent surgery had a patent choana after 1 transnasal endoscopic procedure. The endoscopic aspect of the choana looked nearly normal in 27 of these cases and slightly narrowed, with small granulomas or webs, in 5 cases. The success rate of the primary procedure was 70% (7/10) in neonates; 71% (10/14) in children younger than 6 months, including neonates; and 85% (22/26) in older children. None of these differences is statistically significant (P = .37 and P = .41, Fisher exact test). The mean follow-up period was 18 months. No postoperative complications, such as pain, infection, bleeding, or nasal deformity, were found. Normal feeding was always possible starting the day after surgery. Children younger than 6 months were discharged 12 ± 6 (mean ± SD) days after surgery and older children after 6 ± 2 days. Parents and nurses found that postoperative care was facilitated by the absence of nasal stenting. One patient with a patent choana died of congenital cardiopathy 6 months after surgery.

The success rate for bilateral CA was 71% (10/14) and for unilateral CA 84% (22/26) and did not differ statistically (P = .41, Fisher exact test). The clinical and radiological features and typical outcome of bilateral CA related to CHARGE association are shown in Figure 4. Twelve (86%) of the 14 children who had undergone surgery before endoscopic repair were successfully treated in 1 procedure. Nine (64%) of the 14 children had bilateral CA, and 8 (89%) of these 9 children were treated successfully. Eight (20%) of 40 patients had restenosis, always less than 3 months after the primary repair. Six (75%) of the 8 children had a bony atretic plate, 4 (50%) were younger than 6 months, and 4 (50%) had bilateral CA. Gastroesophageal reflux (clinical symptoms or positive results on 24-hour pH recording) was found in 13 (32%) of the 40 children. Postoperative granulomas or narrowing of the choanal aperture were found in 8 of 13 children with GER and in only 5 of 27 patients without GER (P = .01, Fisher exact test). Seven (87%) of the 8 children who had restenosis also had GER. Six of them underwent a second procedure, which was successful in all cases. No patient underwent a third procedure. One patient who presented with recurrent bilateral CA and a congenitally narrow rhinopharynx was treated with topical...
mitomycin (1 mg/mL for 5 minutes), which seemed to reduce postoperative scarring. Two other children did not undergo revision surgery. In 1 case, the child’s contralateral nasal patency was normal, so the parents decided to wait. The other case involved severe Treacher Collins syndrome with a small mandible and glossoptosis that required a prolonged tracheostomy. The overall final result was normal choanal patency in 38 (95%) of 40 patients.

**COMMENT**

Choosing between the transnasal and transpalatal routes, as well as the use of postoperative stenting, is still a controversial feature of the surgical management of CA. Before the development of endonasal endoscopic techniques, the transpalatal approach was considered to be the most appropriate and successful route for bilateral or unilateral CA in children, both young and old, and for revision cases after failure of previous transnasal techniques. The transpalatal approach can result in several adverse effects, including palatal fistulas, maxillofacial disturbances, peroperative bleeding, and postoperative pain. Since 1990, some studies have reported high success rates using endoscopic techniques and an otologic drill or conventional instruments, but they were usually based on small numbers of children with unilateral CA. Lazar and Younis, in a larger series involving 10 children and operating with transnasal endoscopic techniques and powered instrumentation, reported 2 failures in newborns with bilateral CA. They therefore concluded that this technique was suitable for older children with unilateral CA. Since then, a few studies have reported cases in which neonates were successfully treated using endoscopic techniques. Interestingly, Josephson et al found powered instrumentation very useful in their last 7 cases, as previously suggested by Parsons.

Herein, we describe the treatment of 40 children with CA, including 10 newborns, using a transnasal endoscopic technique and powered instrumentation. This technique combines a protected soft tissue blade or drill and continuous suction that seem particularly useful in small nasal fossae. It provides better visualization and aspiration of blood and mucosal debris; it also seems to cause less tissue injury and allows better healing. Combined with conventional instruments, such as backbiting forceps, it allows the pterygoid process to be drilled laterally, the abnormal part of the vomer posteriorly, and the upper part of the choana and insertion of the septum to the sphenoid superiorly. In our opinion, this technique creates a common posterior cavity that does not require prolonged stenting.

Stents have been used in most, if not all, reported surgical procedures. Many authors believe that stenting prevents postoperative restenosis. The duration and material of stenting vary from one study to another, and the former can range from several weeks to months.
Figure 2. Surgical technique (right side) in a neonate with bilateral choanal atresia. A, Direct endoscopic exposure of the atretic plate and opening of the atretic plate using the powered instrumentation. B, Resection of the posterior part of the vomer using backbiting forceps. C, Drilling of the lateral wall of the choana using the powered instrumentation. D, Final shape of the choana at the end of the procedure. MT indicates middle turbinate; IT, inferior turbinate; S, nasal septum; and Sp, inferior part of the sphenoid bone.

Figure 3. Fiberscopic view of the choana 1 year after endoscopic treatment of left-sided choanal atresia in a 4-year-old child. A, View of the right choana (normal side). B, View of the surgically treated side.
Stents are associated with local infections and pain, formation of granulation tissue, and nasal synchia. Stent management is often complicated by migration or excessive pressure on the nasal ala. Our results compare favorably with those of other endoscopic series and clearly suggest that postoperative stenting is not necessary, provided that the nasal cavity is washed with abundant saline, especially in small children. Gastroesophageal reflux has also been suspected to induce choanal restenosis and should be looked for and treated when present. We believe that revision endoscopy is mandatory because removal of crusts is always necessary 1 week after surgery. This procedure sometimes requires a short-acting general anesthetic when there are granulomas or mucosal synchiae and makes it possible to evaluate the healing process. The efficacy of topical mitomycin in selected cases (eg, more than 2 failed procedures or bilateral CA with narrow rhinopharynx) needs further investigation, but it has been suggested that this antibiotic can reduce the risk of choanal restenosis.

Transnasal endoscopic repair of congenital CA is a safe and effective procedure. The use of powered instrumentation greatly improves the results, especially in younger children, and does not require prolonged nasal stenting. This technique is suitable for use in young children, even in neonates, with bilateral CA or in revision cases after previous transnasal or transpalatal approaches have failed. None of the children referred to our department since 1996 has required any other type of approach.

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REFERENCES


Figure 4. Bilateral choanal atresia in a child with CHARGE association (a malformative syndrome that includes coloboma, heart disease, choanal atresia, retarded development, genital hypoplasia, and ear anomalies, including hypoplasia of the external ear and hearing loss). A, Note the typical shape of the external ear (absence of earlobe). B, Non-contrast-enhanced bony-windowed axial computed tomographic scan. Note the enlargement of the posterior part of the vomer, the narrow diameter of the rhinopharynx, and the absence of semicircular canals. C, View of the choana 6 months after surgery. Note the good patency of the choana but the narrow size of the rhinopharynx.