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Pharyngoplasty and Other Options for Treatment of Obstructive Sleep Apnea: Review Article

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ABSTRACT
Background: Obstructive sleep apnea (OSA) is a persistent respiratory problem that affects an increasing number of people. The pharyngeal airway becomes obstructed and narrowed at regular intervals during sleep in people with OSA. Heart disease, metabolic diseases, cognitive impairment, and depression are only some of the long-term effects of untreated OSA. Optimal nasal continuous airway pressure usage and restoration of normal breathing are the goals of nasal reconstructive surgery for patients with nasal airway obstruction due to bony or cartilaginous growths or hypertrophied tissues.
Objective: Review of the literature on Pharyngoplasty and other options for Treatment of obstructive sleep apnea.
Methods: We searched PubMed, Google Scholar, and Science Direct for information on Pharyngoplasty, and Treatment of obstructive sleep apnea. However, only the most current or comprehensive study from March 2004 to January 2022 was considered. The authors also assessed references from pertinent literature. Documents in languages other than English have been disregarded since there are not enough resources for translation. Unpublished manuscripts, oral presentations, conference abstracts, and dissertations were examples of papers that were not considered to be serious scientific research.
Conclusion: The idea of Anterolateral Advancement Pharyngoplasty to avoid transecting the palatopharyngeal muscle (PPM)' lower end and severing any of the muscle fibers in the superior pharyngeal constrictor (SPC), a pharyngoplasty is performed to partially segregate the PPM's anterior and posterior sections. Tension on the lateral pharyngeal wall (LPW) was achieved by first hooking the posterior PPM to the lingual velum psoas muscle, and the remaining PPM and SPC are advanced superolaterally and sutured to the pterygomandibular raphes in a figure-of-eight method.
Keywords: Pharyngoplasty, Treatment, Obstructive sleep apnea.

INTRODUCTION
Reduced or missing airflow during sleep is a hallmark of obstructive sleep apnea (OSA), a respiratory disease. Sleep apnea occurs when the muscles in the upper airway become too relaxed and collapse, causing brief pauses in breathing (hypopneas) or full cessation of breathing (apneas) that last at least 10 seconds. The average length of a pause is between 10 and 30 seconds, while some can extend for up to a minute. Due to this, blood oxygen levels drop dangerously low, sometimes by as much as 40 percent in extreme situations [(1)].

The disorder is characterized by extreme sleepiness during the day, which has been related to negative health outcomes such as a decreased quality of life, reduced cognitive function, and an increased chance of getting in a car accident. In order to properly diagnose OSAs, a thorough clinical evaluation is required. Yet, most data indicate that clinical symptoms alone have limited usefulness in the prediction of the illness [(2)].

Treatment with continuous positive airway pressure (CPAP), in which air is pumped into a mask to keep the airway open, is considered the standard of care for obstructive sleep apnea. Only CPAP, if tolerated, can effectively eradicate apneas in all patients. It also has been found to alleviate metabolic and cardiovascular effects of OSA and may increase survival. Unfortunately, CPAP is not always well tolerated by patients. Patients frequently report difficulty passively exhaling due to the persistent positive pressure. Dry mouth, nose, and sinuses are common complaints of CPAP users because the therapy dehydrates the mucosal membranes [(3)].

Mandibular advancement splints (MAS):
The mandible is held in a forward posture by an oral appliance while the patient sleeps. As a result, these devices have the potential to effectively treat OSA in mild to severe cases. About 40% of patients reported a complete remission of OSA (AHI lowered 5/hr) when using a MAS. About two-thirds of patients saw clinical improvement (a 50% reduction in AHI or more), whereas others may show improvement in symptoms but fail to objectively respond to this treatment. Patients with mild to moderate OSA, and even those with severe OSA who refuse or cannot utilize CPAP, are administered MAS nowadays [(3)].

Positional therapy:
This is because the pharyngeal dimension alterations and the abdominal compression that occurs when a person is lying in a supine position make it more likely that the airway would collapse. Thus, techniques to promote lateral sleep have been tried, with mixed success. Patients with OSA often become accustomed to and switch to supine sleeping positions as a result of positional therapy because of the discomfort, frequent awakenings, and perceived lack of effectiveness of lateral sleeping positions [(3)].

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Weight loss:
Many variables can contribute to the onset of OSA, but if a person loses enough weight, the condition will go away. Significant decreases in AHI have been observed after surgical, nutritional, and exercise treatments [3].

Surgical treatment:
Nasal Reconstruction:
Restoring normal breathing and making the most of nasal CPAP are two of the goals of nasal reconstructive surgery for those who had airway obstruction due to bony or cartilaginous tissue growth or hypertrophy, respectively. Maintaining a mostly nasal airflow requires a patent nasal airway. It is possible to repair the nasal septum and/or the nasal bones during nasal reconstruction surgery. Nasal patency can often be achieved with minimal risk and a high rate of success using these techniques. But on their own, they probably won't do much to help those with moderate or severe OSA [4].
Uvulopalatal flap (UPF):
The uvula is retracted superiorly toward the hard-soft palate junction in uvulopalatopharyngoplasty (UPF), a variant of uvulopalatopharyngoplasty (UPPP), after minimal tissue is removed from the uvula, the lateral pharyngeal wall, and the mucosa. With this procedure, the patient's oropharyngeal airway is enlarged. UPF is favored over UPPP because UPPP raises the possibility of nasopharyngeal incompetence and makes use of sutures along the free edge of the palate. UPF employs a flap that can theoretically be turned inside out. Issues arise, just like they do in the UPPP paradigm [4].

Figure (1): Uvulopalatal flap [4].

Laser-Assisted Uvulopalatoplasty (LAUP):
The uvula and the palate are gradually reduced in length and tightened by laser incisions and vaporizations of carbon dioxide during LAUP. The success rate of LAUP in lowering RDI to less than 10 occurrences per hour is close to 50%, according to studies testing its efficacy. Because of risks of upper airway edema and pain during LAUP. This procedure is less frequently used to treat OSA [4]. This method of surgery was once common, but it is now generally avoided because of the low rate of success and the significant risk of complications.

Lateral pharyngoplasty:
Cahali described a method for treating OSAs in which the tonsils are removed, the superior pharyngeal constrictor muscle is elevated within the tonsillar fossa, superior traction is applied to the upper palatopharyngeus muscle, a lateral palatine flap is created, the palatopharyngeus muscle is subtotally resected, and the flaps are closed using a z-plasty technique. The AHI rate was found to be lower at 9.5 per hour (p = 0.009) compared to 41.2 (p 0.001). The most serious consequence after surgery is dysphagia [4].
Z-palatoplasty (ZPP):
Friedman *et al.* [5] described the ZPP for treating OSAs in people who have already had their tonsils removed. The mucosa covering the uvula and the anterior soft palate must be removed to expose the underlying muscle. Following this, the uvula and inferior soft palate are divided in half with a cold knife, the flaps are turned laterally over the soft palate, and the incisions are sutured closed. This study's findings went beyond what would have been expected from a typical UPPP [5].

®**Expansion sphincter pharyngoplasty:**
It is described by **Pang and Woodson** [6] as follows: For a tonsillectomy, the palatopharyngeus muscle is incised horizontally, the soft palate is severed superolaterally, the inferior section of the palatopharyngeus muscle is suspended superolaterally, and the incisions are closed.

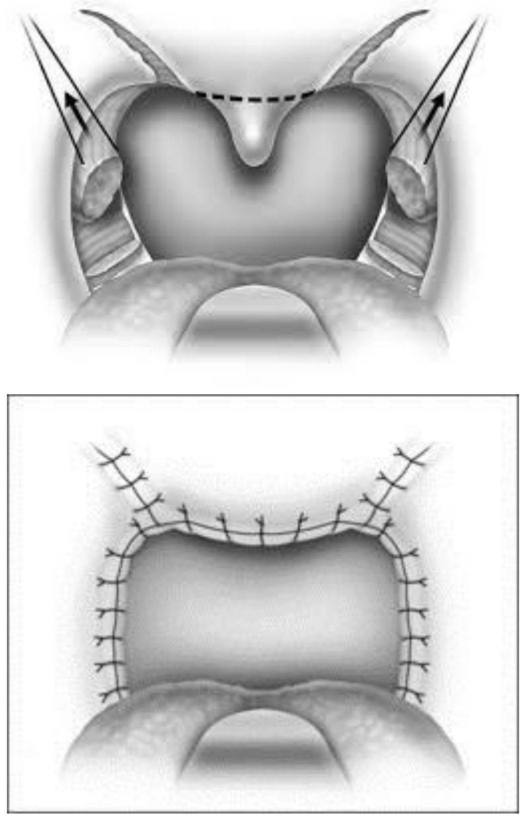

Figure (2): Suture and closure of palatal incision in expansion sphincter pharyngoplasty [6].

Functional Expansion Pharyngoplasty (FEP):
Transecting the PPM, creating a tunnel through the soft palate from the tonsillar fossa's apex to the pterygoid hamulus, and then elevating and rotating the PPM flap superior laterally through the palatine tunnel and fixing it close to the pterygoid hamulus constitutes FEP, a more conservative variant of ESP [7].

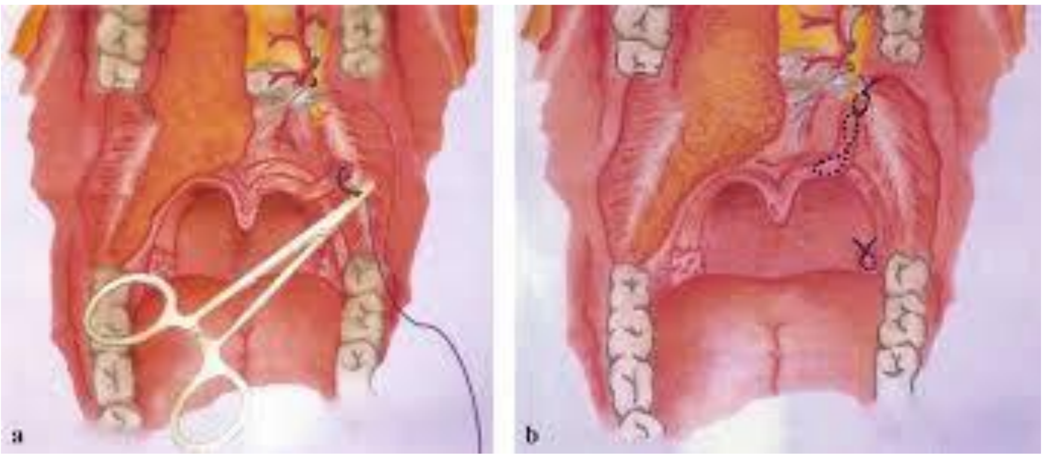

Figure (3): a–b. Superolateral rotation through the palatine tunnel and attachment to the palatine musculature near the pterygoid hamulus lift and secure the PPM flap [(6)].

Relocation Pharyngoplasty:
After having their tonsils removed, the palatoglossus, palatopharyngeus, and SPC muscles were all in plain view. The palatopharyngeus muscle can be used to rotate the hard palate cephalically and laterally, bringing it into closer proximity with the soft palate. The superior pharyngeal constrictor muscle is grasped and sutured laterally to the ipsilateral palatoglossus muscle in a cephalic-tocaudal orientation using a mattress-style suture produced from 2-0 Vicryl. With the remaining palatoglossus muscle exposed, the posterior pillar flap is next elevated from a horizontal to a vertical plane and sutured into position. The non-muscular, distal end of the uvula is cut off once the corresponding procedures on the other side have been performed [(7, 8)].

Barbed reposition pharyngoplasty (BRP):
Salamanca *et al.* [(9)] established a novel method of employing barbed sutures in anterior pharyngoplasty, and subsequently Vicini used a knotless bidirectional reabsorbable suture to move the posterior pillar, enlarging the space between the palate and the soft palate and the oropharynx (palatopharyngeal muscle). To do this, the inferior aspect of the palatopharyngeal muscle was weakened and the posterior pillar was suspended from the pterygomandibular raphe.

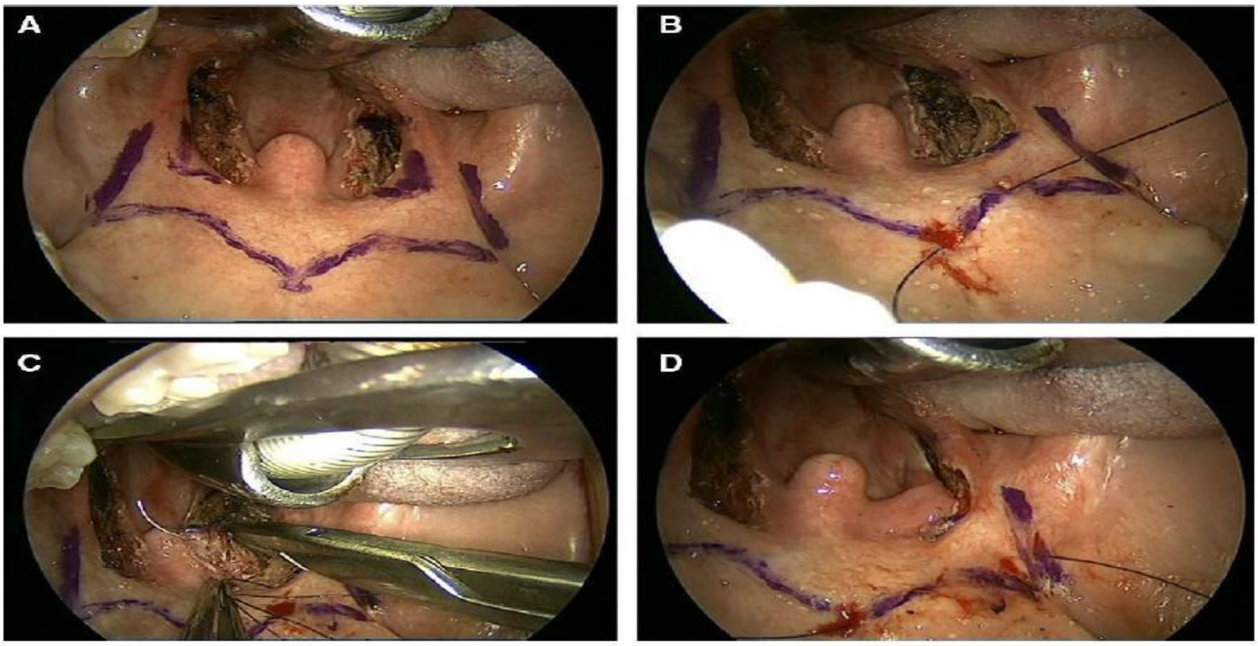

Figure (4): (a) Indicating the pterygomandibular raphe, the center of the palate and the squareness of the anterior pillars. (b) Right raphe, above the barbed suture, which dangles in the middle of the articular disc. (c) The palatopharyngeus muscle is punctured close, rather than through, the mucosa of the posterior pillar. (d) For knotless barbed suturing, a needle is threaded through the raphe's upper pole and hung below it [(8)].

Anterolateral Advancement Pharyngoplasty:
The purpose of this method is to plicate the SPC muscle without cutting through any of its fibers, and to partially separate the PPM (anterior and posterior sections) without transecting its lower end. The LPW tension was achieved by suturing the posterior pterygoid muscle (PPM) to the lingual velum psoas muscle (LVP) (Figure 5), and then advancing the remaining PPM and SPC superolaterally and suturing them to the pterygomandibular raphes in a figure-of-eight manner. Anterolateral advancement of the soft palate and LPW accomplishes LPW stability and pharyngeal extension with less invasiveness and more efficacy than standard pharyngoplasty [10].

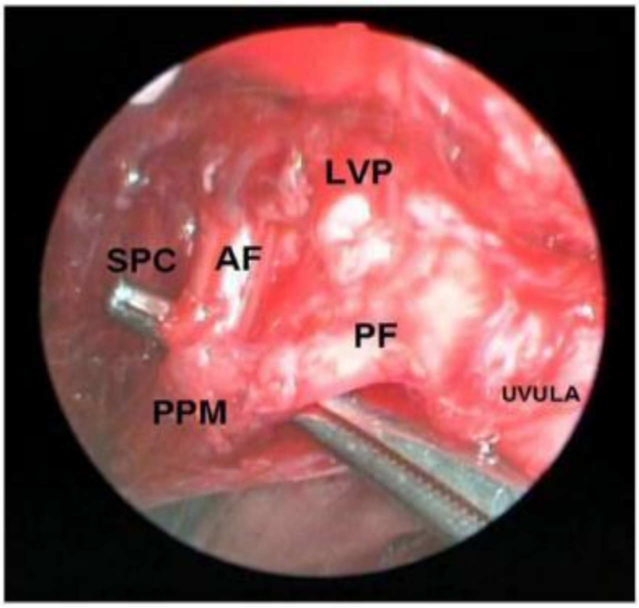

Figure (5): This intraoperative right-side view showed the palatopharyngeus muscle (PPM), superior pharyngeus constrictor (SPC), and levator veli palatini (LVP) being dissected into their anterior fascicules (AF) and posterior fascicules (PF), with the connecting fibres (CFs) left intact [7, 8].

The ALA pharyngoplasty does not involve cutting the PPM fascicules. The SPC muscle was plicated in an attempt to reinforce the base of the tongue and restore the tonsillar fossa. To provide anterolateral support to the oropharynx and the base of the tongue, surgeons often suture the superior palatine crest (SPC) muscle to the pterygoid plate (PPM) and then connect it to the pterygoid raphe. The SPC muscle originates more laterally (in the mandibular mylohyoid line) in the tonsillar fossa region [10, 11].

CONCLUSION
The idea of Anterolateral Advancement Pharyngoplasty to avoid transecting the PPM's lower end and severing any of the muscle fibres in the SPC, a pharyngoplasty is performed to partially segregate the PPM's anterior and posterior sections. Tension on the lateral pharyngeal wall (LPW) was achieved by first hooking the posterior PPM to the lingual velum psoas muscle, and the remaining palatopharyngeal muscle (PPM) and superior pharyngeal constrictor (SPC) are advanced superolaterally and sutured to the pterygomandibular raphes in a figure-of-eight method.

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