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Repair of posterior laryngeal cleft: a 10-year experience in a tertiary referral hospital

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Abstract

Objective. This study aimed to present experience with surgical treatment of laryngeal cleft cases through both open and endoscopic approaches.

Method. A retrospective evaluation of all patients diagnosed as having a laryngeal cleft in a tertiary hospital over 10 years was performed. Pre-operative data, conservative and surgical management of cases, and outcomes were collected, tabulated and analysed.

Results. This study included 43 patients aged from 2 to 44 months with a median of 9.19 months. Concerning management technique, 12 patients had conservative treatment and the remaining 31 underwent a surgical procedure (of them, 20 patients underwent endoscopic intervention and 11 had the open surgical technique). In the open group, we used either tibial periosteum (six cases) or harvested costal cartilage (five cases).

Conclusion. Surgical management in the form of endoscopic Coblation-assisted or an open approach is indicated in severe cases or mild cases not responding to conservative management.

Main Article

Mohamed Deeb takes responsibility for the integrity of the content of the paper

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Introduction

The laryngeal cleft is a rare congenital malformation where an anomalous connection between the laryngo-trachea and the oesophagus is found. Laryngeal cleft incidence is less than 0.1 per cent in the general population and is more common in boys than girls with a ratio of 5:3.[1,2] Laryngeal clefts have a wide spectrum of clinical symptoms and presentations based on the cleft's depth and the child's overall health. It may be as subtle as a mild aspiration to major life-threatening symptoms, such as stridor and respiratory distress.

Over the years, multiple classifications have been described to grade laryngeal clefts, with the one described by Benjamin and Inglis being the most widely up to date.[3] According to this classification, four types of laryngeal cleft are described. Type I represents supraglottic interarytenoid defect, in which the cleft lies above the level of the posterior cricoid cartilage, whereas in type II the cricoid lamina is partially involved with an extension below the level of the true vocal folds. Type III entails total cricoid cleft, and type IV represents a cleft extending into the posterior wall of the thoracic trachea and may extend as far as the carina.

Apart from the delay in diagnosis of laryngeal cleft because of its rarity, especially in types I and II, management of these cases is extremely challenging. In the literature, some studies advocate surgical repair and others advocate conservative management as the first-line therapy.[4,5] According to the aforementioned grades, a surgical repair can be performed through endoscopic or open approaches. This can be achieved using cold instruments[6] or carbon dioxide laser.[7] This manuscript presents our experience with the management of laryngeal cleft cases both conservatively and surgically.

Materials and methods

We performed a retrospective study of all patients diagnosed with a laryngeal cleft in our tertiary hospital between June 2011 and July 2021. Cases associated with other laryngo-tracheal anomalies were excluded from the study. This research was approved by the university ethics committee and written approved consent was obtained from the parents of included patients (approval number: R.22.02.1623.R1).

Patient evaluation

The definite diagnosis of the laryngeal cleft in the included patients was performed under general anaesthesia by palpation of the interarytenoid area. A high index of suspicion during awake fibre-optic nasoendoscopy, as a basic examination tool, is necessary for these cases as

the overlapping posterior laryngeal mucosa in an awake child makes the diagnosis difficult. Also, examination under anaesthesia can detect the cleft's distal extent and type and exclude synchronous airway lesions.

All laryngeal cleft cases were always evaluated through the paediatric airway board, which included the airway surgeon, anaesthetist, neurologist, intensivist, paediatrician, phoniatrician and genetic therapist. Although the primary evaluation of patients with a laryngeal cleft was performed by a neurologist to exclude any evident neurological lesions, in-depth neurological evaluation and radiology were mandated when the severity of swallowing symptoms was not explained by the anatomical deficit. Echocardiography was performed in all cases to assess associated cardiac anomalies and to check pulmonary hypertension as a consequence of airway obstruction by the redundant cleft mucosa. All patients presented with stridor were tested by a level 4 sleep study using overnight pulse oximetry (level 4 studies were usually used to test for paediatric sleep disorders) to detect the severity of airway obstruction.

Swallowing assessment was performed by the phoniatrician utilising either functional endoscopic evaluation of swallowing or videofluoroscopic swallowing study according to the infant's general conditions; for infants with unstable general conditions or uncooperative agitated ones, videofluoroscopic swallowing study was recommended.

Treatment

Patients with type I and some type II laryngeal clefts with mild respiratory and swallowing symptoms and showing no signs of aspiration or penetration on swallowing assessment were managed conservatively and followed up clinically every three months over two years, whereas type III cases always necessitated surgical intervention. However, in any type, patients who exhibited signs of severe airway compromise, recurrent aspiration pneumonia or severe swallowing dysfunction were amended for surgical repair.

Conservative treatment

Conservative management included a modified feeding regimen in the form of thickening of liquids and food consistency, proper positioning and anti-reflux medication.

Surgical treatment

Endoscopic Coblation-assisted technique

This technique was applied for type I and type II laryngeal cleft cases by performing mass closure of the cleft after making raw areas at the edges and bottom of the cleft using a Coblation™ wand. Also, some selected type III laryngeal cleft cases could be treated endoscopically if the caudal end of the cleft was accessible.

The procedure starts with exposure of the laryngeal inlet, without suspension, by the assistant using a Macintosh blade put in the vallecula while the surgeon held the endoscope with the left hand and EVAC™ Coblation wand with the right hand. The mucosal ablation started at the cleft edge just below the corniculate cartilage and continued until the bottom of the cleft; then the other edge was trimmed in the same way. Next, mass closure of the cleft was performed from deep in the cleft using at least three interrupted Vicryl® 4/0 sutures. The false vocal fold retractor was applied at the time as mucosal ablation and during passing of the needle and removed at the time of suture tightening, so all the sutures were performed and then tied from distal to proximal after releasing the retractor. During suturing, the assistant sometimes held both the endoscope and Macintosh blade while the senior surgeon used both hands for suturing and knotting. After closure, unilateral aryepiglottic fold release was performed to avoid supraglottic stenosis. In non-tracheomatised cases, ventilation was performed using the intermittent apnoea technique while apnoea time was prolonged using a high-flow nasal cannula (Figure 1).

Open technique

The open technique is used in deep type III cleft cases where the bottom of the cleft cannot be addressed endoscopically. After a tracheostomy is performed, a transtracheal approach is used. After vertically incising the airway, the redundant cleft mucosa came into direct vision where trimming was performed followed by a layered cleft closure and anterior tracheal wall suturing. In order to comfortably close the oesophageal layer, the assistant should grasp and laterally mobilise the airway layer to give sufficient space for comfortable closure. This is also followed by endoscopic unilateral aryepiglottic fold release whenever supraglottic narrowing was suspected (Figure 2).

For cases of open transtracheal repair of either high-grade clefts or residual fistulae after endoscopic repair of lower-grade clefts, our approach was always to repair in three layers of pharyngo-oesophageal mucosa, airway mucosa and the third layer in between. The third layer was either tibial periosteum (six cases) or harvested costal cartilage (five cases). Any mucosal redundancy or deficiency at the time of closure should be at the pharyngo-oesophageal side, not the airway side.

We always tried oral feeding post-operatively. When a residual fistula was suspected, we undertook examination under anaesthesia and, if a fistula was documented endoscopically, we usually shifted to total parenteral nutrition and then gastrostomy if the fistula persisted. We never inserted the Ryle tube post-operatively in order to avoid damage to the repair. Post-operative monitoring in the paediatric intensive care unit for one night was offered for all cases with peri-operative intravenous steroid administration to minimise airway oedema, especially in non-tracheostomised cases. Post-operative functional endoscopic evaluation of swallowing (functional endoscopic evaluation of swallowing) was performed three months after surgery to detect any residual swallowing dysfunction.

Statistical analysis

Data analysis was performed using SPSS® statistical analysis software (version 27). Quantitative variables were described using mean and standard deviation or median and range according to the type of data. Categorical variables were described using absolute frequencies and were compared using the chi-square, Fisher's exact and Monte Carlo tests when appropriate. For ordinal binary data, the chi-square for the trend test was used. Kolmogorov–Smirnov (distribution-type) and Levene (homogeneity of variances) tests were used to verify assumptions for use in parametric tests. In order to compare quantitative data between two groups, the Mann–Whitney test (for non-normally distributed data) and the independent sample *t*-test (for normally distributed data) were used. The level of statistical significance was set at $p < 0.05$.

Results

This study included 43 patients aged from 2 to 44 months with a median of 9.19 months. Females represented 53.5 per cent of

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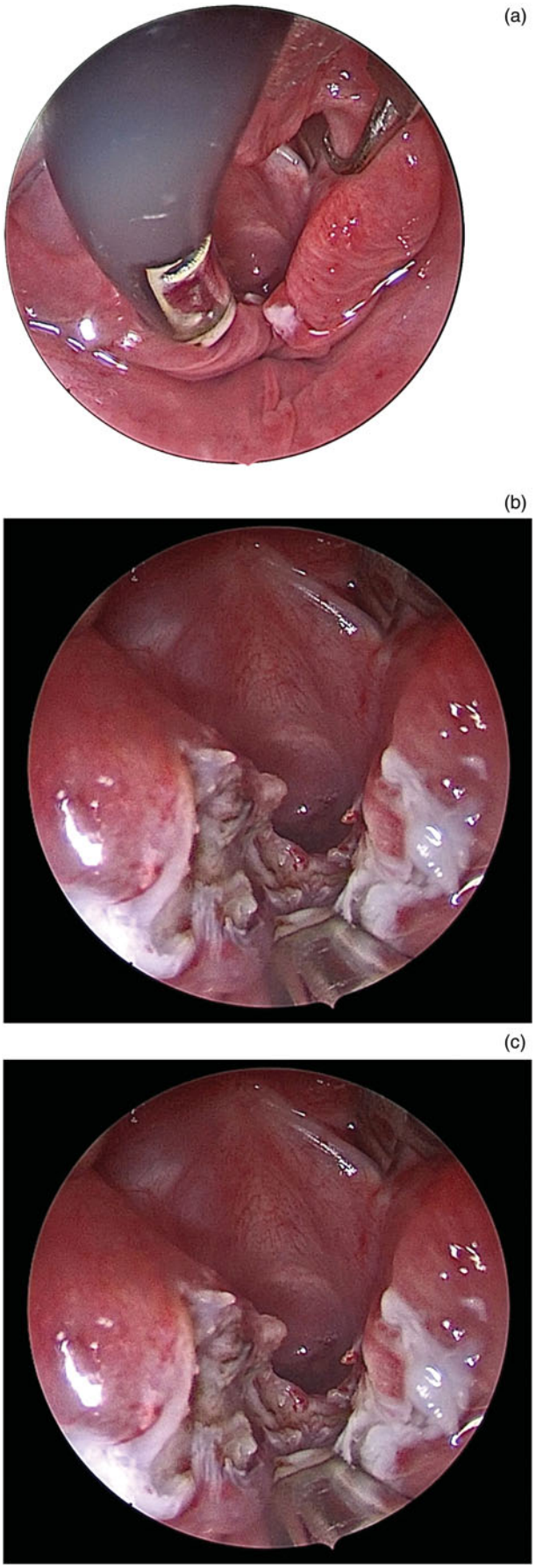

Figure 1. (a) Endoscopic image showing mucosal ablation starting at the cleft edge with an EVAC™ Coblation wand (endoscopic approach). (b) Endoscopic image showing mucosal ablation on one side and trimming on the other side till the bottom of the cleft with an EVAC Coblation wand (endoscopic approach). (c) Endoscopic image showing start of suturing while the false vocal fold retractor is applied (endoscopic approach).

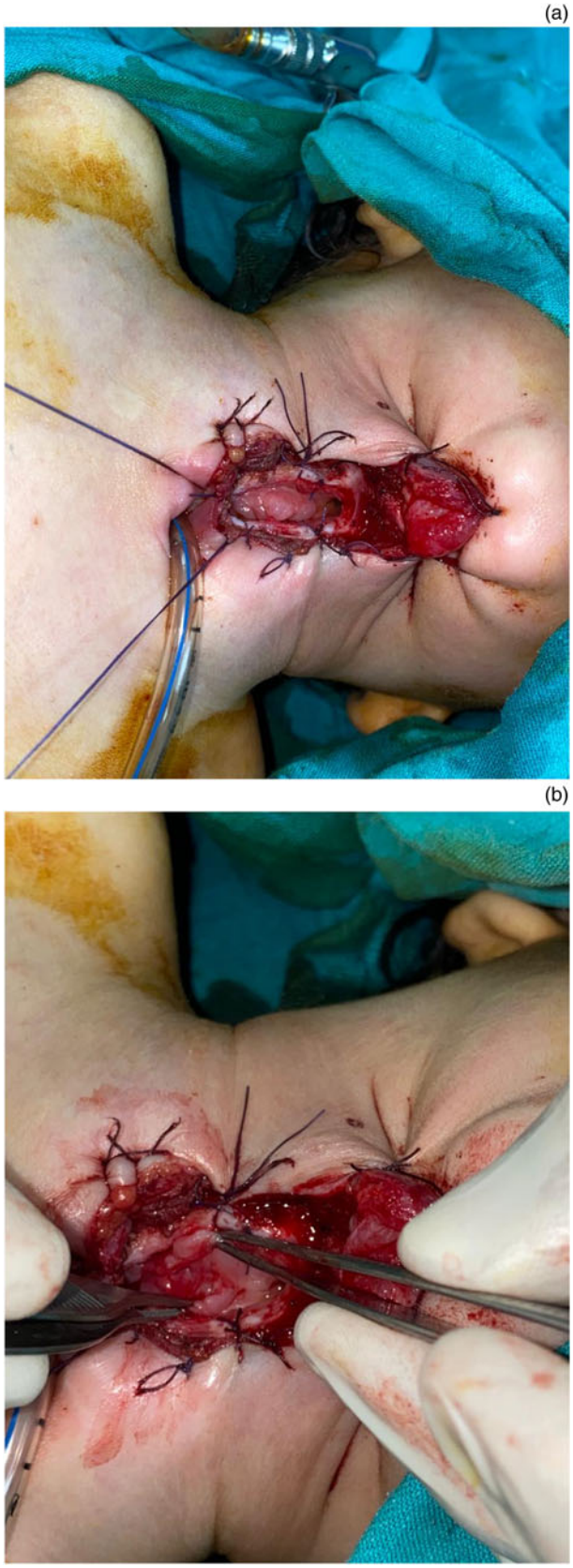

Figure 2. (a) Image showing redundant mucosa of the cleft edges after the laryngofissure (open approach). (b) Image showing incision of the mucosal edges of the cleft (open approach). (c) Image showing the harvested tibial periosteum is trimmed to the appropriate size of the defect (open approach).

patients. Concerning the type, 34.9 per cent, 34.9 per cent and 30.2 per cent had types I, II and III, respectively. About 64.7 per cent had no associated co-morbidity. About 37.2 per cent had associated gastroesophageal reflux disease, 39.5 per cent

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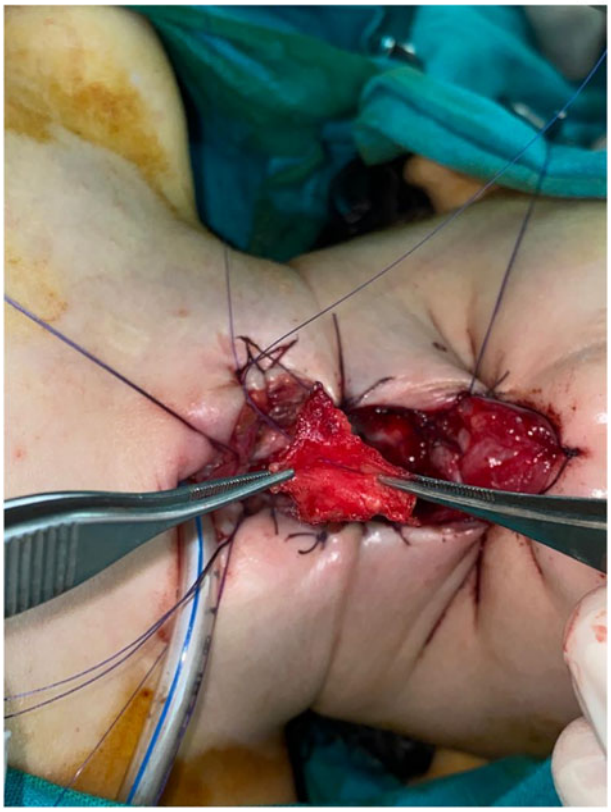

Figure 2. Continued.

had recurrent pneumonia, and 55.8 per cent, 69.8 per cent, 11.6 per cent and 7 per cent presented with feeding difficulties, aspiration, stridor and cyanosis, respectively. About 54 per cent did not need a peri-operative feeding assessment (Table 1).

Concerning management technique, 12 patients had conservative treatment and the remaining 31 underwent surgical techniques (of them, 20 patients underwent endoscopic intervention, and 11 underwent the open technique). There is a statistically significant difference between patients who underwent conservative and surgical techniques regarding type. All those who underwent conservative intervention had type I compared with 10 per cent of those who underwent endoscopic intervention (Table 2).

There is a statistically significant difference between patients who underwent endoscopic and open surgical techniques regarding pre-operative feeding assistance. Thirteen patients who underwent endoscopic intervention did not need peri-operative assistance versus two patients who underwent open surgical intervention (Table 3).

There was a statistically significant difference between the grafts used and decannulation time (significantly higher in those who underwent periosteum graft). Two patients had residual stridor and suture granuloma in the periosteum group, and two patients in the costal cartilage group had residual tracheoesophageal fistula and needed to undergo re-operation (Table 4). Bronchoalveolar lavage was performed in 21 patients; the microbiology of 10 patients showed positive culture.

Discussion

Laryngeal cleft is a rare congenital anomaly with an overall incidence of 1 in 10 000 to 20 000 live births.[1] However, the incidence of both types I and II may be greater than was previously thought.[8]

Table 1. Distribution of the studied patients according to baseline data

Parameter	Value*	Value (%)
Age (months)		
– Mean ± SD	10.6 ± 9.19	
– Range	9.19 (2–44)	
Gender (*n*)		
– Female	23	53.5
– Male	20	46.5
Type (*n*)		
– I	15	34.9
– II	15	34.9
– III	13	30.2
Co-morbidities (*n*)		
– No	29	64.7
– Atrial septal defect	4	9.3
– Ventricular septal defect	1	2.3
– Oesophageal atresia	1	2.3
– Opitz syndrome	2	4.7
– Tracheoesophageal fistula	3	7
– Vater syndrome	1	2.3
– Neurological condition	1	2.3
– Patent ductus arteriosus	1	2.3
Associated gastroesophageal reflux disease (*n*)	16	37.2
Feeding difficulties (*n*)	24	55.8
Aspiration (*n*)	30	69.8
Stridor (*n*)	5	11.6
Cyanosis (*n*)	3	7.0
History of recurrent pneumonia (*n*)	17	39.5
Pre-operative feeding assistance (*n*)		
– Gastrostomy	10	23.3
– Nasogastric tube	10	23.3
– None	23	53.5

*n = 43; SD = standard deviation

Many classification systems were proposed to grade laryngeal clefts, but the most commonly used one is the Benjamin–Inglis classification, where the cleft is graded according to the caudal length of the cleft into four grades.[3] Martha *et al.*,[9] in the review of 1033 cases, reported that the most common type is type I (84.07 per cent) whereas there were only 3 cases of type IV.

Co-morbidities have been reported in 50–88 per cent of children with laryngeal cleft.[10,11] In the present study, 35 per cent of included cases had associated co-morbidity, most often of the heart, such as atrial septal defect and ventricular septal defect. In the Leishman *et al.*[12] series, 26 per cent of patients were diagnosed with associated anomalies.

About 37.2 per cent had associated gastroesophageal reflux disease. The incidence of gastroesophageal reflux disease associated with laryngeal cleft has been estimated between 19 and 44 per cent in other studies.[8,13] Concurrent gastroesophageal reflux disease has been shown to contribute to surgical failure if not managed appropriately.[5] Concerning the need for pre-operative feeding assistance, 53.5 per cent had no need, 23.3 per cent needed a nasogastric tube and 23.3 per cent had gastrostomy for feeding.

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Table 2. Relation between the type of management and baseline data

Parameter	Management		*P*-value
	Conservative (*n* = 12)	Surgical (*n* = 31)	
Age (median (IQR); months)	16 (10.25–21.25)	5 (4–10)	<0.001*,†
Gender (*n* (%))			
– Female	6 (50)	17 (54.8)	0.775‡
– Male	6 (50)	14 (45.2)	
Type (*n* (%))			
– I	12 (100)	3 (9.7)	
– II	0 (0)	15 (48.4)	<0.001*,**
– III	0 (0)	13 (41.9)	
Co-morbidities (*n* (%))			
– No	10 (83.3)	19 (61.3)	
– Atrial septal defect	2 (16.7)	2 (6.5)	
– Ventricular septal defect	0 (0)	1 (3.2)	0.884‡
– Oesophageal atresia	0 (0)	1 (3.2)	
– Opitz syndrome	0 (0)	2 (6.5)	
– Tracheoesophageal fistula	0 (0)	3 (9.7)	
– Vater syndrome	0 (0)	1 (3.2)	
– Neurological condition	0 (0)	1 (3.2)	
– Patent ductus arteriosus	0 (0)	1 (3.2)	
Associated gastroesophageal reflux disease (*n* (%))	5 (41.7)	11 (35.5)	0.707‡
Feeding difficulties (*n* (%))	6 (50)	18 (58.1)	0.633‡
Aspiration (*n* (%))	7 (58.3)	23 (74.2)	0.31‡
Stridor (*n* (%))	1 (8.3)	4 (12.9)	>0.999‡
Cyanosis (*n* (%))	0 (0)	3 (9.7)	0.548‡
History of recurrent pneumonia (*n* (%))	3 (25)	14 (45.2)	0.306‡
Pre-operative feeding assistance (*n* (%))			
– None	8 (66.7)	15 (48.4)	0.163‡
– Gastrostomy	0 (0)	10 (32.3)	
– Nasogastric tube	4 (33.3)	6 (19.4)	

*$p < 0.05$ is statistically significant; †Mann–Whitney test; ‡chi-square test; **chi-square for trend test. IQR = interquartile range

The most common presenting symptoms were aspiration and feeding difficulty in the form of choking, followed by respiratory compromise in the form of stridor, cyanosis and recurrent aspiration pneumonia. Rahbar *et al.* reported that 90 per cent of their patients had respiratory symptoms,[5] and Evans *et al.*[14] found that cyanotic spells during feeding were the most common presenting symptom followed by inspiratory stridor and recurrent chest infections.

Direct laryngoscopy under general anaesthesia is mandatory in cleft cases to allow palpation of the interarytenoid region. As the disease is rare, a delay in diagnosis still occurs, ranging from weeks to years.[5] So, the most important factor in the diagnosis is including this rare anomaly in the differential diagnosis. Pre-operative videofluoroscopy, chest X-ray, barium swallow and fibre-optic endoscopic evaluation of swallowing have been reported, but none are a definitive diagnostic tool.[2,15]

Decision-making in the treatment of type I and some type II laryngeal clefts is not always easy. Some cases may respond to conservative measures, and others should be surgically treated.[11,16] Coppess *et al.*[17] published a comprehensive interarytenoid assessment protocol for precise assessment of cleft severity, meaning that not all low-grade clefts are the same. In general, the endoscopic repair is usually introduced for types I, II and selective type III clefts. Most type III and all type IV clefts are managed better with the open approach.[7,10,18] In selected cases for conservative management, a trial of medical therapy is applied for at least six months. The goals of the conservative treatment are ensuring proper feeding and avoiding recurrent chest infections.[19] Many authors agree that a trial of conservative management in type I clefts can avoid the risks and the need for surgical treatment.[7,8,20,21] Notably, 80 per cent of type I clefts in our series responded to the conservative treatment and had complete symptom resolution. On the other hand, patients are scheduled for endoscopic repair if persistent pulmonary aspiration or recurrent infections are occurring.

Endoscopy was used in the surgical treatment of three cases of type I, all cases with type II and two cases with type III. We used the endoscopic approach if the caudal end of the cleft was accessible endoscopically. The use of endoscopes decreases the

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Table 3. Relation between the surgical approach and baseline data

Parameter	Surgical approach		*P*-value
	Endoscopic technique (*n* = 20)	Open technique (*n* = 11)	
Age (median (IQR); months)	7 (2–12)	3.5 (3–4)	0.073*
Gender (*n* (%))			
– Female	12 (60)	5 (45.5)	0.436†
– Male	8 (40)	6 (54.5)	
Type (*n* (%))			
– I	3 (15)	0 (0)	
– II	15 (75)	0 (0)	0.001‡,**
– III	2 (10)	11 (100)	
Co-morbidities (*n* (%))			
– No	14 (70)	5 (45.5)	
– Atrial septal defect	1 (5.0)	1 (9.1)	
– Ventricular septal defect	0 (0)	1 (9.1)	0.465†
– Oesophageal atresia	1 (5)	0 (0)	
– Opitz syndrome	1 (5)	1 (9.1)	
– Tracheoesophageal fistula	2 (10)	1 (9.1)	
– Vater syndrome	1 (5)	0 (0)	
– Neurological condition	0 (0)	1 (9.1)	
– Patent ductus arteriosus	0 (0)	1 (9.1)	
Associated gastroesophageal reflux disease (*n* (%))	7 (35)	4 (36.4)	>0.999†
Feeding difficulties (*n* (%))	10 (50)	8 (72.7)	0.275†
Aspiration (*n* (%))	15 (75)	8 (72.7)	>0.999†
Stridor (*n* (%))	1 (5)	3 (27.3)	0.115†
Cyanosis (*n* (%))	2 (10)	1 (9.1)	>0.999†
History of recurrent pneumonia (*n* (%))	8 (40)	6 (54.5)	0.436†
Pre-operative feeding assistance (*n* (%))			
– None	13 (65)	2 (18.2)	<0.001†,‡
– Gastrostomy	3 (15)	7 (63.6)	
– Nasogastric tube	4 (20)	2 (18.2)	
Re-operations (*n* (%))			
– 0	17 (85)	9 (81.8)	
– 1	2 (15)	2 (18.2)	
– 2	1 (5)	0 (0)	0.698**
Complications (*n* (%))			
– None	17 (85)	9 (81.8)	
– Cleft recurrence	2 (10)	0 (0)	0.209†
– Cleft recurrence + tracheoesophageal fistula	1 (5)	0 (0)	
– Residual tracheoesophageal fistula	0 (0)	2 (18.2)	

*Mann–Whitney test; †chi-square test; ‡$p < 0.01$; **chi-square for trend test

rate of complications, reduces the risk of surgical site infection or haematoma, and lowers the risk of unsuccessful closure related to the nasogastric tube or tracheostomy cannula.[22] Kubba *et al.*[23] showed no statistically significant difference in the functional outcomes between endoscopic and open procedures and those needing revision surgery.

The novelty of our work is using Coblation instead of a laser in the reduction of the redundant cleft mucosa. The Coblation can be used now in many laryngeal surgical procedures as it causes minimal trauma to the surrounding tissues, performs complete haemostasis and is easier in the post-operative period for the patient.[24,25]

The rationale for the endoscopic repair of low-grade clefts is to create opposing raw surfaces at the mucosal edges and, most importantly, the apex. Many tools are available to denude the mucosa, including cold instruments and carbon dioxide

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Table 4. Relation between graft used in patients who underwent open technique and post-operative events

Parameter	Graft		*P*-value
	Costal cartilage (*n* = 5)	Periosteum (*n* = 6)	
Suture granuloma (*n* (%))			
– Absent	5 (100)	4 (66.7)	0.182*
– Present	0 (0)	2 (33.3)	
Decannulation time (weeks)			
– Mean ± SD	6.2 ± 0.45	8.67 ± 0.52	0.001†,‡
– Range	6–7	8–9	
Residual stridor (*n* (%))			
– Absent	5 (100)	4 (66.7)	0.455*
– Present	0 (0)	2 (33.3)	
Re-operations (*n* (%))			
– 0	3 (60)	6 (100)	0.182‡
– 1	2 (40)	0 (0)	
Complications (*n* (%))			
– None	3 (60)	6 (100)	
– Residual tracheoesophageal fistula	2 (40)	0 (0)	0.182*

*Chi-square test; †$p < 0.01$; ‡chi-square for trend test. SD = standard deviation

lasers.[6,7] In our practice, we usually use Coblation to denude the mucosa and debulk redundant tissues with the advantage of it being a fast and precise haemostatic tool. Nayak *et al.*[26] used Coblation to make a raw cleft margin in three cases, but unlike in our study, they suspended the larynx and used a Coblation mini laryngeal wand in contrast to the EVAC wand used by us without suspension.

Working without suspension in our hands gives a wider space for manipulation and gives a better chance to work using the endoscopic guidance with the advantage of more malleability to work around the corners; moreover, it is the same approach used for supraglottoplasty.[25]

Shah *et al.* performed a retrospective chart review in patients who underwent surgical repair of type I or II laryngeal cleft using Coblation and compared the results with those of laser and cold-steel methods. The study was able to detect significant differences in pre-operative and post-operative swallow study scores for the Coblation and laser groups. The findings of this study supported the efficacy and safety of Coblation for laryngeal cleft repair.[27]

Injection laryngoplasty in the interarytenoid area conferred some benefit in patients with type I laryngeal cleft where the goal was to provide a 'fullness' of the deficient area. But a randomised, controlled prospective study would be needed to determine the patients who would benefit from such treatment.[28]

The best surgical procedure for type III and type IV clefts is still up for debate.[29,30] An open surgical approach (a transtracheal approach) was used to close most of the grade III clefts in the current study. Our approach was always to repair in three layers including the pharyngoesophageal mucosa, laryngotracheal mucosa and the third layer in between. Various grafts, such as periosteum and cartilage, were used as a third layer of repair with no consensus in the literature on which material is best for the repair. In our study, we used both tibial periosteum (six cases) and harvested costal cartilage (five cases). U-shaped sutures were used to sandwich the periosteal graft so tying them did not cause any difficulty with airway mucosa closure.[31]

Different techniques have been reported: these include the anterior approach which involves the transtracheal approach, carrying a risk of laryngeal instability, and the lateral pharyngotomy approach with a higher risk of recurrent nerve lesions.[13,32]

Two patients had residual stridor and suture granuloma in the periosteum group, and two patients in the costal cartilage group had residual tracheoesophageal fistula and needed to undergo re-operation. There is a statistically significant difference between the grafts used and decannulation time (significantly higher in those who underwent periosteum graft).

- This study presents experience with management of laryngeal cleft cases both medically and surgically
- This was a retrospective study of all patients diagnosed with a laryngeal cleft in a tertiary hospital between June 2011 and July 2021
- Management of laryngeal cleft cases should be tailored according to each patient's symptoms, other concomitant findings on airway endoscopy and cleft type
- Conservative treatments are an effective management modality for clefts with mild symptoms, and surgical management can be performed for any type of laryngeal cleft with severe feeding or respiratory compromise
- Coblation is a well-tolerated tool in the endoscopic management of the laryngeal clefts minimising operative time and oedema, allowing for optimal post-operative outcomes

The early decannulation in costochondral grafts is usually related to its rigidity making tracheomalacia less likely to happen. For the cases complicated by suture granuloma treatment, the local injection of betamethasone succeeded in both cases. We avoided removing the granuloma to prevent wound breakdown.

When comparing the merits and demerits of both graft materials, we recommend tibial periosteum as the primary graft material, although the limited number of cases cannot give statistically significant clues. Three-layer closure tends to decrease the short and long-term repair breakdown, and in our concept, it is the most important advantage of open repair.[29,33]

It was rather difficult to assess the voice outcome following the open technique because most children have not developed

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a considerable language yet; however, the presence or absence of dysphonia was evaluated by auditory-perceptual assessment of children's cry.

A post-operative functional endoscopic evaluation of swallowing was performed for cases with residual swallowing dysfunction three months after the surgery. Persistent aspiration was found in one case and residual penetration was found in two cases despite being anatomically corrected. This was attributed to a possible underlying neurological mechanism.[34]

Bronchoalveolar lavage was performed in 21 patients; the microbiology of 10 of the patients showed positive cultures that were managed with antibiotics before the surgical repair. Our results were close to Chiang *et al.*, who showed that 54.5 per cent of their patients had positive cultures.[35] In our series, three patients (in the endoscopic group) had a revision endoscopic suturing of the cleft because of a residual defect and two patients in the open costal cartilage graft group had residual tracheoesophageal fistula and needed to undergo re-operation.

The limitations of our study are its retrospective design and the limited number of cases, which hinders statistical comparisons.

Conclusion

Management of laryngeal cleft cases should be tailored according to each patient's symptoms, other concomitant findings on airway endoscopy and cleft type. Conservative treatments appear to be an effective management modality for clefts with mild symptoms, while surgical management can be performed for any type of laryngeal cleft with severe feeding or respiratory compromise. Coblation is a well-tolerated tool in the endoscopic management of the laryngeal clefts, minimising operative time and oedema and allowing for optimal post-operative outcomes. Further prospective studies are needed to compare the periosteal graft with costal cartilage in the open surgery of the cleft.

Competing interests. None declared

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