Quality Improvement Study

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Management of velopharyngeal insufficiency by a new modification of sphincter pharyngoplasty technique in cleft palate patients, clinical and radiographical prospective study

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Background: This study was designed to investigate the effectiveness and outcome of a new modification of the sphincter pharyngoplasty technique in the treatment of velopharyngeal insufficiency patients, with the determination of a specific dimension of velopharyngeal port and velum length of no hypernasality, snoring, and nasal regurgitation potential.

Materials and methods: The study included 10 patients, who were suffering from consistent hypernasal speech after failure of conservative speech therapy. Clinical and radiographic measurements of the velopharyngeal port and velum length before and after surgery were done, with clinical patient follow-up to assess snoring and nasal regurgitation after surgery for 1, 6, and 12 months.

Results: Before surgery, the mean clinical anteroposterior distance/velopharyngeal depth was 16.40 ± 1.7 mm, and the mediolateral distance was 20.20 ± 3.4 mm. After surgery, the mean anteroposterior distance decreased to 8 ± 0.9 mm, and the mean mediolateral distance decreased to 12.60 ± 2.06 mm. Both measurements showed statistically significant ($P = 0.0001$). After 12 months postoperatively, the radiographic CT axial anteroposterior distance was 12.09 ± 1.4 mm, and the mean mediolateral distance was 19.82 ± 5.6 mm, compared to the mean CT anterioposterior before surgery 15.60 ± 2 mm and mediolaterally 21.28 ± 2.7 mm. The anteroposterior measurement showed a statistically significant ($P = 0.002$), while the mediolateral measurement did not ($P = 0.3$). The mean velum length before surgery was 25.80 ± 1.5 mm and 27.03 ± 0.6 mm after 12 months postoperatively. Snoring and nasal regurgitation occurrence were assessed at 1, 6, and 12 months postoperatively, with all reports being negative.

Conclusion: Sphincter pharyngoplasty using posterior tonsillar pillars for treating VPI patients results in improved speech outcomes without snoring or nasal regurgitation.

Keywords: cleft palate, sphincter pharyngoplasty, velopharyngeal depth, velopharyngeal insufficiency, velum length

Introduction

Cleft lip and/or palate is an embryological phenomenon that reflects a failure of fusion of the medial nasal processes and maxillary processes. This failure of fusion results in a spectrum of aesthetic and functional deformities to the lip, alveolus, and palate. The most critical deformity is the potential disruption of speech development[1].

Velopharyngeal insufficiency (VPI) is a condition where the soft palate does not close tightly against the back of the throat, leading to air coming out the nose during speech[2,3]. This could lead to speech difficulties and produce nasal voice[2,3]. The impact of VPI on speech and resonance can range from minor speech distortion to severe impairment of speech clarity, resulting in the inability to effectively communicate verbally[4].

The most common causes of VPI are the palatal cleft even after repair, or soft palate that is too short or muscles of the soft palate are not normally functional[3]. Therefore, it needs revision sur gery to correct this deformity.

The treatment of VPI can be surgical or conservative therapies[1,5]. Speech therapy can help the patients adjust the way they speak to reduce the sounds of VPI, and surgery can correct the underlying cause[2,6]. The main goal of the surgical techniques is to create a permanent partial obstruction of the velopharyngeal space and velum lengthening to correct hypernasal speech[2].

Pharyngeal flap and sphincter pharyngoplasty remain the

HIGHLIGHTS

- Management of velopharyngeal insufficiency by using sphincter pharyngoplasty in a new surgical technique.
- Clinical and radiographic dimensions of VP port and velum length before and after surgery.
- Determine a specific clinical and radiographical proposed measurements of good outcome.

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procedures most frequently chosen by craniofacial surgeons for management of VPI. Both techniques have successful speech outcomes and negative consequences[3].

Pharyngeal flap is the mainstay of surgical therapy for velopharyngeal insufficiency in many facilities[3,7]. In this procedure, a flap of tissue is pedicled superiorly (most common) or inferiorly from the posterior pharyngeal wall and sutured to the palate. Most reports describe good speech after pharyngeal flap surgery. However, there are also studies that report unpleasant side effects such as nasal obstruction, hypernasality, sleep apnea, and lateral port stenosis because the flap obstructs the air passage[2,8]. Another drawback is it needs a mobile lateral pharyngeal wall to open the ports during breathing and close during speech[8]. Also, it limits the mobility of the soft palate[8].

Sphincter pharyngoplasty or lateral pharyngoplasty is another common surgical treatment for VPI. The posterior tonsillar pillars are used as donor flaps to be sutured across an incision in the nasopharyngeal posterior wall (the original technique). Many variations have been made to this procedure by many clinicians, like cerclage sphincter pharyngoplasty and palatopharyngeal sling, to be not sutured in the posterior pharyngeal wall[3,8]. These procedures create a transverse sphincter or narrowing velophar yngeal (VP) port of variable diameter with preservation of mobi lity of the soft palate. This approach is advantageous when cor onal or circular closure is present and lateral pharyngeal wall motion is deficient. Several studies have reported a success rate (i.e. correction or significant reduction in hypernasality) from 78 to 90%. The incidence of postoperative hypernasality is esti mated to be 12–17%[7–10].

Snoring seems to be more frequently, if not almost exclusively, associated with pharyngeal flap surgery 93%[7]. However, many centers consider pharyngeal flap to be more effective procedures for correcting VPI particularly in severe cases[4,11,12].

This study presented a new surgical technique for the treatment of VPI in which bilateral posterior faucial/tonsillar pillars are elevated together and sutured to a raw surface of the soft palate and bilateral pillars mucosa.

The authors hypothesized that VPI treatment could be effective in reducing hypernasality speech. Thus, enhancing the quality of voice. In addition, reduce the velopharyngeal port. The aim of this study is to assess the efficacy of this novel surgical technique in the treatment of VPI.

Materials and methods

This study was conducted with the Declaration of Helsinki for human studies and this work has been reported in line with the SQUIRE criteria. The patients were informed about the details of the surgery and their written parent's informed consent was obtained. Included criteria in this study include patients complaining of consistent hypernasality speech after anatomical cleft palate defect repair and failed speech therapy with their ages between 10 and 20 years with no history of maxillary advancement surgery.

This study was conducted on 10 patients in the period from December 2021 to November 2023 who met the included criteria for entry into the research (3 out of 13 were excluded due to age above 20 years old). All patients were subjected to the following:

1. Preoperative assessment.
2. General examination to exclude any other congenital anomalies.
3. History taking and full oral, ENT examination.
4. Assessment of the speech by recording the nasal sounds to compare them postoperatively.
5. CT scan before surgery and after 12 years postoperative.
6. Follow-up 1, 6, and 12 months after surgery to assess snoring and nasal regurgitation potential.

Operative technique

After induction of general anesthesia with orotracheal intubation, and after putting a throat pack, a Dingman retractor was inserted. The posterior tonsillar pillars and soft palate are injected with 1:50 000 lidocaine 2% with adrenaline for homeostasis purposes (Fig. 1). The incisions were marked with a pencil and an incision was made from the middle of the palatine velum down the medial border of the posterior pillar to the point where suturing with the opposite side would be possible without flap tension (Fig. 2). The same procedure is done on both sides. In the palatine velum, the nasal and oral mucosa are separated from the palatine velum muscles, and in the posterior pillar is separated

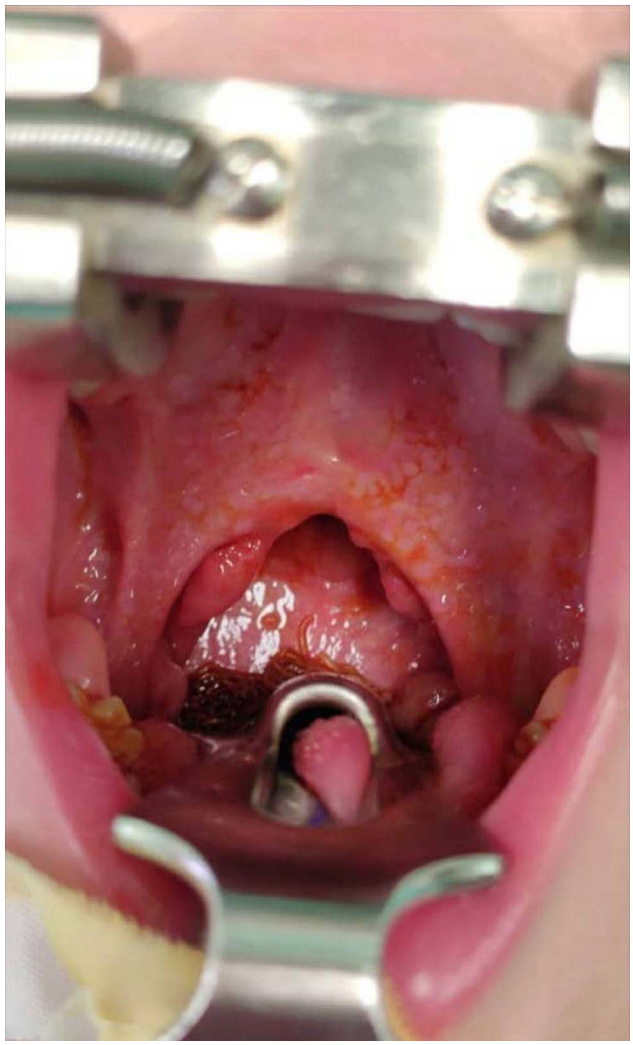

Figure 1. Clinical image of the back of the throat that demonstrates the posterior tonsillar pillars, posterior velum edge, and posterior pharyngeal wall before surgery.

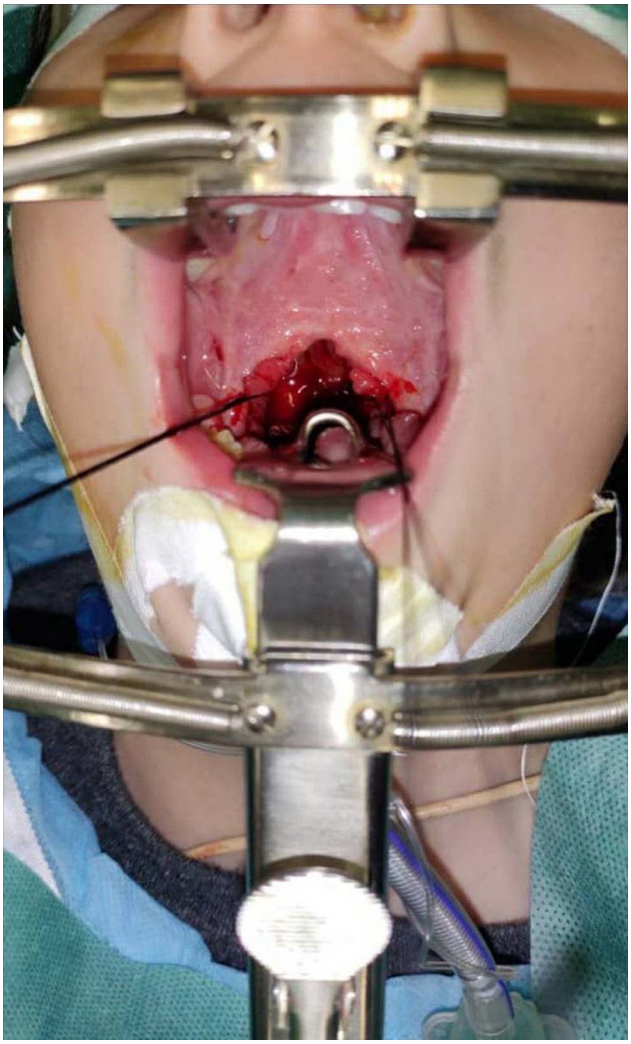

Figure 2. Clinical image of elevated bilateral palatopharyngeal muscle flap with the traction of 2/00 silk suture material.

into the posterior and anterior mucosa and the palatopharyngeal muscle is exposed. The posterior mucosa is then sutured using vicryl (000, round, Vertmed) suture material at both sides then the palatopharyngeal muscle to the velum muscles. A releasing incision is made at the base of pillars if necessary. Followed by mucosa approximation with vicryl 3/000 suture material (Fig. 3).

Clinical evaluation

The measurement was done after oral intubation and introducing the Dingman retractor and before the incision from the tip of the uvula to the posterior pharyngeal wall/anterioposterior (AP) by using a rule and approximate size of the lateral pharyngeal wall to the opposite lateral wall/mediolateral by depressing the base of the tongue and retract the anterior tonsillar pillars for full measurement of the velopharyngeal port (Fig. 4). The measurement was repeated at the end of the surgery. Figure 5 demonstrates the follow-up clinical image of the velopharyngeal port 12 months after surgery.

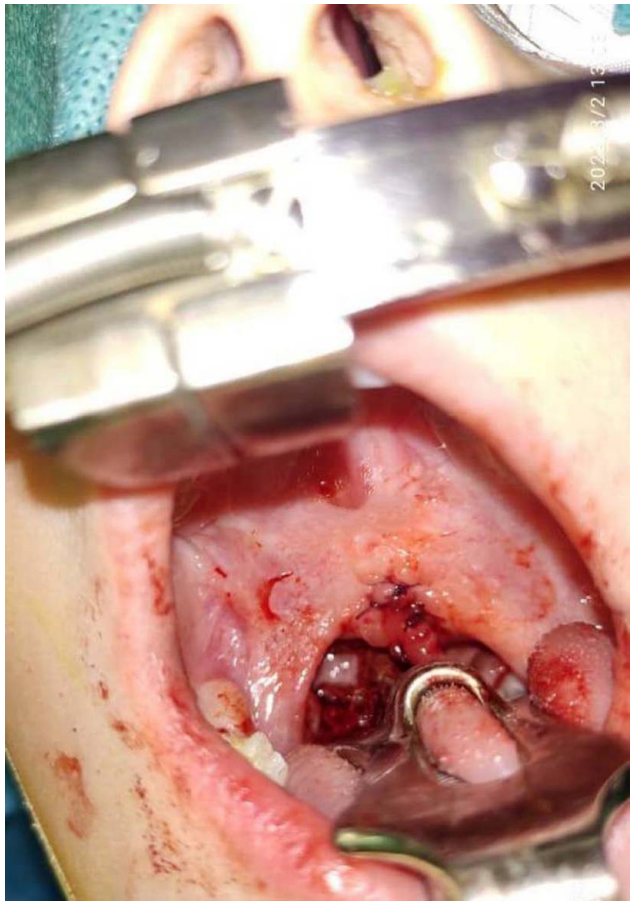

Figure 3. Clinical image of velopharyngeal port after suturing the bilateral palatopharyngeal flaps to the posterior edge of the soft palate with vicryl 3/000 round suture material and after approximating of mucosa with vicryl 3/000 cutting suture material.

Radiographical evaluation

Radiographic comparison was done using computed tomography (CT) by using RadiAnt DICOM Viewer software for measurement of the anterioposterior size in the axial plane from the uvula to the posterior pharyngeal wall and from the

Figure 4. Clinical measurement image before surgery of anterioposterior/tip of the uvula to the posterior pharyngeal wall distance using a rule.

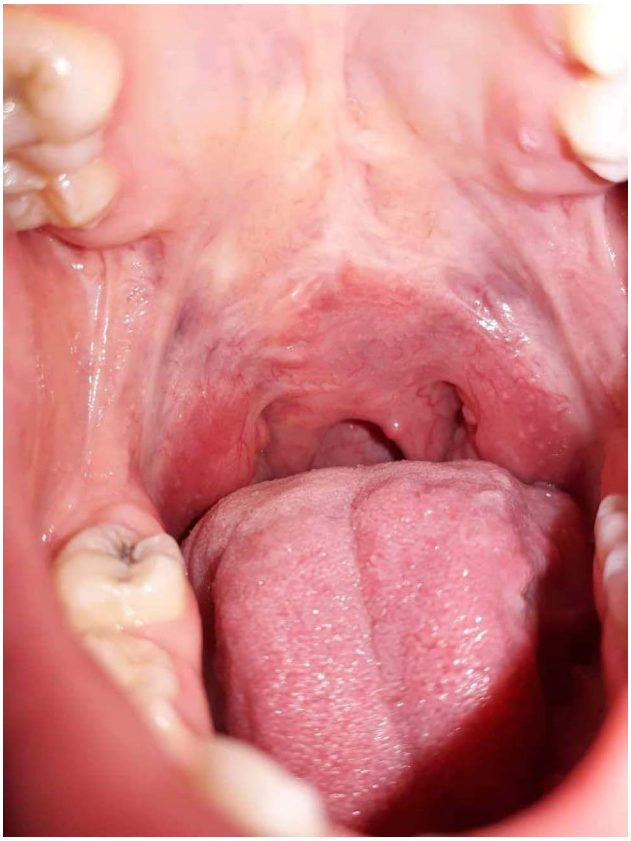

Figure 5. Follow-up clinical image of patient velopharyngeal port after 12 months postoperatively.

lateral wall to the opposite lateral wall of the velopharyngeal port (mediolateral dimension) with velum length in sagittal plane.

The measurement was done before surgery (Fig. 6) and after 12 months (Fig. 7) with the reference point in the axial section was the incisive foramen that corresponded the approximate level of the soft palate and velopharyngeal port closure.

Results

All data was analyzed using IBM SPSS version 25.0 software for Windows.

A paired *t*-test sample was used for analyzing the results to show differences between the dimensions of velopharyngeal port clinical and radiographical before and after surgery. *P*-value of > 0.05 was considered to be statistically significant.

This study was conducted on 10 patients who complained of hypernasality speech that results from velopharyngeal insufficiency. As regarding the clinical and radiographical preoperative and postoperative measurement mean and SD data were compared (Tables 1, 2).

Preoperatively, the patients had a radiographic average uvula-posterior pharyngeal wall/anterioposterior distance/velopharyngeal depth was 15.60 ± 2 mm by CT axial section at the level of the incisive foramen, and mediolateral distance/lateral pharyngeal wall to the opposite one was 21.28 ± 2.7 mm.

Postoperatively, the average radiographic anterioposterior distance after 12 months was 12.09 ± 1.4 mm and mediolateral distance was 19.82 ± 5.6 mm.

The comparison between the preoperative and postoperative results of radiographic anterioposterior size was statistically significant ($P = 0.002$) with narrowing of A-P velopharyngeal port was 3.51 mm (22.5%) postoperatively. And the preoperative and postoperative results of radiographic mediolateral comparison were not statistically significant ($P = 0.3$) with narrowing of mediolateral velopharyngeal port was 1.46 mm (6.86%) postoperatively.

The mean radiographic sagittal velum length before surgery was 25.80 ± 1.5 mm and 27.03 ± 0.6 mm after 12 months postoperative with an increase of 1.23 mm (4.55%) with no statistically significant ($P = 0.09$).

The mean clinical measurement of anterioposterior distance preoperatively was 16.40 ± 1.7 mm with mediolateral distance was 20.20 ± 3.4 mm compared with postoperative AP distance 8 ± 0.9 mm with mediolateral distance 12.60 ± 2.06 mm.

The comparison between the preoperative and postoperative results of clinical anterioposterior distance was statistically significant, $P = 0.0001$ with A-P narrowing was 8.4 mm (51.2%) and mediolateral distance was also

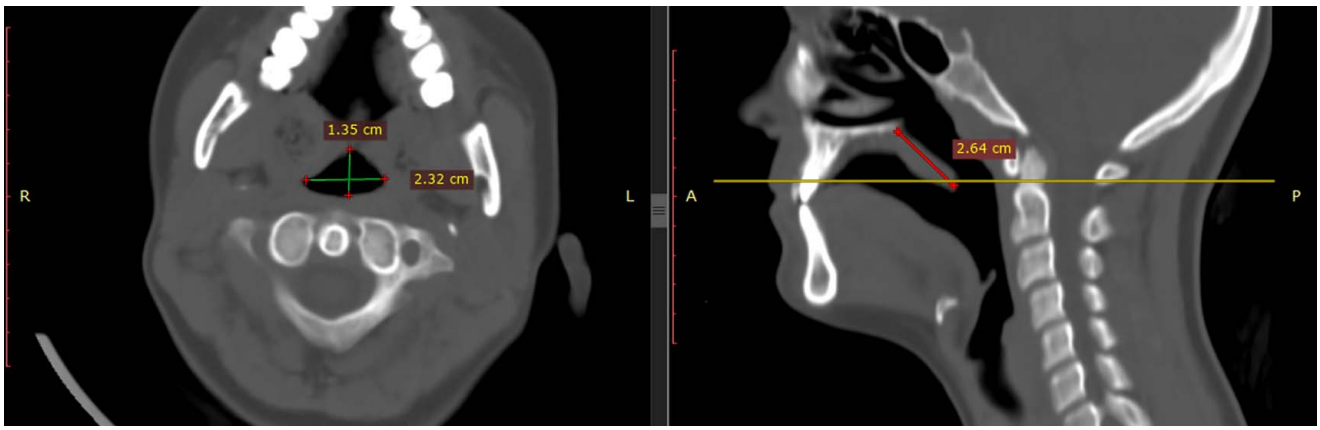

Figure 6. Radiographic measurement of the velopharyngeal port at the level of the incisive foramen that demonstrates the anterioposterior and mediolateral distances before surgery.

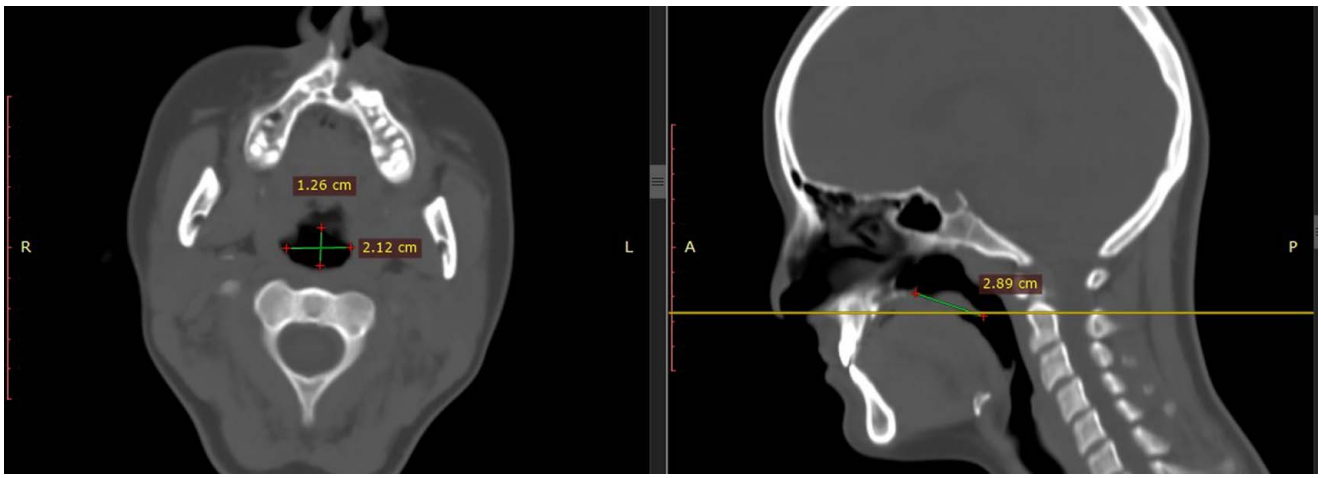

Figure 7. Radiographic measurement of velopharyngeal port at the level of the incisive foramen that demonstrates the anterioposterior and mediolateral distances 12 months after surgery.

statistically significant, $P = 0.0001$ with narrowing was 7.6 mm (37.6%).

The snoring and nasal regurgitation are evaluated by asking the patients or their parents 1, 6, and 12 months after surgery and they were all negative compared with eight patients positive to nasal regurgitation preoperatively.

Discussion

In this study, we treated 10 patients presented with diagnosed VPI after cleft palate repair and failure of speech therapy with this new modification of sphincter pharyngoplasty.

The surgical management of VPI that includes narrowing the velopharyngeal port leads to reducing the patient's hypernasality and reducing nasal regurgitation. In this study, we evaluated the degree of narrowing by comparing the preoperative and postoperative clinical and radiographic measurement of VP port.

There is a lack in the medical literature about the specific range of VP port size that may cause the hypernasality as well as the snoring potential. The normal general range of VP port in literature was 10–20 mm.

The novelty of this article included the measurement of velopharyngeal port size anterioposterior (A-P) and mediolateral dimension with velum length and proposed measurement with good clinical outcome.

In this study, we noticed that the radiographic size of the VP port below 13 mm A-P and 18 mm mediolaterally and velum length above 27.5 mm with clinical size postoperatively A-P 8 mm and 14 mm mediolaterally was related to good speech outcome (reducing hypernasality) with no incidence of snoring or nasal regurgitation.

The limitation of this study was the lack of a speech and language pathologist that best determined the preoperative and postoperative hypernasality. In addition, we were unable to confirm the perfect plane of axial sections that had been used to evaluate VP port using the incisive foramen as a reference point.

The enhancement of speech and elimination of the nasal regurgitation is the responsible for the VP mechanism that fully closes the nasal cavity during swallowing and production of oral sounds.

VPI may occur because of a structural or anatomical defect that results from the inability to close the gap between the velum and back of the throat. This problem may appear in patients after cleft palate repair and it is characterized by hypernasality speech, appearance of speech compensatory articulation and nasal regurgitation, which ultimately results in a lower quality of life.

This surgical technique improved the quality of voice by reducing the dimension of the velopharyngeal port size, which leads to reducing hypernasality speech and eliminating nasal regurgitation and snoring. Thus, enhancing the self-assurance of the patients.

The treatment options presented in the literature are varied, including noninvasive (speech therapy and prosthesis placement) and invasive (palatoplasty and palatopharyngoplastyies) treatments.

Table 1

Radiographical measurement data of anterioposterior and mediolateral velopharyngeal port and velum length before and after 12 month postoperatively

	Velum length (before)	Velum length (after)	Anterioposterior distance size (before)	Mediolateral distance size (before)	Anterioposterior distance size (after)	Mediolateral distance size (after)
Mean/mm	25.80	27.03	15.6	21.28	12.9	19.82
Range/mm	23.10–28.20	26.30–28.30	12.90–20.30	17–26.60	9.40–14.50	11.40–32
SD/mm	1.5	0.6	2.3	2.7	1.4	5.6
N	10	10	10	10	10	10

mm, millimeter; *N*, study patient number.

Table 2

Clinical measurement data of anterioposterior and mediolateral velopharyngeal port at the start and end of surgery

	Anterioposterior distance size (before)	Mediolateral distance size (before)	Anterioposterior size (after)	Mediolateral distance size (after)
Mean/mm	16.40	20.2	8	12.6
Range/mm	15–20	15–26	7–10	9–15
SD/mm	1.7	3.4	0.9	2.06
N	10	10	10	10

mm, millimeter; *N*, study patient number.

Surgical intervention remains the cornerstone of the treatment of VPI, although there is no golden standard technique for correction of VPI. Nevertheless, the clinician should recognize the risks associated with these interventions, such as development of OSA and the risk of hemorrhage, infection, and prevalence of otitis media.

Conclusion

The choice of the sphincter pharyngoplasty by using the posterior tonsillar pillar in the management of the VPI has a good speech outcome with no snoring or nasal regurgitation incidence.

Ethical approval

The ethical approval from our institution Scientific Research Board Resolution- Tishreen University, Latakia, Syria. Board status: approved approval no. 3153/2021 (3/08/2021).

Consent

Written informed consent was obtained from the patient's parents for publication and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

J.H.: first surgeon of all cases included in this study, writing the manuscript, data collection, data analysis, and drafting the article; H.Y.: supervision.

Conflicts of interest disclosure

The authors declare no conflicts of interest.

Research registration unique identifying number (UIN)

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