

Augmentation of the posterior pharyngeal wall with autologous tragal cartilage for velopharyngeal valve insufficiency after repair of cleft palate in pediatric patients

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Purpose

The aim of this study was to evaluate posterior pharyngeal wall augmentation using autologous tragal cartilage graft in patients with velopharyngeal valve insufficiency (VPI) after simple palatoplasty for cleft palate.

Patients and methods

This study included 18 patients with postpalatoplasty VPI (grade 2 or 3), with ages ranging from 5 to 14 years. Patients were followed up for 24–48 months postoperatively. Percent of speech intelligibility and grade of closure of velopharyngeal valve with nasopharyngoscope were evaluated preoperatively and postoperatively.

Results

Statistically significant improvement in grade of closure of velopharyngeal valve ($P=0.001$) and percent of intelligibility ($P=0.001$) was found after surgery.

Conclusion

Augmentation of the posterior pharyngeal wall using tragal cartilage is a safe technique, with generally good surgical and phoniatic outcomes in the management of pediatric patients with grades 2 and 3 VPI after simple palatoplasty to overcome hypernasality.

Keywords:

augmentation, autologous, cartilage, cleft palate, posterior pharyngeal wall, tragal, velopharyngeal valve insufficiency

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Introduction

Velopharyngeal valve insufficiency (VPI) after primary repair of cleft palate is a common condition due to failure of the repaired palate to close the space between the nasopharynx and the oropharynx during phonation. An overall 25–30% of patients suffer social shyness due to abnormal resonance and hypernasality [1]. The most commonly used techniques are pharyngeal flaps, uvulopharyngoplasty, and sphincter pharyngoplasty [2]. Augmentation of the posterior pharyngeal wall is an alternative technique to the commonly performed pharyngeal flaps that achieve a more physiologic result for the patient [3]. A wide variety of implants in the posterior pharyngeal wall have been used, such as Gore Tex [3], autologous fat [4], porous polyethylene [5], calcium hydroxyapatite [6], and cartilage [7]. The aim of our study was to evaluate the effectiveness of autologous tragal cartilage implantation in the posterior pharyngeal wall in treating VPI after repair of cleft palate.

Patients and methods

This prospective study included 18 pediatric patients attending the ENT Department of Ain Shams University Hospitals between April 2012 and April 2014. All patients had previously undergone simple

palatoplasty for cleft palate, which resulted in residual hypernasality that did not respond to a minimum of 6 months of speech therapy and with VPI grades 2 and 3 according to Bassiouny *et al.* [8] classification. We excluded patients with nasal regurgitation, auricular deformities, aberrant internal carotid artery, and those with previous trials to treat VPI with pharyngeal flaps. The study protocol was approved by the Ethics Committee of Ain Shams University Hospitals, Ain Shams University, and informed consent was obtained from all patients after explaining the study protocol and aims.

Surgical procedure

All operations were performed under general anesthesia. Following endotracheal intubation, harvesting of the tragal cartilage with its perichondrium was performed and then divided it into two equal rectangular sheets and sutured to each other using 4–0 vicryl with a round needle to have a double-layered cartilage (Fig. 1).

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The mouth is opened with a mouth gag, and the surgeon palpates the posterior pharyngeal wall to exclude aberrant internal carotid artery. The soft palate is moved toward the posterior pharyngeal wall to detect and mark the shortest anteroposterior diameter, which will be the lower end of the pocket. Lidocaine with epinephrine (1: 200 000) is injected into the posterior pharyngeal wall. A transverse incision, ~2cm in length and just inferior to the adenoid, is made. A pocket for the graft is created by dissecting between the constrictor muscle and the prevertebral fascia toward the lateral pharyngeal wall and then inferiorly. The graft is then placed transversely in the pocket and fixed with two stitches to prevertebral fascia (Fig. 2). The incision is closed with interrupted simple stitches (Fig. 3).

All patients recovered quickly from surgery with no intra-operative and immediately postoperative complications. All of them were discharged the same day with oral

medications (amoxicillin–clavulanic acid as an anti-biotic and paracetamol as analgesic).

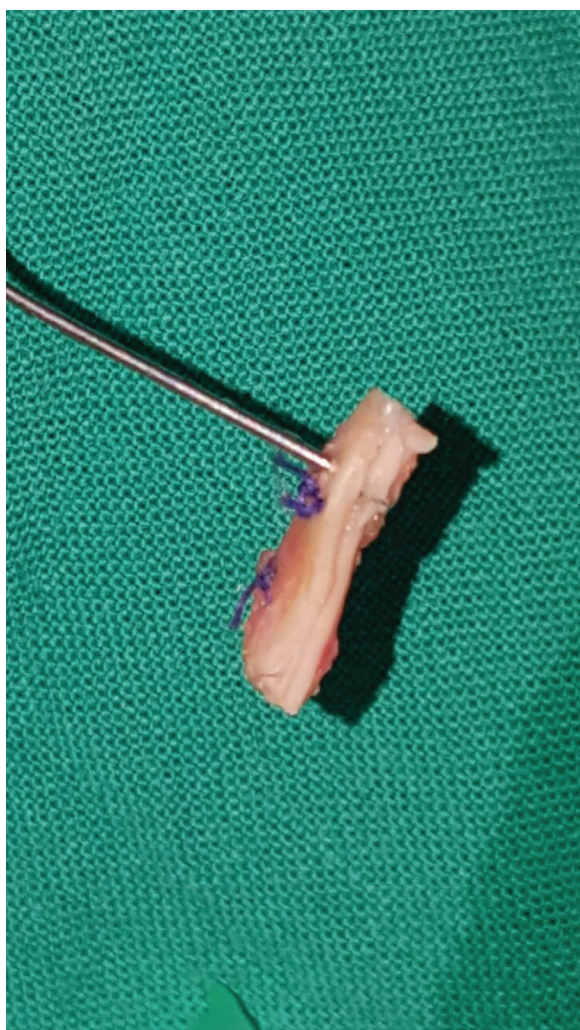
Speech therapy

Speech therapy was performed by the speech pathologist during the 6–12 months postoperatively. Patients were followed up for 24–48 months after the operations.

Assessment of velopharyngeal valve insufficiency

- (1) The function of the velopharyngeal valve was assessed by an expert phoniatician at the Phoniatic Unit, Ain Shams University Hospitals. Nasoendoscopic examination of the patients was planned to give dynamic visualization of the area, allowing assessment of the pattern of velopharyngeal closure during speech, as well as identification of tonsils and adenoids, submucous clefts, or pharyngeal scarring. All patients were examined using a flexible endoscope after a nasal tamponade was applied with topical anesthesia; the nasofibroscope was attached to a digital camera, which in turn was connected to a

Figure 1



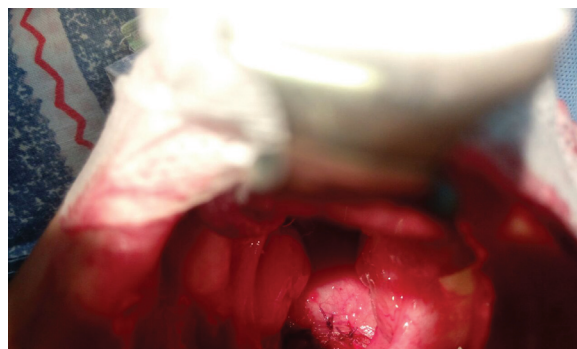
Double-layered tragal cartilage with its perichondrium.

Figure 2



Transverse incision in the posterior pharyngeal wall with virtual horizontal position of the graft in the pocket.

Figure 3



Interrupted simple sutures.

personal computer and saved on the computer for further analysis and ratings.

The velopharyngeal valve was rated on the basis of a four-point scale; this evaluation included recording ratings of the following:

- (a) Velar movements.
- (b) Lateral pharyngeal wall movement.
- (c) Posterior pharyngeal wall movement.
- (d) Shapes of the gap between the soft palate and the posterior pharyngeal wall.

The four-point scale of the velopharyngeal valve (VPV) wall movement was graded according to the extent of movement of a particular wall to the corresponding opposite wall. On the anteroposterior level, the velar movement is given grade '4' when it reaches and touches the posterior pharyngeal wall, grade '2' when it reaches half way the distance to the posterior pharyngeal wall, and '0' when there is no movement at all. Grade 1 is midway between 0 and 2, and grade 3 is midway between 2 and 4 [8].

Nasoendoscopy was performed for all patients at 3 months and 1 year postoperatively to evaluate grade of closure.

Speech intelligibility was measured using the Arabic Speech Intelligibility test. The Arabic Speech Intelligibility test is meant to be a quasiobjective measure. The test comprises 100 cards carrying 50 pictures (each picture is repeated twice). Pictures are structurally organized into three sets as follows:

- (a) Set A included 20 pictures of monosyllabic words that start with bilabial, nasal, epicardial, and supraalveolar consonants.
- (b) Set B included 20 pictures of monosyllabic words that start with dorsopalatal, uvular, velar, and pharyngeal consonants.
- (c) Set C included 10 pictures indicating simple action verb sentences.

The pictures of each set are shuffled carefully and presented one by one to the patient who is asked to name what is in the picture. Thereafter, the clinician writes down what he or she heard from the patient in the clinician response form. The Arabic Speech Intelligibility test is designed to provide an estimation of the overall speech intelligibility of patients by providing a total score in percentage. The categorical values of the Arabic Speech Intelligibility test are as follows: 0–29%, unintelligible speech; 30–50%, poor intelligibility; 51–66%, fair intelligibility; 67–84%, good intelligibility; and 85–100%, excellent intelligibility [8].

Data management and statistical analysis

Continuous variables are expressed as mean and SD. Categorical variables are expressed as frequencies and percents. Student's *t*-test was used to assess the statistical significance of the difference between two study group means. Fisher's exact test was used to examine the relationship between categorical variables. Person and Spearman's correlation was used to assess the correlation according to the data distribution. The paired *t*-test and Wilcoxon signed-rank test were used for comparing paired data according to data distribution. A significance level of *P* less than 0.05 was used in all tests. All statistical procedures were carried out using SPSS (version 15 for Windows; SPSS Inc., Chicago, Illinois, USA).

Results

Eighteen patients with VPI after repair of cleft palate (11 male and seven female) were included in this study. All patients recovered uneventfully from surgery. Their ages ranged from 5 to 14 years (mean: 8.61 years). Table 1 summarizes the clinical and demographic data of the study population.

Assessment of the degree of velopharyngeal valve closure preoperatively with fiberoptic nasopharyngoscopy showed that 13 patients had grade 2 and five had grade 3 VPI. Three patients with grade 2 and two patients with grade 3 remained in their grade with no

Table 1 The clinical and demographic data of the study population

	<i>N</i> (%)
Age (mean±SD)	8.61±3.20
Sex	
Male	11 (61.1)
Female	7 (38.9)
Grade of closure preoperatively	
Grade 2	13 (72.2)
Grade 3	5 (27.8)
Grade of closure postoperatively	
Grade 2	3 (16.7)
Grade 3	9 (50.0)
Grade 4	6 (33.3)
Change in grade	
No change	5 (27.8)
One-grade change	10 (55.6)
Two-grade change	3 (16.7)
Severity of speech intelligibility% preoperatively	
Poor intelligibility	16 (88.9)
Fair intelligibility	2 (11.1)
Severity of speech intelligibility% postoperatively	
Poor intelligibility	1 (5.6)
Fair intelligibility	4 (22.2)
Good intelligibility	9 (50.0)
Excellent intelligibility	4 (22.2)

Table 2 Difference in the grade of closure preoperatively and postoperatively

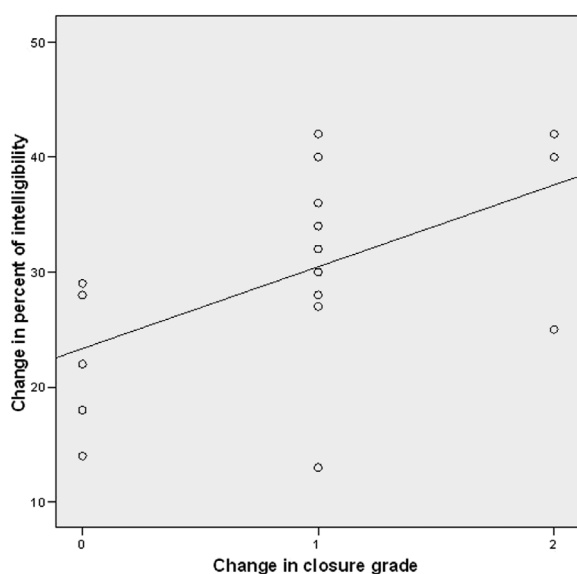
	Preoperative		Postoperative		P-value
	Mean±SD	Median	Mean±SD	Median	
Grade of closure	2.28±0.46	2.0	3.17±0.71	3.0	0.001*

*Wilcoxon signed-rank test.

Table 3 Difference in speech intelligibility% preoperatively and postoperatively

	Mean±SD	P-value
Speech intelligibility% preoperatively	44.78±7.511	0.001*
Speech intelligibility% postoperatively	74.44±11.932	

*Paired samples test.

Figure 4

Correlations between change in grade and change in percent of intelligibility after operation.

change. Sixteen of 18 patients had poor speech intelligibility preoperatively, whereas only one patient remained with postoperative poor intelligibility. Postoperative improvement in grade of closure and speech intelligibility was statistically significant ($P=0.001$) (Tables 2 and 3).

A positive correlation between change in grade and change in percent of intelligibility after operation was found (Fig. 4). Table 4 shows that there was no statistically significant correlation between age or sex and improvement in grade of closure and change in percent of intelligibility after surgery.

Discussion

VPI is a common problem after repair of cleft palate. Many techniques are used to overcome the problem of hypernasality. Flaps are the most commonly used

Table 4 Correlations between demographic data and improvement in grade of closure and change in percent of intelligibility after surgery

	P-value	
	Improvement in grade of closure	Change in percent of intelligibility after surgery
Age	0.552*	0.543 [§]
Sex	1.0**	0.138*

*Student t-test. **Fisher exact. [§]sPearson correlation.

technique by surgeons with the possibility of obstructive sleep apnea and snoring postoperatively [9,10]. The earliest age to begin the treatment of VPI is around 5 years, because diagnostic methods such as nasopharyngoscopy and pressure-flow measurements could not be used before the age of 4–5 years [11]. The main aim regardless of the operation performed is to create a perfect separation of the nasopharynx and the oropharynx during phonation and deglutition.

Posterior wall augmentation is not a new technique, as Gersuny [12] used Vaseline about 115 years ago to decrease the anteroposterior diameter between the velum and posterior pharyngeal wall. Since that time, many trials were performed with various materials such as paraffin [13], silicone [14], Teflon [15], collagen [16], calcium hydroxyapatite [6], fat [4–17], proplast [18], Gore Tex [3], and cartilage [19]. All materials have advantages and disadvantages but none of these methods have been widely adopted [19].

Hollweg and Perthes are the first to augment the posterior pharyngeal wall with autologous cartilage through a transverical approach and they reported some improvements, and Wardill introduced the transoral approach. Authors used autologous or homologous costal cartilage for augmentation of posterior pharyngeal wall with a superiorly based pocket [7].

To our knowledge, we are the first authors to use tragal cartilage in the augmentation of posterior pharyngeal wall in such cases with the advantages of being easier to take at time of operation, cut, and prepare double-layered rectangular shape compared with costal cartilage. Moreover, in all our patients there were no complications at the donor site. Hess *et al.* [7] were the first to assess cartilage pharyngoplasty over an 8-year

period. They included 31 patients; autogenous cartilage was used for five patients and viable homologous cartilage for 26 patients. They stated that there was no difference between younger and older patients as regards velar motility preoperatively and postoperatively [2,7]. In agreement with these findings, we did not find a statistically significant effect of age or sex on the improvement in grade of closure and change in percent of intelligibility after surgery. We found that cartilage pharyngoplasty improved the grade of closure of velopharyngeal gap and the percent of intelligibility after surgery. These findings were stated by Hess *et al.* [7] as well. Trigos *et al.* [20] found similar results in their preliminary study of a series of 10 patients with borderline VPI who underwent homologous cartilage implantation.

The largest study to date is by Lypka *et al.* [3]. It was a retrospective analysis of 111 patients who underwent posterior pharyngeal augmentation over a period of 40 years. They used various implants, mainly Gore Tex block and textured silicone pillow. Rib cartilage was used for only one patient. They concluded that the posterior pharyngeal augmentation is a safe and effective treatment for patients with VPI. They stated that all implants were well tolerated and that speech substantially improved [3]. Accordingly, posterior pharyngeal augmentation is a technique that is largely forgotten and understudied. Very few studies aimed at evaluating cartilage implantation in VPI and none at comparing different grafts. Thus, we recommend further multicentered studies with larger number of patients, different graft materials, and a longer period of follow-up to determine long-term outcomes.

Conclusion

Augmentation of the posterior pharyngeal wall using tragal cartilage is a safe technique, with generally good surgical and phoniatic outcomes in the management of pediatric patients with grades 2 and 3 VPI after simple palatoplasty to overcome hypernasality. We recommend that further studies with longer follow-up duration and in adult patients be carried out.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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