Objective: To evaluate the postoperative results of patients treated with and without the use of stents at the time of initial surgical treatment of choanal atresia (CA). Surgical treatment of CA in the neonatal period is complicated by postoperative stenosis, often necessitating multiple revision surgical procedures.

Design: Retrospective medical record review.

Setting: Tertiary care academic center.

Patients: The medical records of 9 patients treated for bilateral CA during the neonatal period were reviewed. All patients were treated with an endoscopic approach. Outcomes were compared for patients with and without stent use at the initial operation.

Main Outcome Measures: Medical records were analyzed for diagnostic modality, clinical symptoms, age at surgery, sex, surgical repair, placement of stents, recurrence of atresia, follow-up time, and postoperative outcomes.

Results: The mean age at initial surgery was 8 days (range, 5-15 days). Four patients had endotracheal tube stents placed at the time of initial surgery for a duration of 4 to 6 weeks. All patients required at least 1 additional surgery (mean, 2.6 procedures), and 3 (75%) had restenosis during infancy. The mean follow-up time for this group was 7.5 months. Five patients did not have stents placed at the time of initial surgery. None of these patients required additional surgical procedures during infancy, and none developed restenosis. The follow-up time for this group was 2.5 months.

Conclusions: This study suggests that the placement of stents for bilateral CA repair during the neonatal period results in a high rate of restenosis as well as the need for multiple subsequent procedures during infancy. The use of an endoscopic approach without stent placement appears to result in superior healing without the need for revision surgery.


CHOANAL ATRESIA (CA) IS A narrowing of the posterior nasal aperture. It has a rare incidence of approximately 1 in 7000 births. Statistics have shown it be more prevalent in female neonates. Unilateral stenosis is also more common than bilateral stenosis. Evidence has shown a 70% incidence of mixed bony and membranous anomalies, with a 30% incidence of pure bony atresia. Choanal atresia is often seen in association with other neural development disorders such as the CHARGE syndrome (coloboma of the eye, heart anomaly, CA, retardation, and genital and ear anomalies), Treacher Collins syndrome, and Tessier syndrome. There is an increased incidence of CA and other craniofacial abnormalities in subjects with Down syndrome. There are 4 current hypotheses to explain the existence of choanal atresia: (1) the persistence of the nasobuccal membrane of Hochstetter, (2) persistence of the foregut buccopharyngeal membrane, (3) abnormal mesodermal adhesions forming in the nasal choanae, and (4) the misdirection of mesodermal flow due to local factors. Others believe that misdirection of the neural crest cells are induced by genetic mutations or environmental factors that cause defects in the palate and nose.

Neonates are obligate nasal breathers and may need surgical correction of the stenotic area in the presence of bilateral CA. Early diagnostic signs consist of stertor and cyclic cyanosis. Suspicion for CA arises when 5F catheters cannot pass through the nasal cavity into the nasopharynx. Definitive diagnosis is made with nasal endoscopy. A computed tomographic scan of the sinus region can further demonstrate the atretic plate and assist in identifying anatomy for surgical repair.
Postoperative stenosis is the most common complication encountered with surgical repair of bilateral CA, necessitating multiple revision surgical procedures. Current literature supports transnasal endoscopic repair of CA without the use of stents as safe and effective, but few studies focus solely on bilateral CA in the neonate. It was the objective of this study to determine if single-staged endoscopic repair during the neonatal period without the use of stents allows for correction of the atresia with decreased incidence of restenosis and subsequent need for additional procedures.

METHODS

Nine neonates with the diagnosis of bilateral CA were surgically treated from July 2005 to April 2006 at Egelston Children's Hospital of Atlanta, Atlanta, Georgia, by the 2 pediatric otolaryngologists in the Department of Otolaryngology at Emory University, Atlanta. A retrospective medical record review was conducted of all patients presenting with bilateral CA at birth. All patients received a full history review and physical examination with fiberoptic nasal endoscopy and underwent an attempt to pass suction catheters and computed tomographic scanning to confirm diagnosis (Figure 1). Medical records were analyzed for diagnostic modality, clinical symptoms, age at surgery, sex, surgical repair, placement of stents, reoccurrence of atresia, follow-up time, and postoperative outcomes.

SURGICAL TECHNIQUE

All patients were put to sleep using general anesthesia and endotracheal intubation if not already intubated. Pledgets soaked in oxymetazoline, 0.05%, were applied to the bilateral nasal cavity. The nasal cavity was examined with a 4.0-mm, 0° telescope, and diagnosis was confirmed. The atretic plate was examined and punctured with an olive tip suction. Next, serial dilations were performed using urethral sounds through the nasal cavity with palpation through the neonate’s mouth. The area was then widened with a stapes curette. A backbiting instrument was then used to take down posterior bony septum. If necessary, remnant tissue was then removed carefully with a microdebrider. Once this was completed, Ciprodex (ciprofloxacin, 0.3%, and dexamethasone, 0.1%; Alcon Laboratories Inc, Fort Worth, Texas)-soaked pledgets were applied to each nare at the end of the procedure (Figure 2).

The 4 patients who received stents followed a similar protocol; however, at the end of the procedure, 2 small 3.5-mm inner-diameter endotracheal tubes were placed into the nasal cavity and sutured in place with a Prolene suture (Ethicon Inc, Somerville, New Jersey). These patients were taken back to the operating room between 4 and 6 weeks for removal of the stents and endoscopic evaluation.

POSTOPERATIVE CARE

All patients were extubated 24 to 48 hours after surgical repair. Patients were seen for endoscopic examination 2 to 4 weeks after surgery. If a stent was placed, endoscopic evaluation was made in the operating room at the time of stent removal 4 to 6 weeks postoperatively. Patients who were repaired without stent placement were advised to use Ciprodex otic drops, 5 drops twice daily, to the nasal airway with suctioning. Patients were not administered postoperative oral steroids or oral antibiotics. Patients with stents were given suction catheters, and parents were taught how to suction endotracheal tube stents daily with the use of saline irrigation and portable suction devices.

RESULTS

Of the 9 patients treated for bilateral CA, only 2 had syndromic conditions—one with CHARGE syndrome and the other with Down syndrome. The mean age at the time of surgery was 8 days (range, 5–15 days).

Four patients had postoperative stenting with endotracheal tube left in place for 4 to 6 weeks. Of this group, 3 patients (75%) had restenosis after stent removal. The mean number of additional surgical procedures was 2.6 revision procedures. The mean length of follow-up for this group of patients was 7.5 months.

Five patients underwent surgical repair in a single-staged procedure with no stent placement. None of these patients had evidence of restenosis, and none of the patients in this group required revision procedures. The mean length of follow-up for this group was 2.5 months (Table). Surgical success was determined by the absence of respiratory symptoms and patent choanae on endoscopic examination.

COMMENT

Choanal atresia is a challenging pathologic condition. The neonate with bilateral CA presents with immediate cyanosis and retractions and will require airway intervention and likely intubation. Because of obligatory nasal breathing, these patients are often intubated for their respiratory distress. Surgical correction is encouraged early in life to prevent prolonged intubation and to allow for oral feeding.

Goals of the surgical repair include restoring normal nasal passage, preventing further damage to growing structures, and having a short operative time with limited hospitalization afterwards. Currently, transnasal and transpalatal approaches are the most commonly used and safest methods of surgical repair. Transnasal approaches include dilations, curettage, drill-outs, and laser removal. Tran-
septal repair is used for older patients with unilateral atresia. The transpalatal approach has the disadvantages of long operative times, and risks of palatal fistula, crossbite, palatal muscle dysfunction, and dentoalveolar growth disturbance. Difficulty with transnasal approaches have included high failure rates, septal deviation, and turbinate hypertrophy. Endoscopic transnasal repair carries the risk of disruption of growth centers, cerebrospinal fluid leaks, skull base injury, and injury to the sphenopalatine artery. Among the multiple approaches for repair of bilateral CA, evidence supports the safety and utility of endoscopic repair. Endoscopic repair allows for excellent visualization of the choana, short operative times, and very minimal bleeding. Several authors even advocate endoscopic repair in an effort to be able to fashion flaps over raw areas to prevent possible postoperative stenosis. Josephson et al report high success rates using the endoscopic technique in groups with all types of stenosis by having better visualization and safer removal of the posterior septum with the use of endoscopes.

There is considerable debate on the benefit of using stents in surgical correction of CA. Many authors have argued that the use of stents is absolutely necessary for successful repair. There is also a lack of consensus on the time stents should be left in place or which type of stents should be used for the best surgical results. Currently, soft Silastic (Dow Corning Corporation, Midland, Michigan) tubing, rolled Silastic sheeting, Portex endotracheal tubes (Smiths Medical International, Watford, England), and custom made Silastic stents are being used to keep the nasal airway open after surgery. Schoem was able to show by experience that stenting was not necessary for the successful repair of both unilateral and bilateral CA. This author attributes high success rates without stenting to the evolution of the transnasal approach. Previously in the 1980s, the transnasal approach consisted of microscopic views with marked lateral wall trauma and incomplete vomer removal. With the current highly advanced endoscopic approach, microdebriders, small drill bits, and telescopes are used without causing traumatic injury that would lead to postoperative scarring.

Some authors have explored the use of mitomycin as an adjunct to CA repair. Mitomycin is an aminoglycoside antibiotic made from the fungus Streptomyces caespitosus and has been used as an antineoplastic agent for its ability to inhibit DNA synthesis. Some authors have found that the addition of mitomycin allows for better healing with decreased scar formation in both patients

### Table. Neonates With Bilateral Choanal Atresia

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, d</th>
<th>Other Abnormalities</th>
<th>Stent</th>
<th>Restenosis</th>
<th>Follow-up Time, mo</th>
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</thead>
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<td>No</td>
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</tr>
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<tr>
<td>9/F/6</td>
<td>Down syndrome</td>
<td>No</td>
<td>No</td>
<td>2</td>
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</table>

Abbreviation: CHARGE, coloboma of the eye, heart anomaly, choanal atresia, retardation, and genital and ear anomalies.

Figure 2. Single-stage choanal atresia repair (right side demonstrated). A, Atretic plate; B, puncture with suction; C, dilation with urethral sounds; D, widening of opening with stapes curette; E and F, removal of posterior nasal septum with backbiter; and G, panoramic view of nasopharynx.
with and without stents. The first study to explore the use of mitomycin with CA repair reported a decreased rate of restenosis in patients with stent placement who had the adjunct of mitomycin application. We did not use mitomycin in the present study.

Our experience indicates that the use of nasal stents after endoscopic transnasal repair of CA results in a high rate of stenosis and the need for additional surgical procedures. Although our sample size was small, in the 4 patients who received endotraechal tube stents, 3 had resultant stenosis. Once we adapted our technique of single-stage stentless repair, our later cohort of patients repaired without stents had 100% successful repair on the first attempt. Our problems with restenosis could clearly be attributed to the presence of the Portex stent.

Our follow-up time frame was short for our patients who did not receive postoperative stents. Patients in this group had their initial follow-up examination after 4 to 6 weeks. Our assumption was that if we did not hear from the patient or the primary physician about new symptoms of respiratory distress or feeding difficulties, the patient had a successful repair. Patients in the stenting group often had longer follow-up times on average owing to the repeated recurrence of symptoms, postoperative complications, and follow-up visits after each surgical correction. The patients in the stent group often had stenosis after less than 3 weeks since stent removal. It appears that restenosis will happen soon after dilation procedures. A follow-up of 8 weeks should be past the time frame of restenosis. Future studies should investigate long-term outcomes for these patients and a larger population size.

The ability to perform this surgery as a single-stage procedure avoids the difficulty of revision procedures and multiple trips to the operating room. Avoiding stents allows for immediate oral feeding and shorter hospitalization stays. When we eliminated the use of the stenting endotraechal tubes, patients were able to heal without concentric stenosis of the operative site. The indwelling nasal stents were often difficult to use, with repeated crusting and clogging. They could also cause local infections, pain, granulation tissue, and nasal synechia. Without stents in place, we were able to easily administer Ciprodex solution to patients to prevent postoperative granulation tissue. This study demonstrates the increased success rate in the repair of neonatal CA without the placement of stents.

In conclusion, endoscopic repair of the neonate can be done as a single-stage procedure without the placement of stents. Our data show that single-stage procedures are superior to multiple-stage procedures with the placement of stents.

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Author Contributions: Dr Sobol had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Zuckerman, Zapata, and Sobol. Acquisition of data: Zuckerman, Zapata, and Sobol. Analysis and interpretation of data: Zuckerman, Zapata, and Sobol. Drafting of the manuscript: Zuckerman, Zapata, and Sobol. Critical revision of the manuscript for important intellectual content: Zuckerman and Zapata.

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REFERENCES