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Original Article

# Comparative Study between Laryngotracheal Reconstruction with Partial and Complete Laryngofissure for Management of High Grade Glottic Web

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## ABSTRACT

**Background:** Laryngeal (glottic) webs are associated with airway stenosis at the level of the glottis. Surgical intervention is the gold standard. Laryngotracheal reconstruction (LTR) is the standard technique with partial or complete laryngofissure. The choice between partial and complete laryngofissure remains debated. Thus, this study aimed to compare the efficacy of LTR with partial or complete laryngofissure for management of thick glottic web.

**Patients and Methods:** This study included 20 patients. All patients were clinically evaluated by full history (from the patient and his/her guardians), clinical examination, laboratory investigations and endoscopic laryngeal examination. Then submitted to surgical intervention in the form of LTR with partial or complete laryngofissure (each 10 subjects). Patients were referred to Phoniatric Outpatient Clinic to perform pre- and post-operative phoniatric assessment.

**Results:** Patients in both groups were comparable regarding their demographics, preoperative clinical and voice assessment. Operative time was significantly longer in complete than partial groups (166.5±11.07 vs 117.5±8.9 minutes). Postoperative voice data showed that LTR with complete laryngofissure was significantly associated with lower fundamental frequency and jitter when compared to partial group (260.69±26.98, 1.61±1 vs 309.6±48.9, 2.61±1, successively). Time to decannulation was significantly longer in LTR with complete than partial laryngofissure. Rewebbing was registered for 3 cases in partial groups (2 grade-1 and 1 grade-2), while laryngeal collapse was reported in 1 patient in complete group. Improvement of breathing was reported for all patients in both groups. In addition, voice was improved in all patients in complete, but only in 70% of partial groups. Overall surgical success was registered for all compared to 70% of partial groups.

**Conclusion:** Complete LTR offers superior functional results, particularly for achieving stable, high-quality voice, and can be considered the preferred approach when maximal structural and phonatory restoration was desired.

**Keywords:** **Endoscopy; Dysphonia; Phonatory; Vocal Cords; Laryngeal Webs.**

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## INTRODUCTION

Laryngeal webs (sometimes called glottic webs), first described by Fleischmann in 1882, lead to airway stenosis at the level of the glottis. However, subglottic extension is common. It may be congenital or acquired [1,2]**.** Congenital laryngeal webs represent 5.0% of all laryngeal congenital anomalies. It is due to failure of recanalization of the larynx during embryogenesis. It may be a sole congenital anomaly or associated with other syndromes (e.g., Velocardiofacial Syndrome (VCFS)). It is also known as 22q11.2 deletion syndrome, which is the commonest chromosomal microdeletion syndrome, caused by hemizygous deletion of a small segment of the long arm of chromosome 22). On the other hand, acquired web are due to different causes (e.g., end laryngeal surgery, trauma, caustic ingestion, infection, or prolonged intubation) [3-6]**.**

The anterior glottis is the commonest site of involvement of laryngeal webs and may be associated with inferior extension. Traditionally glottic webs are classified into four subtypes as described by Cohen. In type I, membranes consist of < 35% of glottic involvement. It is usually thin and does not extend to the subglottic region. Type II is thin or moderately thick membranes, which have a 35%-50% glottic involvement and may present concomitant isolated subglottic stenosis. Type III defined when webs have a 50%-75% glottic involvement. It is thick and potentially have a cartilaginous involvement of the adjacent subglottic region. Type IV webs are uniformly thick and involve from 75%-90% of the glottic area with cartilaginous subglottic extension [4,7,8]**.**

Vocal cords are usually visible through the web membrane in types I and II. But delimitation of vocal cords in types III and IV is usually difficult. The clinical presentation varies according to the extent of glottic involvement. Shorter webs usually present with dysphonia (a weak cry) and relative respiratory distress depending on the degree of obstruction. However, in types III and IV, respiratory distress is the main compliant and usually noticeable from birth [9-12]**.**

Treatment options are variable and developed over years. Both endoscopic and external approaches were described. Endoscopic techniques include an end laryngeal mucosal flap, and placement of a keel. External approaches include laryngofissure with division of the web or laryngotracheal reconstruction (LTR) [13]**.** Cohen type 1 and 2 webs can be treated conservatively, with regular follow up, if asymptomatic. When surgery is indicated, it can be performed endoscopically with the web divided with cold steel or a $CO_2$ laser. However, Type III and IV often require a definitive repair, which often nbeed an open LTR with placement of graft is necessary to resolve the stenosis [14]**.**

Since its introduction in the 1970s, LTR with autologous cartilage graft has become the standard augmentative airway approach. The principle of the procedure is enhancement of airway caliber with graft interposition while maintaining the structural integrity of the laryngotracheal complex. It often involves a postoperative tracheostomy which may impair phonation in the child by the diversion of air flow from the larynx [15]**.** However, LTR with partial or complete laryngofissure for thick webs is not sufficiently addressed. Thus, this study aimed to compare the efficacy of laryngotracheal reconstruction with partial or complete laryngofissure for management of thick glottic web regarding voice assessment, operative length, breathing outcome, time of decannulation and incidence of complications.

## PATIENTS AND METHODS

**Study design:** This was a multi-center randomized clinical trial, which included 20 patients. They were selected from the Ear, Nose and Throat (ENT) department (Mansoura university Hospital), and ENT department (Al-Azhar University Hospital (New Damietta). Patients were referred to Phoniatric Outpatient Clinic in Mansoura University Hospital to perform pre- and post-operative phoniatric assessment. The duration of the study extended between January 2023 to December 2025.

**Inclusion criteria:** we included patients aged less than 16 years, from both genders with type 3 and 4 glottic web according to Cohen's criteria, who complained from respiratory distress or difficulty of breathing.

**Exclusion criteria:** Patients with **p**revious laryngeal operations, tracheostomy at malposition, or parental refusal to participate, were excluded.

**Randomization:** An online randomization program (http://www.randomizer.org) was used to generate a random list and each patient's code was kept in an opaque sealed envelope. Patients were randomly allocated with 1:1 allocation ratio into two groups in a parallel manner: **Group I (n=10):** Patient underwent LTR with complete laryngofissure. **Group II (n=10):** Patient underwent LTR with partial laryngofissure. This study was open label due to different techniques used.

### Methods

All eligible patients were clinically evaluated by full history taking (from the patient and his/her guardians), detailed clinical examination, laboratory investigations and endoscopic laryngeal examination.

**Endoscopic laryngeal examination:** The awake endoscopic laryngeal examination was done using fiberoptic nasoendoscopy or

rigid laryngoscopy (depending on the compliance of the infant and the clearance of the view) for infants with a suspected laryngeal abnormality. The latter was speculated by the presence of stridor, dysphonia, or presence of multiple congenital anomalies. Endoscopic laryngeal examination aimed to study the airway's anatomy without assessing swallowing during this endoscopic examination (Figures 1 and 2).

**Figure (1):** Fiberoptic nasoendoscopy (karl storz 11101rp2)

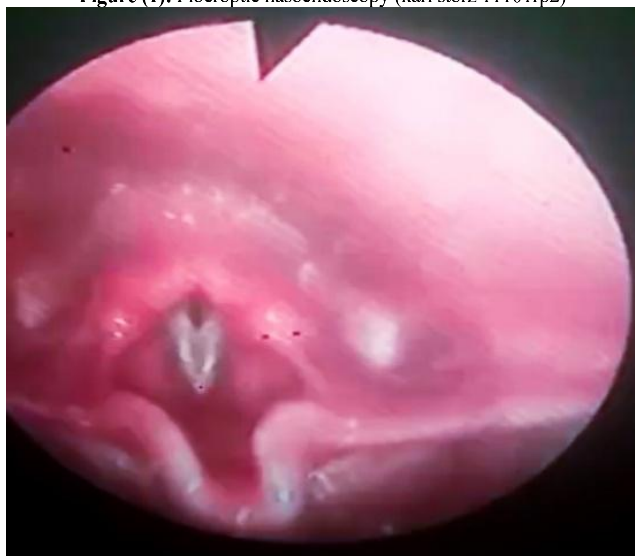

**Figure (2):** Preoperative flexible laryngoscopy

**Voice assessment:**

**Auditory Perceptual Assessment of voice (APA):**

Modified Grade, Roughness, Breathiness, Asthenia, Strain (GRBAS) scale is routinely used for APA of voice. It is four grades from 0 (normal/not existing) to 3 (severe dysphonia), for determining the grade and character of dysphonia. For the glottic web, APA of voice was evaluated by the R-B-H scale. R-B-H stands for Roughness, Breathiness, and overall Hoarseness on an ordinal scale with four grades from 0 to 3 (0 = not existing, 1 = mild, 2 = moderate, 3 = severe).

**Voice recordings:** Voice recordings of continuous speech samples (about 30 seconds long) from all participants were evaluated. Each patient had his voice recorded before and after the intervention. For comparison, we chose the mean scores of the overall grade (ie, "G" Grade, "H" Hoarseness), together with breathiness (B) and roughness (R) from both GRBAS and RBH scales.

**Voice analysis:** Acoustic analysis of voice was done to determine fundamental frequency F0 (pitch), jitter, shimmer, and harmonics to noise ratio (H/N). Each patient sat in a quiet room with a dynamic microphone (Radioshack 3300660) and laptop (HP 620) to record prolonged /a/ sound at a comfortable pitch and loudness. Those voice samples analyzed using PRAAT 64-bit edition software to obtain CPP, jitter, shimmer, and H/N ratio. The duration of processed voice samples ranged from 1 to 3 seconds. The most stable phonated sample was selected for analysis [16].

**Oral-motor structure and function assessment:** Lips, tongue, palate, and jaw were evaluated for appearance, precision, strength, range of motion by using the frequency and strength of the sucking pattern.

**Flexible endoscopic evaluation of swallowing (FEES):** The infants were typically positioned on a caregiver's lap in an upright or semi-setting position. For infants under the age of 1-year, topical anesthesia was not commonly administered. For older infants, a small amount of topical 2% lidocaine was instilled in the nasal cavity. A flexible Fiberoptic nasoendoscopy (karl storz 11101rp2) was advanced through the nasal cavity. The patients were then fed an age-appropriate diet with different consistencies. For most infants, formula or breast milk was given via a bottle. For the flexible endoscopic evaluation of swallowing (FEES) studies, the presence of aspiration and penetration in the different consistencies was noted.

**Ethical considerations:** Informed consent was obtained from the parents or legal guardians of all children participating in the study. There are adequate provisions to maintain privacy of participants and confidentiality of the data. Parents were given the full right to refuse participation of their children in the study without any consequences. Data was coded and patient names were hidden. The results of the study were used only in a scientific manner and not to use it in any other aims.

**Preoperative preparation:** Patients fasted for 6 hours before the surgery. Chest x-ray was performed to exclude chest infection and skeletal anomalies in case costal cartilage graft was needed. Four patients tracheostomized two in each group.

**Intraoperative Approach:** Operations were performed under general anesthesia with oral endotracheal tube of suitable size, while the tracheostomized patients the endotracheal tube inserted from the tracheostomy stoma. The patient was in supine position on the operating table with a slightly extended neck.

**LTR with complete laryngofissure:** Intraoperative direct laryngoscopy with suitable sized Lindholm Benjamin laryngoscope was performed to assess the airway and identify the extent of the web **(Figure 3.1).**

Costal cartilage graft harvesting was performed, as grafting was essential to maintain anterior cricoid expansion. A horizontal incision made over the right 5th, 6th, or 7th rib (typically the 6th). The right side was preferred to avoid confusion with cardiac pain postoperatively and safeguard the pericardium. Harvest was in the form of a segment of cartilage (approximately 3–4 cm) was harvested. Care was provided to preserve the perichondrium on one side (which will face the airway lumen) **(Figure 3.2).**

Transverse cervical neck incision was set at level just below of cricoid the cartilage **(Figure 3.3).** Subplatysmal flap was elevated cranially up to the level of the hyoid bone and Stay sutures for Subplatysmal flap to chin were done **(Figure 3.4).**

The strap muscles were dissected at the midline and retracted laterally with 4-0 silk sutures **(Figure 3.5).** Adequate exposure to the thyroid notch and the upper three tracheal rings were achieved, and additional 4-0 silk sutures were placed to enhance visualization **(Figure 3.6).**

**Lateral Retraction:** Once strap muscles separated, the muscles were retracted laterally by 2-0 Silk stay sutures through the muscle bellies to pull them laterally **(Figure 3.7).**

This provided better exposure than metal retractors, which can slip or cause pressure injury**.** The midline anatomical landmark was identified by diathermy **(figure 3.8).**

An anterior vertical incision through the cricoid and the first two tracheal rings were made to enlarge the subglottic lumen. The incision was extended into a full laryngofissure to provide maximum exposure and maximum expansion potential **(Figure 3.9, 3.10).**

Expansion of the subglottic space was completed using a mosquito clamp to facilitate web incision and midline thyroid cartilage splitting. The thyroid alae were divided directly in the midline at the anterior commissure. This procedure was carried out from below by palpating the slit of the anterior commissure with a blunt elevator. The interarytenoid and subglottic spaces have been enlarged **(Figure 3.11).**

Section of the thyroid cartilage is made under visual control from cranial to caudal. The vocal cords were identified by passing a 5-0 Prolene sutures through the laryngeal ventricle **(Figure 3.12).**

The vocal ligaments were identified on both sides and fixed anteriorly to the thyroid cartilage using 6.0 Vicryl sutures. This avoids mucosal shearing and keeps the vocal folds securely attached to the future anterior commissure **(Figure 3.13).**

Preparation of the laryngeal stent (foley catheter) was done. Tube matching the child's age was selected. The upper end was typically positioned at the level of the false vocal cords (vestibular folds) or just above the arytenoid. The lower end was situated immediately superior to the tracheostomy tube **(Figure 3.14).**

Further, two 3-0 Prolene sutures were placed (in supraglottis and trachea) for fixation of the stent. It thus remained fixed to the larynx during swallowing or neck movements and prevented friction-induced granulation tissue. The stent was left in place for 4 to 6 weeks **(Figure 3.15).**

Suturing Precise reconstruction of the anterior laryngeal commissure was essential. This was achieved using 4.0 or 5.0 vicryl sutures, placed submucosally through the thyroid cartilage, at the vocal cord level **(Figure 3.16).**

The costal cartilage was carved into a boat-shaped graft, keeping large flanges all around the designed graft. The perichondrial side of the graft should face the lumen, and the thickness of the boat-shaped portion of the graft should match as closely as possible that of the subglottic and tracheal walls. The large flanges of cartilage were likely to prevent prolapse of the graft into the airway, once the stent was removed **(Figure 3.17).**

The 4.0 vicryl sutures stitches used to suture the graft into position. The stitches emerge exactly at the angle created by the perichondrial interface, with the cut edge of the boat shaped. This precise approximation facilitates the re-epithelialisation process over the perichondrium of the cartilage inset **(Figure 3.18).**

Surgiflo was applied to the bleeding site to enhance hemostasis by creating a gelatin-based matrix that accelerates clot formation and controls oozing **(Figure 3.19).** Re-approximation and 4-0 silk sutures of the strap muscles in the midline were performed **(Figure 3.20).** The tracheostomy stoma was sutured to the trachea **(Figure 3.21).** Two rubber drains were inserted to facilitate the continuous evacuation of blood and serous fluids and prevent blood hematoma **(Figure 3.22).** The wound was closed in two layers. Absorbable suture (Vicryl, 3–0) was used for the subcutaneous and skin closure **(Figure 3.23).** The end result of surgery **(Figure 3.24).**

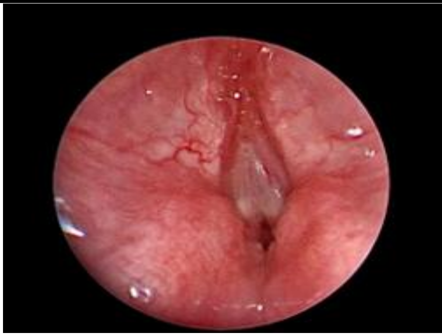
Figure (3.1): Intraoperative direct laryngoscopy

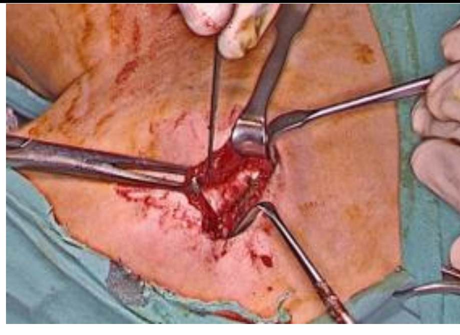
Figure (3.2): Costal cartilage graft taken

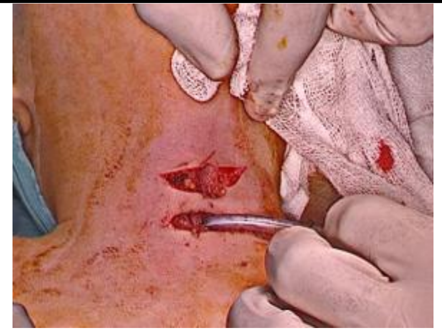
Figure (3.3): Neck incision

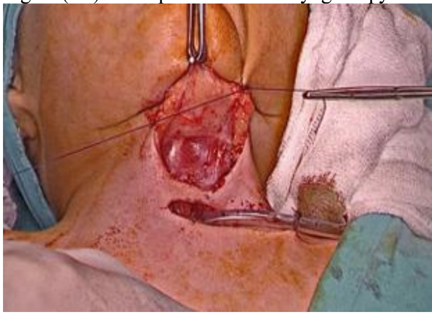
Figure (3.4): Subplatysmal dissection

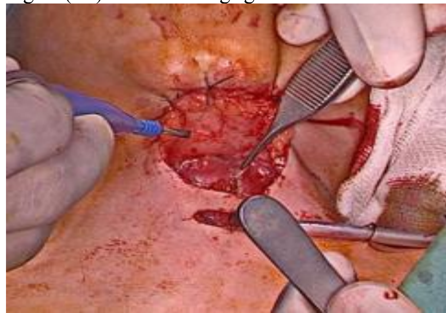
Figure (3.5): Dissection of strap muscle midline

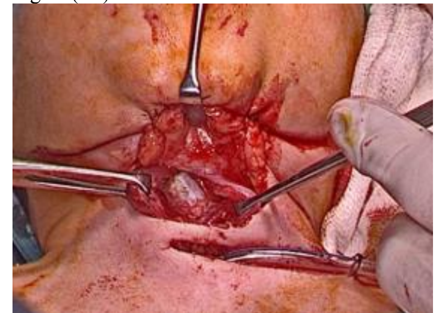
Figure (3.6): Exposure to thyroid notch and upper 3 tracheal ring

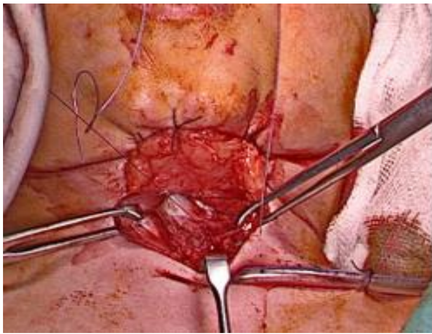
Figure (3.7): Stay suture for strap muscles

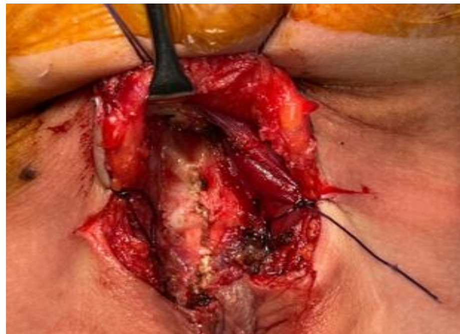
Figure (3.8): Landmark of midline

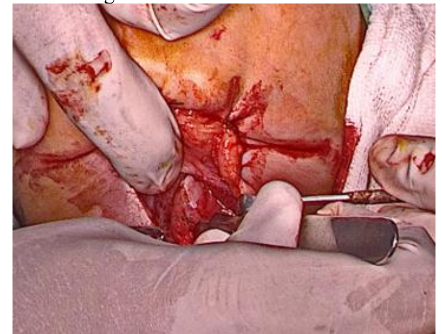
Figure (3.9): Incision of upper 2 tracheal rings and cricoid in midline

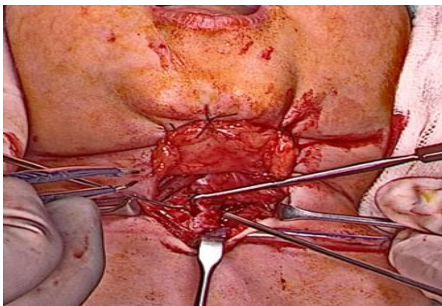
Figure (3.10): Expansion of cricoid by 2 hooks

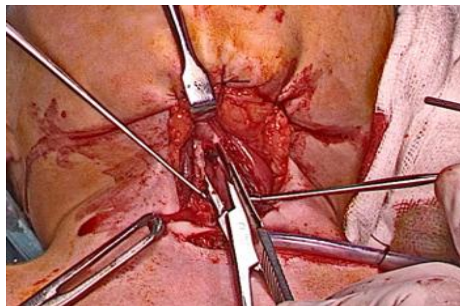
Figure (3.11): Expansion of subglottic space by mosquito for incision of web and thyroid cartilage in midline

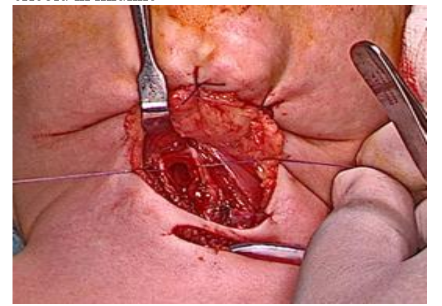
Figure (3.12): Landmark of vocal cords by suture pass through the ventricle

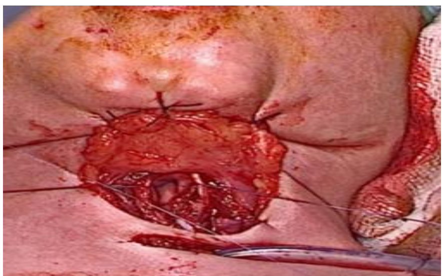
Figure (3.13): Suturing true vocal folds to the thyroid cartilage

Figure (3.14): Stent prepare

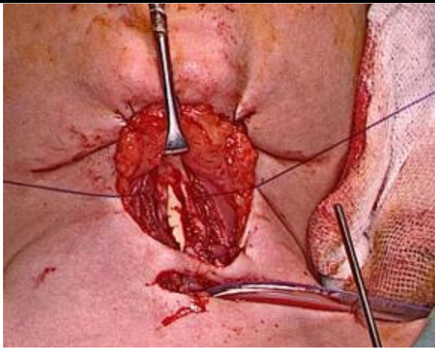

Figure (3.15): Fixation of stent by prolene suture size 3/0 pass through the lumen of stent

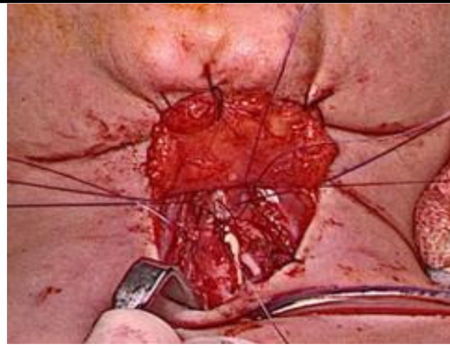

Figure (3.16): Suturing of epiglottic petiole and thyroid cartilage in midline

Figure (3.17): Graft prepare

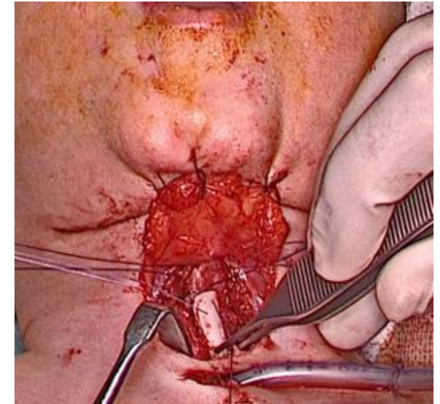

Figure (3.18): Suturing of the graft between the cricoid and upper 2 tracheal rings with perichonderial surface facing inner lumen of trachea

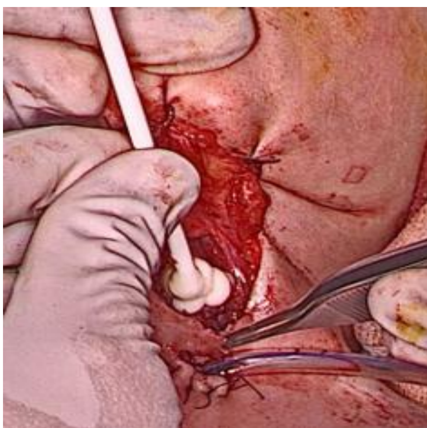

Figure (3.19): Surgiflo for hemostasis

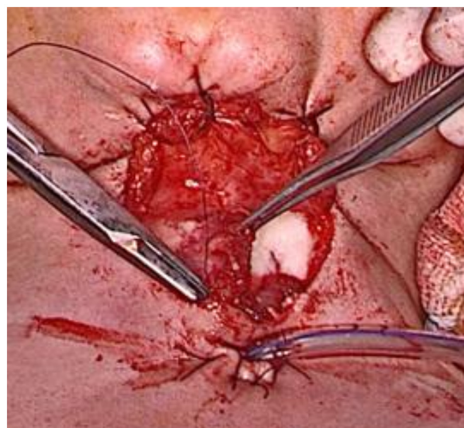

Figure (3.20): Suturing of strap muscle in midline

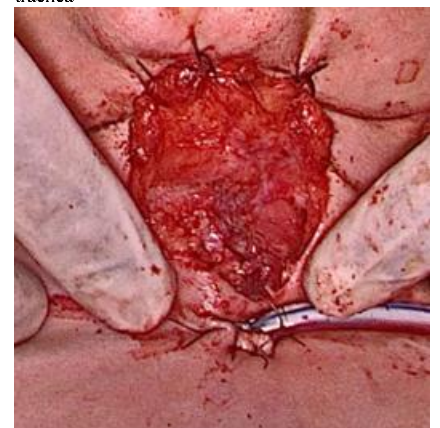

Figure (3.21): Tracheostomy maturation

Figure (3.22): Rubber drains

Figure (3.23): Suturing the wound in two layers

Figure (3.24): The end result of surgery

**LTR with partial laryngofissure:**

This procedure followed the same steps as the complete laryngofissure technique, differing only by a partial laryngofissure incision of the upper two tracheal rings, cricoid cartilage, and thyroid cartilage down to the subcommissure to preserve the anterior commissure. The web was exhibited by mosquitoes, scalpels or through direct laryngoscope at the beginning of surgery.

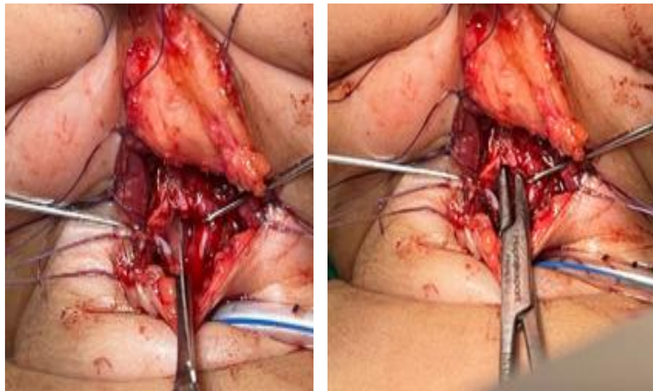

**Figure (4):** Web excised in partial laryngofissure

**Postoperative care and follow upe:**

All patients were admitted to the intensive care unit for 2-3 days after the operation, with daily monitoring. They were then transferred to the inpatient ward for 3-5 days before being discharged home. Follow-up continued weekly until the stent was removed from the larynx after six weeks. Patients were then monitored weekly with laryngoscopes under general anesthesia to check the graft's position and address any problems. The patients' condition was monitored, and weaning was done 2-6 weeks after stent removal. Then follow up were at 3, 6 and 9 months postoperatively outpatient clinic to document any residual or recurrent web. Voice of the patients was re-assessed, and incidence of complication were noted and documented. There were 3 cases of laryngeal re-webbing in the second group and one case of superior laryngeal collapse in the first group. The outcome after surgery was measured by assessing the improvement in breathing and voice improvement as judged by phoniatric assessment. Chest films were routinely taken to rule out pneumothorax (after rib cartilage harvesting) or atelectasis from plugged bronchial secretions or blood clots. Antibiotics were continued and adjusted during postoperative follow-up as necessary (in the case of superinfection, change in bacteriological sensitivity). Inspection of the neck for subcutaneous emphysema, hematoma, seroma or superinfection is carried out over 10 days. Proper monitoring by parents and nursing personnel were a prerequisite for a successful surgical outcome.

**Statistical analysis:** Statistical analysis was done by SPSS v27 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's t- test. Qualitative variables were presented as frequency (%) and were analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. A two tailed P value < 0.05 was considered statistically significant.

## RESULTS

In this study, 29 patients were assessed for eligibility; six patients did not meet the criteria and three patients refused to participate in the study. The remaining patients were randomly allocated into two equal groups (10 patients in each). All allocated patients were followed up and analyzed statistically.

In the current work, patient age ranged from 1 to 12 years and there was no significant difference between groups 1 and 2. In addition, males represented 50% of group 1, compared to 40.0% of group 2, with no significant differences **(Table 1).**

No dysphagia or previous laryngeal surgery were recorded for any patient. Tracheostomy before surgery was reported in 2 patients in each group. Stridor was in the form of grade 1 or grade 2, with no significant differences between groups (grade 1 and 2 was reported in 30.0% and 30.0 in group 1, compared to 40.0% and 20.0% in group 2, respectively). Comorbid conditions were reported only in group 2, and it was in form of epidermolysis and cardiac ASD (one patient for each). Finally, the preoperative diagnosis was identical between groups 1 and 2 (it was grade 3 in 7 patients and grade 4 in 3 patients) **(Table 1).**

Regarding operative time, it was ranged between 105 and 180 minutes and there was a statistically significant reduction of operative time in group 2 than group 1 (117.5 ± 8.9 vs 166.5 ± 11.07 minutes, p < 0.001). The degree of stridor was identical in both groups. All patients used anterior costal cartilage, and all were double staged. In addition, all patients submitted to stenting duration of 6 weeks **(Table 2).**

Preoperative voice data: In group 1, fundamental frequency ranged from 377.81 to 562.44 HZ with mean value(±SD) was 460.93 (±75.98) HZ and ranged from 347.76 to 601.34 HZ with mean value(±SD) was 426.51 (±84.42) HZ in group 2. Preoperative jitter ranged from 1.32 to 7.4 % with mean value(±SD) was 4 (±2) % in group 1 and ranged from 1.82 to 6.83% with mean value(±SD) was 4.18 (±1.73) % in group 2. Preoperative shimmer ranged from 1.99 to 15.87% with mean value(±SD) was 7.83 (±3.89) % in group 1 and ranged from 3.18 to - 11.16% with mean value(±SD) was 7.31 (±2.41) % in group 2. In group 1, preoperative H/N ratio dB ranged from 5.9 to 17.4 with mean value(±SD) was 11.57 (±3.95) and ranged from 5.21 to 15.53 with mean value(±SD) was 11.03 (±3.24) in group 2. Dysphonia

was grade 1 in 4 (40%) patients in both groups, grade 2 in 6 (60%) patients in group 1 and 5 (50%) patients in group 2 and grade 3 in 1 (10%) patient in group 2 and didn't occur in group 1. All patients had high pitches, low loudness and breathy character. Preoperative fundamental frequency, jitter, shimmer, H/N ratio dB and dysphonia were insignificantly different between the two groups **(Table 3).**

**Postoperative voice data of the studied groups:**

In group 1, fundamental frequency ranged from 223.68 to 293.55HZ with mean value(±SD) was 260.69 (±26.98) HZ and ranged from 241.98 to 382.76HZ with mean value(±SD) was 309.6 (±48.9) HZ in group 2. Postoperative jitter ranged from 0.59 to 3.92 % with mean value(±SD) was 1.61 (±1) % in group 1 and ranged from 0.97 to 3.95 % with mean value(±SD) was 2.61 (±1) % in group 2.

Postoperative shimmer ranged from 1.16 to 8.92% with mean value(±SD) was 4.34 (±2.32) % in group 1 and ranged from 2.29 to 7.98% with mean value(±SD) was 5.09 (±1.86) % in group 2. Postoperative H/N ratio dB ranged from 15.6 to 24.99 with mean value(±SD) was 20.36 (±3.13) in group 1 and ranged from 8.75 to 24.55 with mean value(±SD) was 16.44 (±5.53) in group 2.

Dysphonia was grade 1 in 3 (30%) patients in group 2 and didn't occur in any patients in group 1. In group 1, pitch was normal in all patients (100%) and in 7 (70%) patients in group 2 while it was high in 3 (30%) patients in group 2. A loudness was normal in all patients (100%) in group 1 and in 7 (70%) patients in group 2 while was low in 3 (30%) patients in group 2. Character was normal in all patients (100%) in group 1 and in 7 (70%) patients in group 2 while was breathy in 3 (30%) patients in group 2. Postoperative shimmer, H/N ratio dB, dysphonia, pitch, loudness and character were insignificantly different between the two groups. Postoperative fundamental frequency and jitter were significantly lower in group 1 than group 2 (P value=0.013 and 0.045 respectively) **(Table 4).**

**Complications and time to decannulation:**

All patients didn't suffer from fistula complications. Re-webbing complications were grade 1 in 2 (20%) patients and grade 2 in 1(10%) patient in group 2 and didn't occur in group 1. Supraglottic laryngeal collapse complications occurred in 1 (10%) patient in group 1 and didn't occur in group 2. Time to decannulation was 11 weeks and 12 weeks in 3 (30%) patients and was 10 weeks and 13 weeks in 2 (20%) patients in group 1. Time to decannulation was 8 weeks in 5 (50%) patients, was 9 weeks and 12 weeks in 1(10%) patient and was 10 weeks in 2 (20%) patients of group 2. Postoperative rewebbing complications and laryngeal collapse complications were insignificantly different between the two groups. Time to decannulation was significantly delayed in group 1 than group 2 (P value=0.043) **(Table 5).**

**Outcome:**

Breathing outcome improved in all patients. Voice outcome improved in all patients in group 1 and in 7 (70%) patients in group 2 while was unchanged in 3 (30%) patients in group 2. Overall surgical success was success in all patients in group 1 and in 7 (70%) patients in group 2 and was partial success in 3 (30%) patients in group 2. Voice outcome and overall surgical success was insignificantly different between the two groups. **(Table 6)**

**Table (1):** Demographic data and clinical data of the studied groups.

| | | | Group 1 (n=10) | Group 2 (n=10) | P value |
|---|---|---|---|---|---|
| **Age (years)** | Mean ± SD | | 3.4 ± 3.2 | 3.9 ± 2.51 | 0.702 |
| | Min. – Max. | | 1 - 12 | 1 - 9 | |
| **Gender (n, %)** | Male | | 5 (50%) | 4 (40%) | 0.98 |
| | Female | | 5 (50%) | 6 (60%) | |
| **Clinical data** | Dysphagia | | 0(0%) | 0(0%) | - |
| | Previous laryngeal surgery | | 0(0%) | 0(0%) | - |
| | Tracheostomy before surgery | | 2 (20%) | 2 (20%) | 1.00 |
| | Stridor | Grade 1 | 3 (30%) | 4 (40%) | 0.782 |
| | | Grade 2 | 3 (30%) | 2 (20%) | |
| | Comorbid conditions | Epidermolysis | 0 (0%) | 1 (10%) | 0.279 |
| | | Cardiac ASD | 0 (0%) | 1 (10%) | |
| | Preoperative Diagnosis | Grade 3 | 7 (70%) | 7 (70%) | 1.00 |
| | | Grade 4 | 3 (30%) | 3 (30%) | |

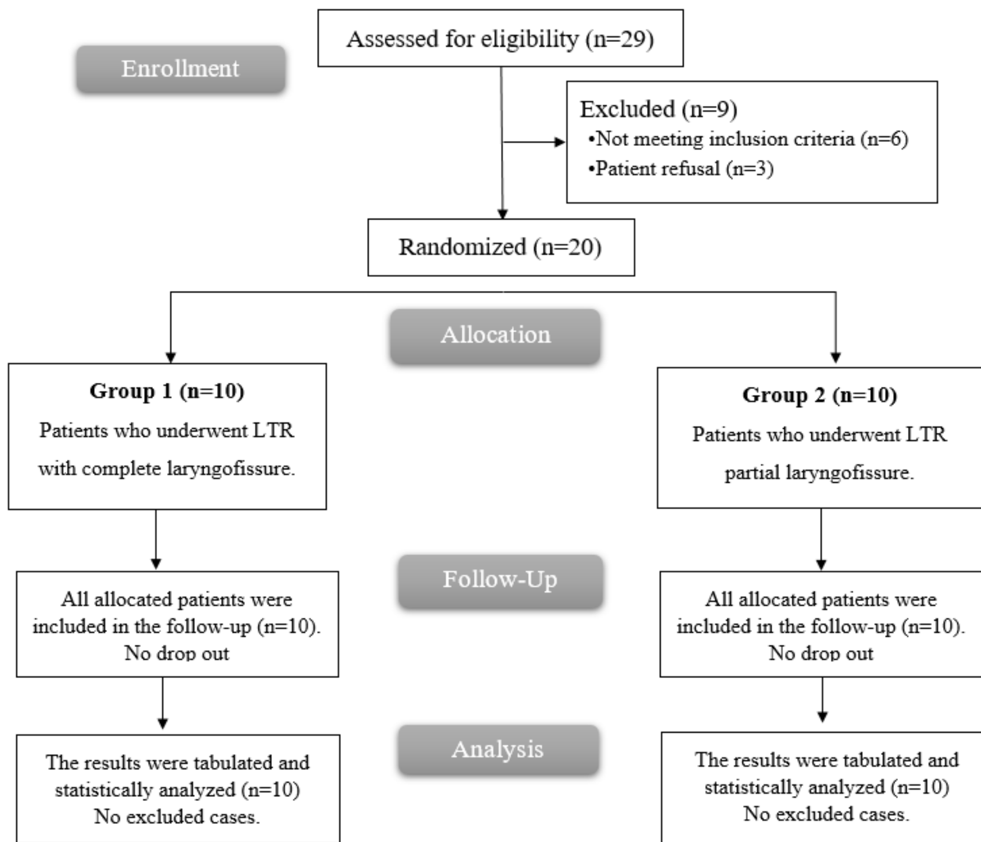


**Figure (5):** CONSORT flowchart of the enrolled patients

**Table (2):** Operative data among study groups

| | | Group 1 (n=10) | Group 2 (n=10) | P value |
|---|---|---|---|---|
| **Operative time (minutes)** | Mean ± SD | 166.5 ± 11.07 | 117.5 ± 8.9 | <0.001* |
| | Min. – Max. | 150 - 180 | 105 - 130 | |
| **Degree of airway obstruction** | About 60 % | 4 (40%) | 4 (40%) | 1 |
| | About 70 % | 3 (30%) | 3 (30%) | |
| | About 80 % | 1 (10%) | 1 (10%) | |
| | About 90 % | 2 (20%) | 2 (20%) | |
| **Type of the graft** | Costal cartilage | 10 (100%) | 10 (100%) | - |
| **Graft site** | Anterior graft | 10 (100%) | 10 (100%) | - |
| **Single or double stage (tracheostomy)** | Double | 10 (100%) | 10 (100%) | |
| **Duration of stenting (weeks)** | 6 weeks | 10 (100%) | 10 (100%) | |

**Table (3):** Preoperative voice data of the studied groups

| | | Group 1 (n=10) | Group 2 (n=10) | P value |
|---|---|---|---|---|
| **fundamental frequency (F0) (HZ)** | Mean ± SD | 460.93 ± 75.98 | 426.51 ± 84.42 | 0.351 |
| | Min. – Max. | 377.81 - 562.44 | 347.76 - 601.34 | |
| **Preoperative jitter (%)** | Mean ± SD | 4 ± 2 | 4.18 ± 1.73 | 0.838 |
| | Min. – Max. | 1.32 - 7.4 | 1.82 - 6.83 | |
| **Preoperative shimmer (%)** | Mean ± SD | 7.83 ± 3.89 | 7.31 ± 2.41 | 0.724 |
| | Min. – Max. | 1.99 - 15.87 | 3.18 - 11.16 | |
| **preoperative H/N ratio dB** | Mean ± SD | 11.57 ± 3.95 | 11.03 ± 3.24 | 0.741 |
| | Min. – Max. | 5.9 - 17.4 | 5.21 - 15.53 | |
| **Dysphonia** | Grade 1 | 4 (40%) | 4 (40%) | 0.343 |
| | Grade 2 | 6 (60%) | 5 (50%) | |
| | Grade 3 | 0 (0%) | 1 (10%) | |
| **Pitch** | High | 10(100%) | 10(100%) | --- |
| **Loudness** | Low | 10(100%) | 10(100%) | --- |
| **Character** | Breathy | 10(100%) | 10(100%) | --- |

**Table (4):** Postoperative voice data of the studied groups.

| | | Group 1 (n=10) | Group 2 (n=10) | P value |
|---|---|---|---|---|
| **Fundamental frequency (F0) (HZ)** | Mean ± SD | 260.69 ± 26.98 | 309.6 ± 48.9 | 0.013* |
| | Min.–Max. | 223.68 - 293.55 | 241.98 - 382.76 | |
| **Postoperative jitter (%)** | Mean± SD | 1.61 ± 1 | 2.61 ± 1 | 0.045* |
| | Min.–Max. | 0.59 - 3.92 | 0.97 - 3.95 | |
| **Postoperative shimmer (%)** | Mean± SD | 4.34 ± 2.32 | 5.09 ± 1.86 | 0.435 |
| | Min.–Max. | 1.16 - 8.92 | 2.29 - 7.98 | |
| **Postoperative H/N ratio dB** | Mean± SD | 20.36 ± 3.13 | 16.44 ± 5.53 | 0.067 |
| | Min.–Max. | 15.6 - 24.99 | 8.75 - 24.55 | |
| **Dysphonia** | Grade 1 | 0 (0%) | 3 (30%) | 0.210 |
| | No | 10 (100%) | 7 (70%) | |
| **Pitch** | Normal | 10 (100%) | 7 (70%) | 0.210 |
| | High | 0 (0%) | 3 (30%) | |
| **Loudness** | Normal | 10 (100%) | 7 (70%) | 0.210 |
| | Low | 0(0.00%) | 3 (30%) | |
| **Character** | Normal | 10 (100%) | 7 (70%) | 0.210 |
| | Breathy | 0 (0%) | 3 (30%) | |

Table (5): Complications and time to decannulation the studied groups

| | | Group 1 (n=10) | Group 2 (n=10) | P value |
|---|---|---|---|---|
| **Fistula complications** | | 0 (0%) | 0 (0%) | --- |
| **Rewebbing complications** | Grade 1 | 0 (0%) | 2 (20%) | 0.171 |
| | Grade 2 | 0 (0%) | 1 (10%) | |
| **Laryngeal collapse complications** | | 1 (10%) | 0 (0%) | 0.304 |
| **Time to decannulation (weeks)** | 7 weeks | 0 (0%) | 1 (10%) | 0.043* |
| | 8 weeks | 0 (0%) | 5 (50%) | |
| | 9 weeks | 0 (0%) | 1 (10%) | |
| | 10 weeks | 2 (20%) | 2 (20%) | |
| | 11 weeks | 3 (30%) | 0 (0%) | |
| | 12 weeks | 3 (30%) | 1 (10%) | |
| | 13 weeks | 2 (20%) | 0 (0%) | |

**Table (6):** Outcome of the studied groups

| | | Group 1 (n=10) | Group 2 (n=10) | P value |
|---|---|---|---|---|
| **Breathing outcome** | Improved | 10 (100%) | 10 (100%) | --- |
| **Voice outcome** | Improved | 10 (100%) | 7 (70%) | 0.210 |
| | Unchanged | 0 (0%) | 3 (30%) | |
| **Overall surgical success** | Success | 10 (100%) | 7 (70%) | 0.210 |
| | Partial | 0 (0%) | 3 (30%) | |

## DISCUSSION

High-grade laryngeal (glottic) webs are complex anomalies of the larynx. These are characterized by fibrous tissue bridging the vocal folds, leading to airway obstruction, dysphonia, and, in severe cases, life-threatening respiratory compromise [17]. Cohen system was used to grade the condition from 1 (mild) to IV (severe). High-grade webs pose a surgical challenge due to the dual goals of restoring airway patency and preservation of phonatory function [18]. Surgical management has evolved, with laryngo-tracheal reconstruction (LTR) being a key technique with partial or complete laryngofissure ([19,20]).

The choice between partial and complete laryngofissure remains debated [21], and comparative studies are limited, especially in pediatric patients [22]. Therefore, this study aimed to compare the efficacy of LTR with partial or complete laryngofissure for management of thick glottic web regarding, voice assessment, operative length, breathing outcome, time of decannulation and incidence of complications.

In this study, tracheostomy before surgery, swelling, tracheal obstruction, respiratory distress, inspiration, diagnostic evaluation, observation, and relief (STRIDOR), comorbidities and preoperative diagnosis were comparable between groups. All patients didn't suffer from dysphagia, and no patients underwent previous laryngeal surgery. This indicated that the clinical

characteristics and disease severity were comparable before surgery, ensuring a fair and unbiased comparison between the two surgical techniques. The absence of dysphagia and prior laryngeal surgeries further reflected a homogeneous sample without confounding factors that could influence surgical or voice outcomes.

In the current study, time of operation was significantly longer in group 1 than group 2 (166.5±11.07 vs 117.5±8.9 minutes). Degrees of airway obstruction were insignificantly different between the two groups, indicating that complete laryngofissure was requiring extensive exposure and precise reconstruction for cases, where the longer operative time reflected the complexity needed to optimize airway and voice outcomes. **Evermann *et al.*** [23] included 45 patients with laryngotracheal stenoses who underwent LTR. They found that mean operative time was 169 ± 59 minutes in complete laryngofissure.

Moreover, **Schweiger *et al.*** [24] included 15 patients with complex glotto-subglottic stenosis to analyze the influence of single-stage laryngotracheal reconstruction (SSLTR) on the functional outcome after surgery. They noted that operative time was 259 ±30 minutes in complete laryngofissure. In addition, **Nguyen *et al.*** [25] included 45 patients with laryngotracheal stenosis (LTS) treated by thyroid ala cartilage (TAC) and costal cartilage (CC) grafts in pediatric primary anterior laryngo-tracheoplasty (LTP). They found that operative time was 222 ±56 minutes for patients who underwent partial LTP.

In the present study, type of graft used was costal cartilage in all patients; the graft site was anterior graft. All patients underwent double stage tracheostomy. The duration of stenting was 6 weeks in all patients. The selection of a costal cartilage graft at the anterior glottic site was used to provide structural reinforcement to the laryngeal framework. It preserves the critical role of the anterior commissure in maintaining airway patency and optimal vocal fold vibration. This was confirmed by **Albrecht and Ostrower** [26]**.**

The use of a double-stage approach permitted secure airway management during the postoperative healing period, mitigating the risk of acute obstruction. Additionally, a six-week stenting interval was employed to ensure adequate graft integration and epithelialization. Thus, minimizing the likelihood of restenosis or graft displacement. This approach strategically balanced the objectives of airway safety, structural stability, and preservation of postoperative voice quality [27]**.** Our results agree with **Raol *et al.*** [28] who included 44 patients with LTS treated by traditional single stage LTR (SSLTR) and double-stage LTR (dsLTR). They reported that dsLTR involved preservation of the tracheostomy tube in place following reconstruction and placement of a suprastomal stent to maintain a patent airway lumen while healing occurred. In addition, **El-Sobki *et al.*** [18] included 31 patients with LTS to determined use LTR with good support for the laryngeal framework and with suitable accommodation to the complex glottic shape. They noted that the duration of stenting ranged from 3 to 6 weeks in patients with LTS.

In this study, preoperatively, both groups had comparable voice characteristics. However, postoperatively, group 1 demonstrated a lower fundamental frequency (mean ± SD: 260.69 ±26.98 Hz) and jitter (1.61±1 %) compared to group 2 (309.6 ± 48.9 Hz and 2.61±1 %, respectively). Other postoperative voice measures including shimmer, H/N ratio, dysphonia grade, pitch, loudness, and voice character showed no significant differences between groups, indicating that complete laryngofissure was associated with improved vocal stability and lower pitch while overall voice quality remained comparable. **Evermann *et al.*** [23] showed that postoperative decreased in fundamental frequency, while other acoustic and perceptual voice parameters remain largely unchanged, indicating that overall voice quality was generally preserved with only mild expected alterations in complete laryngofissure. Also, **Schweiger *et al.*** [24] reported that voice measurements revealed a significantly low fundamental voice frequency (P=.006) in complete laryngofissure.

In the present study, the complication profile in the current study could be explained by the fact that more extensive laryngeal framework disruption, wider mucosal incisions, and increased cartilage manipulation are known to prolong postoperative edema resolution, mucosal re-epithelialization, and stabilization of the reconstructed airway. **De Trey L *et al.*** [7] conducted a study on 14 patients with severe congenital laryngeal web by a LTR (full laryngofissure) to investigate respiratory and voice outcomes after open surgery for severe congenital laryngeal web. They noted that all patients were successfully decannulated in a median time of 4 months after surgery. In line with our findings, **Schmidt *et al.*** [29] conducted a study on 44 patients with subglottic stenosis to review outcomes of pediatric LTS treated by DSLTR with anterior and posterior cartilage grafts and compare decannulation rate for DSLTR. They reported that DSLTR with anterior and posterior cartilage grafts appeared to be a safe and effective technique for managing patients with high-grade subglottic stenosis at intermediate size children's hospitals. In addition, **Cui and Chen** [30] conducted a study on 129 patients with LTS to evaluate the efficacy of LTR with costal cartilage grafting for the treatment of LTS. They concluded that LTR with anterior costal cartilage grafting was a safe and effective method LTS.

In the current study, breathing outcome improved in all patients. Voice outcome and overall surgical success was insignificantly different between the two groups. Overall surgical success was success in all patients in group 1 and in 7 (70%)

patients in group 2 and was partial success in 3 (30%) patients in group 2. Voice outcome and overall surgical success was insignificantly different between the two groups. These results are in line with **Tan L *et al.*** [31] who conducted a study on 8 patients with laryngeal web to investigate outcomes of LTR with anterior and posterior costal cartilage grafts in severe pediatric subglottic stenosis (SGS) or laryngeal web (LW). They stated that LTR with anterior and posterior costal cartilage grafts was an effective and safe treatment for severe SGS or LW. Supporting these findings, **Avelino *et al.*** [5] showed that all patients were successfully decannulated, with good voice quality and no complications associated with the surgeries. In addition, **Cheung *et al.*** [32] conducted a study on 46 patients with LTS. They believed that good outcomes were achieved following open LTR for pediatric LTS despite postoperative complications, (89.1%) were successfully decannulated. Also, **De Trey *et al.*** [7] reported that breathing and voice were improved.

**Conclusion:** Complete LTR offers superior functional results, particularly for achieving stable, high-quality voice, and can be considered the preferred approach when maximal structural and phonatory restoration is desired.

**Study limitations and recommendations:** The current work had some limitations, the relatively small size, short duration of follow-up and included only pediatric patients. Thus, further prospective, multicenter studies with larger sample sizes are needed.

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