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Modified genioglossus advancement with radiofrequency tongue base reduction for retroglossal collapse in Obstructive sleep apnea patients

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A R T I C L E I N F O

Keywords:
Obstructive sleep apnea
Modified genioglossus advancement
Radiofrequency tongue base reduction

A B S T R A C T

Objective: To study the combined effect of modified genioglossus advancement (MGGA) and radiofrequency tongue base reduction (RFTBR) a long with anterolateral advancement (ALA) pharyngolplasty on OSA patients with retrolingual airway collapse.
Study design: Prospective clinical study.
Setting: Zagazig and Benha Universities Medical Hospitals.
Patients and methods: Twenty-one patients (21)with multilevel OSA underwent modified genioglossus advancement with radiofrequency tongue base reduction and anterolateral advancement pharyngolplasty. All patients were assessed before and 6 months after surgery by history talking, clinical examination, Epworth Sleepiness Scale evaluation fiberoptic examination during muller's maneuver, drug induced sleep endoscopy (DISE), panoramic X-ray, Cephalometry and polysomnography.
Results: Postoperative mean ± SD Epworth Sleepiness Scale (ESS) significantly decreased from 18.86 ± 2.03to 8.19 ± 1.86 (P-value was <0.001 95% (CI) 9.80 to 11.53).postoperative mean ± SD AHI decreased from 53.39 ± 14.10 to 26.66 ± 5.44 (P-value was <0.001 95% CI 22.37 to 32.81), postoperative mean ± SD LOS increased from 68.33 ± 9.12 to 86.0 ± 4.96 (P-value was <0.001 95% (CI) 15.24 to21.33).Based on cephalometric analysis postoperative mean ± SD PAS at mid retrolingual point in mm increased from 6.43 ± 1.25 to 11.98 ± 1.69 (P-value was <0.001 95% (CI) 4.78 to 6.32), also postoperative mean ± SD Distance between H-MP in mm decreased from 23.38 ± 1.14 to 15.17 ± 0.97 (P-value was 0.001 95% (CI) 7.66 to 8.76).The postoperative mean ± SD distance from hyoid to menton (H-me) in mm decreased from 39.47 ± 2.37to24.83 ± 2.43(P-value was 0.001 95% (CI) 7.31 to 8.41), the mean ± SD distance of genioglossus muscle advancement in mm was 14.45 ± 1.12.With a success rate defined as AHI < 20 and/or 50% reduction in AHI of the pre- operative value, the surgical success was 81%.
Conclusion: MGGA with RFTBR along with anterolateral advancement pharyngoplasty in a single session is well tolerated and safe surgery in the treatment of multilevel OSA patients. It is effective in reducing respiratory parameters and subjective symptoms of OSA.

1. Introduction

Obstructive sleep apnea (OSA) is a condition that results in complete upper airway obstruction during sleep. There are three types of obstruction, type I occurs at level of oropharynx, type II occurs at level of oropharynx and hypopharynx and type III that occurs at level of hypopharynx. Most patients have type II obstruction involving both the soft palate and the tongue base [1].

Many risk factors have been identified to increase the susceptibility to the disease, this include obesity, male gender, ethnicity, and craniofacial structure. OSA has a drastic effect on increasing morbidity and mortality which has been linked to cardiovascular and cerebrovascular disease [2].

Heretofore, the gold standard in the treatment of OSA is continuous

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positive airway pressure (CPAP). However, some patients with OSA cannot tolerate the therapy of CPAP and are also often unwilling to undergo traditional aggressive surgical treatment [3].

Riley et al., were the first to describe multilevel reconstructive surgery to alleviate obstruction of the posterior airway space at the soft palate and hypopharynx, using uvulopalatopharyngoplasty (UPPP) and inferior sagittal osteotomy of the mandible for genioglossus muscle advancement [4]. The goal of this procedure was to stabilize the hypopharyngeal airway by pulling the genioglossus muscle forward, creating tension at the base of the tongue, and thereby extending the airway in anteroposterior dimensions. Over the previous thirty years, various improvements to the original approach have been made to improve the outcome and reduce the occurrence of problems, according to Powell et al., described the rectangular osteotomy to reduce the incidence of mandibular fracture by keeping at least 10 mm of the inferior border of the mandible intact [5]. Mintz et al., studied the relations between the genial tubercles and the roots of the canines and recommended genioglossus muscle advancement with circular osteotomy technique [6]. To advance the genioglossus muscle, Lee and Woodson proposed using a trephine osteotomy approach [7]. The mandibular trapezoid osteotomy, encompassing the inferior mandibular boundary, was described by Dattilo [8]. One of the most recent modifications is modified genioglossus advancement described by Emara et al., in 2011 through this technique there is no change in chin point, a dramatic decrease in the incidence of mandibular fracture, also it is a more physiological technique as there is no twist or rotation of the advanced segment that leads to disruption of muscle fibers. The advanced segment holds both genioglossus and geniohyoid muscle so it can affect hyoid bone position by advancing this bone anteriorly and superiorly [9].

The electromagnetic (EM) spectrum includes a radio frequency (RF), which is described as a continuous frequency spectrum of vibrating massless energy quanta. Powel first described radiofrequency tongue base reduction (RFTBR) in 1999 as a minimally invasive surgery for treating retrolingual obstruction in OSA patients [10]. RFTBR has been shown to be a safe and effective method in both upper and lower pharyngeal obstruction [11].

The objective of this study was to describe the effect of performing combined anterolateral advancement pharyngoplasty, modified genioglossus advancement and radiofrequency tongue base reduction to treat OSA patients with multilevel collapse.

2. Patient and methods

2.1. Study design

Prospective study on 21 patients(15 male cases and 6 female cases) with moderate to severe OSA having retrolingual and retropalatal collapse. From the Department of Otorhinolaryngology-Head &Neck Surgery, Zagazig and Benha Universities, Egypt starting from 2018 till 2020. Inclusion criteria:Both sex, Patients>18 years old, and <60 years. BMI of patients less than 35 kg/m2, Patients diagnosed with moderate to severe OSAS according to American Academy of Sleep Medicine(defined as AHI > 15) with both retro-palatal and retro-lingual collapse confirmed preoperatively with flexible fiberoptic endoscope during Muller maneuver and drug induced sleep endoscopy (DISE), Friedman tongue position III or IV, Documented failure/refusal of attempts of conservative treatment measures including continuous positive airway pressure (CPAP)and Class 1 occlusion. Preoperative assessment included history taking; Epworth Sleepiness Scale (ESS) evaluation, hypersleepiness is considered with an ESS above10; complete clinical and radiological examination; Fiberoptic endoscopy during muller's maneuver, DISE cephalometry; panoramic X-ray and polysomnography (PSG),. All twenty-six patients were re-evaluated at 6 months after the surgery with the same preoperative assessment in addition to Visual analogue scale (VAS) for pain and dysphagia:VAS for pain was taken in the 1st day post-operative, 1 week and 4 weeks post-operative. (0 means no pain, 10 means maximum pain). VAS for dysphagia was taken in the 3rd day postoperative when soft diet started, 1 week and 4 weeks postoperative.(0 means no difficulty, 10 means maximum difficulty) [12]. The success rate was defined as AHI <20 and a 50% decrease in AHI of the preoperative value. Informed written consent was obtained from all patients and Zagazig university institutional review board (IRB) approved this study.

2.2. Surgical procedure

All patients underwent ALA pharyngoplasty following (Emara et al., 2016) then radiofrequency tongue base reduction according to (Powell et al., 1999) and modified genioglossus advancement following (Emara et al., 2011).

The procedure started with ALA pharyngoplasty, after a bilateral tonsillectomy, the anterior and posterior parts of the palatopharyngeus muscle (PPM), as well as the superior pharyngeal constrictor (SPC) muscle in the upper half of the tonsillar fossa, were carefully identified. The anterior part of the PPM's muscular fasciculus was partially separated from the SPC muscle after meticulous dissection, and the SPC muscle was grabbed and plicated with 2–0 Vicryl through two mattress sutures. The main PPM and the plicated SPC were sutured with a 0 Vicryl suture directly below the confluence of both the anterior and posterior fasciculi and subsequently elevated and advanced to be fixed to the pterygomandibular raphe through a “figure-of-eight suture style” to achieve anterolateral expansion, and then the inferior half of the PPM was laterally sutured to the SPC through two mattress sutures.

The patient was then positioned in a sniffing position with his neck flexed and his head extended, the tip of the tongue was sutured with 0–0 Vicryl suture to draw out the tongue base, and a Boyle-Davis mouth gag was used, with the shortest and widest blade favored. In the place where the RF probe would be implanted, 1.5 ml of 1:200.000 bupivacaine hydrochloride was injected into the base of the tongue. A radiofrequency generator was used to provide RF following Nelson Powell's landmarks at 4 MHz. A custom-fabricated device with a 10-mm active length allowed for precise electrode placement. To prevent surface damage, a protective thermal sheath was applied to the electrode's proximal portion. The treatment site was chosen in the midline, at the point where the anterior two-thirds of the tongue meets the posterior one-third. The treatment sites were marked by the apex of the circumvallate papilla, which is located in the midline of the tongue. The treatment zone was defined as a 1.5 to 2.0 cm2 area that encircled the apex. Two points in the center (1st zone) and one point on the periphery for each side (2nd zone). We used a 30° endoscope to get a better view of the tongue base and monitored the surgery on the monitor screen. RF was delivered for 18–20 s on average, at a power of 13 watts, delivering 600 Jules per site. To reduce postoperative edema, 2 ml of steroid was administered at the treated zones at the base of the tongue at the end of the procedure (Fig. 1).

Finally, MGGA was performed, after infiltration of a local anesthetic with a concentration of 1,200,000 epinephrine at the lower gingivolabial sulcus, incision of the mucosa down to periosteum was done, subperiosteal dissection was performed to expose the anterior aspect of the mandible to the lower border inferiorly, and to the mental neurovascular bundles laterally. In order to avoid injury to the canine root, a full evaluation of cephalometry and panoramic X-ray was used to define the precise direction of the incisors and canine roots. After marking the osteotomy sites, a horizontal bone cut was done, about 5 mm below the roots of the incisor teeth and stopping before the canine roots. A second horizontal bone cut was done about 5 mm above the lower mandibular border. Two vertical cuts were used to join the two bone cuts, avoiding harm to the mental neurovascular bundles. A monocortical titanium mini-screws was inserted into the center of the osteotomized portion to facilitate manipulation. Bone cuts were gradually deepened until they reached the lingual cortex, then the bony segment was gently detached

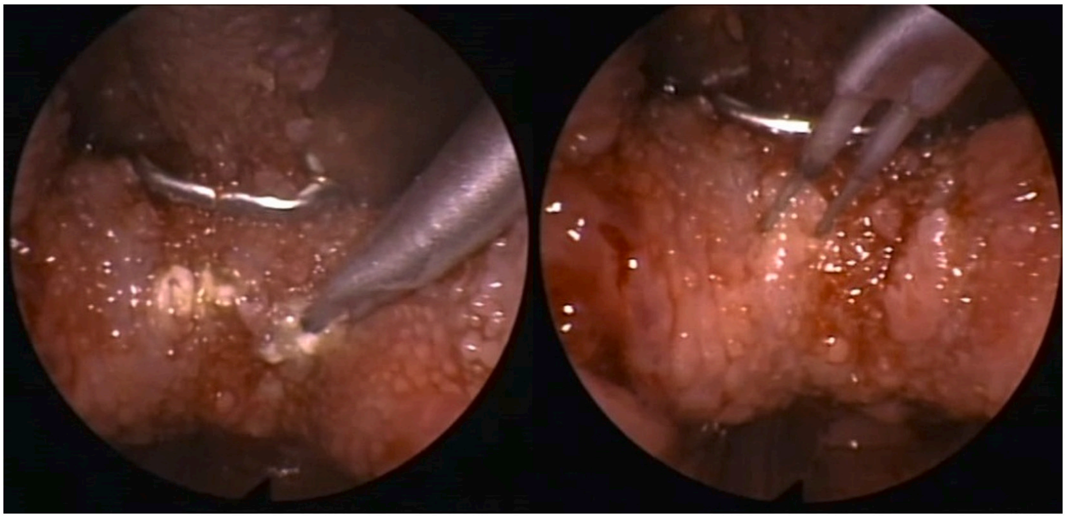

Fig. 1. Application the RF probe to the base of the tongue.

holding the genial tubercles with both genioglossus and geniohyoid muscle attachments. The osteotomized bone segment was then gently pushed anteriorly with a titanium screw until the lingual cortex met the rest of the facial cortex of the mandible. The labial cortex and the medullary bone in between were then removed. The lingual cortex was then fixed to the rest of the mandible with a titanium miniplate and mini-screws. The Labial cortex and medullary bone were then used to fill any bony defect. The gingival incision is then closed with 3/0 vicryl sutures (Fig. 2A–D).

2.3. Statistical analysis of the data

The IBM SPSS software program version 20.0 was used to examine the data that was supplied to the computer. (IBM Corporation, Armonk, NY). The Kolmogorov-Smirnov test was employed to ensure that the distribution of variables was normal. For regularly distributed quantitative variables, the paired *t*-test was used to compare two periods, whereas the Wilcoxon signed ranks test was used to compare two periods for abnormally distributed quantitative variables. To compare between more than two periods or stages, use the Friedman test for abnormally distributed quantitative variables and the Post Hoc Test (Dunn's) for pairwise comparisons. The significance of the acquired results was assessed at a 5% level of significance.

3. Results

The age of all patients ranged from 35 to 60, the mean ± SD was 45.53 ± 5.44. Regarding gender, there was a male predominance; 71.4% were males(15 cases). The mean ± SD BMI was 31.93 ± 1.41.

Postoperative mean ± SD Epworth Sleepiness Scale (ESS) significantly decreased from 18.86 ± 2.03to 8.19 ± 1.86 (P-value was <0.001 95% (CI) 9.80 to 11.53).

The polysomnographic parameters showed significant improvement on the study, postoperative mean ± SD apnea-hypopnea index (AHI) decreased from 53.39 ± 14.10to 26.66 ± 5.44 (P-value was <0.001 95% confidence interval (CI) 22.37 to 32.81), postoperative mean ± SD lowest oxygen saturation (LOS) increased from 68.33 ± 9.12to 86.0 ± 4.96 (P-value was <0.001 95% (CI) 15.24 to21.33).

Based on cephalometric analysis postoperative mean ± SD posterior airway space(PAS) at mid retrolingual point in mm increased from 6.43 ± 1.25to 11.98 ± 1.69 (P-value was <0.001 95% (CI) 4.78 to 6.32), also postoperative mean ± SD Distance between Hyoid – Mandibular plane (H-MP)in mm decreased from 23.38 ± 1.14 to 15.17 ± 0.97 (P-value was 0.001 95% (CI) 7.66 to 8.76).The postoperative mean ± SD distance from hyoid to menton (H-me) in mm decreased from 39.47 ± 2.37to24.83 ± 2.43(P-value was 0.001 95% (CI) 7.31 to 8.41), the mean ± SD distance of genioglossus muscle advancement in mm was 14.45 ± 1.12 (Table 1). With a success rate defined as AHI < 20 and/or a 50% reduction in AHI of the pre-operative value, the surgical success was 81%, the visual analogue scale(VAS) for pain was significantly high in the 1st day postoperative with mean ± SD of 8.16 ± 0.62, then the pain intensity gradually decreased in the 1st week postoperative with mean ± SD of 3.55 ± 0.59, in the 4th week postoperative pain nearly disappeared with mean ± SD of 0.15 ± 0.17.VAS for dysphagia was significantly high in the 3rd day postoperative with mean ± SD of 7.36 ± 1.07, then of dysphagia improved over the 1st week with mean ± SD of 4.50 ± 0.92. Dysphagia disappeared in the 4th week postoperative with mean ± SD of 0.18 ± 0.24 (Table 2: Fig. 3).

4. Discussion

The issue of multilevel upper airway obstruction in OSA patients is a subject of much debate. Fujita was the first to characterize the varying levels of anatomic obstruction in OSA. He realized that half of the patients who had uvulopalatopharyngoplasty (UPPP) were non-responders. The majority of non-responders were found to have multilevel obstruction. In his study, 54.5% (36/66) of patients had both oropharyngeal and hypopharyngeal obstruction. As a result, it is evident that Fujita never intended to imply that UPPP will treat the majority of OSA patients [13]. Riley et al. published their surgical experience in 1993, laying forth a multilevel concept. Each patient was assigned to one of three types of obstruction: oropharyngeal exclusively (type 1) or hypopharyngeal only (type 3), type 2 multilevel obstruction referred to a mix of oropharyngeal and hypopharyngeal obstruction. Multilevel obstruction, type 2 was found in 93.3% (223 patients) of the 239 patients. Only 16 (6.7%) of the patients had a single-level obstruction. Ten of the patients had type 1 obstruction, while six had type 3 obstruction [14]. Fujita and Riley's early classification was based on a physical examination of the patients and a set of vague guidelines. There were no specific criteria for distinguishing between single-level and multilevel obstruction. The Friedman tongue position (FTP) was developed later, allowing for a more straightforward means of staging levels of obstruction. According to preliminary findings based on FTP, around 25% of individuals with OSA had single-level obstruction, while 75% had multilevel obstruction [15]. Sleep endoscopy is suggested as a superior approach for more precisely identifying anatomic sites of obstruction during sleep. The number of single-level obstructions recorded by den Herder et al. was particularly high. Only 37% of the 127

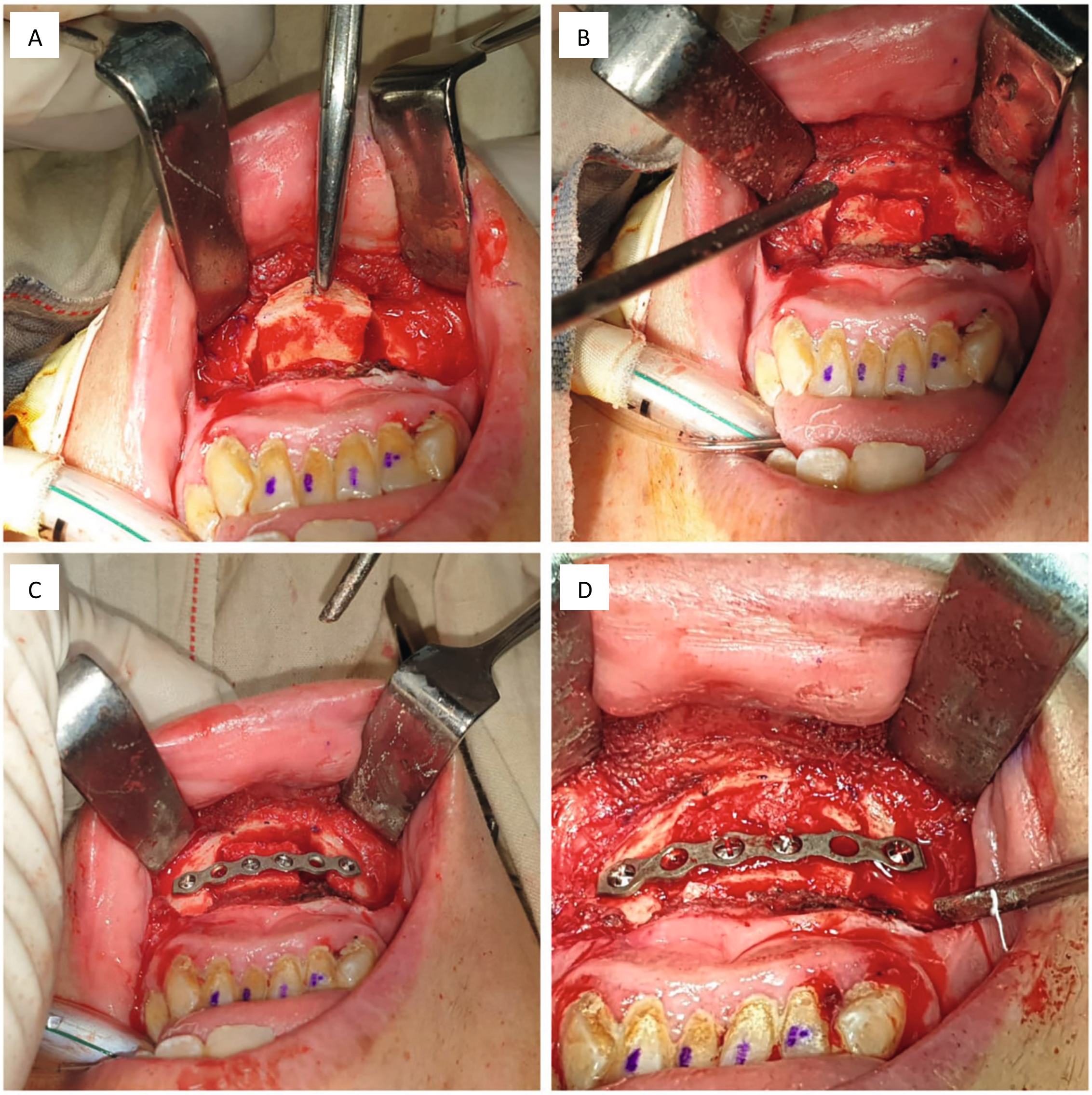

Fig. 2. A: Making osteotomy of the anterior bony mandible holding the origin of both genioglossus and geniohyoid muscles B: Labial cortex and medulla of the osteotomized bone had been removed leaving only lingual bone C: fixation the lingual cortex with miniplate and screws D: bone chips from removed labial cortex and medullary bone filling the defect between advanced segment and rest of the mandible.

Table 1
Preoperative and postoperative ESS, Polysomnography, and cephalometric findings (n = 21).

	Mean ± SD (n = 21)		Test of sig	95%CI	P-value
	preoperative	postoperative			
ESS	18.86 ± 2.03	8.19 ± 1.86	$t = 25.644$*	9.8 to 11.53	<0.001
AHI	53.39 ± 14.10	26.66 ± 5.44	$t = 11.034$	22.37to 32.81	<0.001
LOS, %	68.33 ± 9.12	86 ± 4.96	$t = 12.545$*	15.24 to 21.33	<0.001
PAS, mm	6.43 ± 1.25	11.98 ± 1.69	$t = 15.0$	4.78 to −6.32	<0.001
H-MP, mm	23.38 ± 1.14	15.17 ± 0.97	$t = 31.062$	7.66 to 8.76	<0.001
H-me, mm	39.47 ± 2.37	24.83 ± 2.43	$t = 31.027$*	7.31 to 8.41	<0.001
GGmuscle advancement, mm		14.45 ± 1.12			

Abbreviations: AHI, apnea-hypopnea index; ESS, Epworth Sleepiness Scale; LOS, lowest oxygen saturation; H-MP, Distance between Hyoid – Mandibular plane;; H-me, distance from hyoid to menton in mm. GG: genioglossus muscle: confidence interval, t: Paired *t*-test.

patients in their research exhibited multilevel disease, whereas 63% had single-level obstruction [16]. However, the study could have misclassified the level of blockage; tongue base obstruction pushing the palate backward, generating secondary palatal obstruction, could have been classified as the main palatal obstruction in the study. Abdullah van Hasselt's study corroborated the high prevalence of multilevel disease, finding that 87% of their 893 patient populations had multilevel obstruction [17].

Positive airway pressure (PAP) therapy, which includes continuous positive airway pressure (CPAP), bi-level positive airway pressure (BI-

Table 2
Vas for pain and dysphagia (n = 21).

	After 1 Day	After 1 Week	After 4 Weeks	Fr	P
VAS for pain					
Mean ± SD	8.16 ± 0.62	3.55 ± 0.59	0.15 ± 0.17	42.0*	<0.001*
VAS for dysphagia					
Mean ± SD	7.36 ± 1.07	4.50 ± 0.92	0.18 ± 0.24	41.518*	<0.001*

Abbreviations: VAS, visual analogue scale, Fr: Friedman test, Sig. bet. Periods was done using Post Hoc Test (Dunn's) p: p-value for comparing between different periods.

PAP) and adjustable positive air-way pressure (APAP), is an important, non-invasive method of treatment patients with OSA, but it is sadly dependent on patient compliance and tolerance. Patient compliance with CPAP therapy can be as low as 40% to 50%, and the incidence of refusal of CPAP therapy once a patient has been identified can be as high as 24%, according to numerous published research studies [18].

Surgical techniques range from procedures that increase or stabilize the airway by removing or repositioning tissues to procedures that completely bypass the site of airway collapse, such as tracheostomy. Surgery must be tailored to the patient's demands and directed to the main areas of collapse in the airway following a thorough endoscopic assessment [19].

The genioglossus muscle (GGM) is a prominent pharyngeal dilator and the main tongue protrusor. Riely et al., published an inferior mandibular osteotomy technique in 1985 that captured only the inferior section of genial tubercles, rather than extending the osteotomy superiorly to include the entire genial tubercle. Powell et al. described the rectangular osteotomy in 1991, which involves leaving at least 10 mm of the inferior border of the mandible intact in order to reduce the incidence of mandibular fracture. He moved the rectangular osteotomy 45 to 90 degrees to rest on the mandible's labial cortex and fixed it with titanium mini-screws. This may result in the stripping of certain GGM fibers by causing rotation to disrupt the fibers' typical anatomical orientations. Mintz et al. identified the genial tubercles' width as ranging from 3 to 8 mm, and the circular osteotomy as being around 8 mm in 1995. Dattilo described the trapezoid osteotomy procedure in 1998, which incorporated the inferior border of the mandible. The GGM attachment was defined by Silverstein et al. to be up to 15 mm broad. More genioglossus advancement occurs when all GGM attachments are captured [20]. In 2011 Emara et al., published a modified technique of genioglossus muscle advancement, which was applied in this study. We could avoid most of the complications of previous techniques. This modified wide osteotomy segment allows capturing the whole genioglossus and geniohyoid muscles attachments. We did not perform any twisting or rotation of the osteotomized segment holding the origin of the GGM. So stripping or detachment of any fibers of the GGM did not occur. The wide surgical field made the delivery, removal of outer cortex and medulla and anterior advancement of the osteotomized segment safely done under complete vision of the muscle fiber attachment [21].

Radiofrequency (RF) offers the advantage of treating multiple levels of the airway including soft palate and base of the tongue. It could be given once or repeated over time with minimal morbidity. However, there is no consensus of RF application as regards the total amount of RF energy needed and the total number of application required.

Stuck et al., used MRI to investigate the effect of RF on tongue volume and found no reduction in tongue volume or increase in retrolingual space. As a result, they concluded that the beneficial effects of radiofrequency surgery are not based on volumetric changes, but rather on changes in upper airway collapsibility caused by scarring formation [22]. This is in contrast to the findings of Powell et al., who discovered a 17% reduction in tongue volume in his study [10]. Our observation postoperatively by awake endoscopic examination with the Muller maneuver was that the response of the tongue base to RF varied due to individual differences after complete maturation of the RF scar. We reported both effects: a reduction in the base of the tongue as well as scar formation.

RF alone does not offer a polysomnographic improvement in OSA patients when used as a standalone procedure, and the failure of RF to improve oxygen saturation may warrant that other treatment modalities should be considered. In this study, we used RF to treat tongue base by delivering 600 joules in three sites concomitantly with MGGA and ALA pharyngoplasty the results of this study document statistically significant improvement in ESS, AHI, lowest oxygen saturation and cephalometric measurements. Although AHI and oxygen desaturation are widely used to evaluate the effectiveness of the treatment of OSA, the most important parameter is the degree of improvement in quality of life and its influence on cardiovascular morbidity and mortality.

Many studies had been performed as multilevel procedures to treat patients with moderate to severe OSA. Djupesland et al., performed UPPP at level of the palate and midline partial glossectomy at level of tongue base on 19 patients AHI declined from 54 to 31 with a surgical success rate of 31.6% [23]. Johonson and Chinn performed UPPP at level of the palate and genioglossus advancement at level of tongue base on 9 patients AHI declined from 58.7 to 14.5 with surgical success rate of 77.8% [24]. Ramirez and Lobue performed UPPP at level of the palate and genioglossus advancement with hyoid suspension at level of tongue base on 12 patients AHI declined from 49 to 23 with a surgical success rate of 41.7% [25]. Elasfour et al., performed UPPP at level of the palate and midline partial glossectomy at level of tongue base on 18 patients AHI declined from 65to 29.2 with a surgical success rate of 44.4% [26]. Lee et al., performed UPPP at level of the palate and genioglossus advancement at level of tongue base on 33 patients AHI declined from

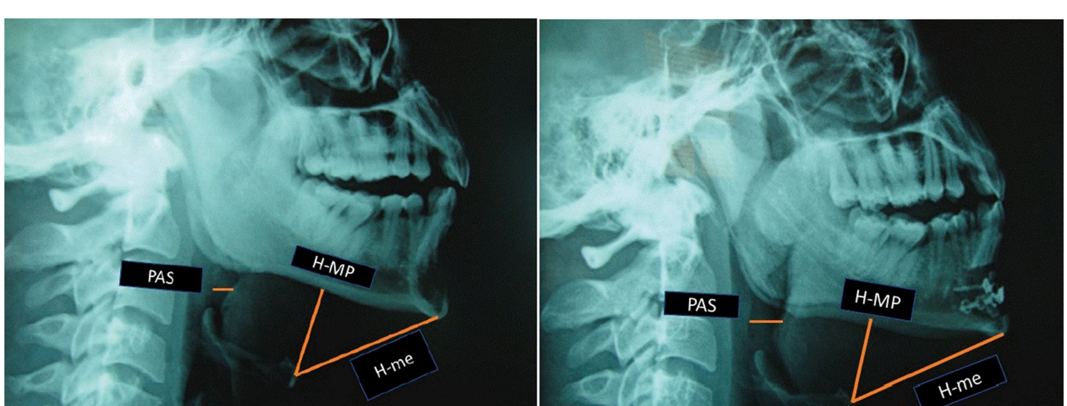

Fig. 3. pre & postoperative cephalometry showing improvement of PAS, reduction in H-MP and H-me distance.

55.2to 21.7 with a surgical success rate of 66.7% [27]. Bettega et al., performed UPPP at level of the palate and genioglossus advancement with hyoid suspension at level of tongue base on 44 patients AHI declined from 45.2to 42.8 with a surgical success rate of 22.7% [28].Hsu et al., performed UPPP at level of the palate and genioglossus advancement with hyoid suspension at level of tongue base on 13 patients AHI declined from 52.2to 15.6 with a surgical success rate of 76.9% [29]. Hendler et al., performed UPPP at level of the palate and genioglossus advancement at level of tongue base on 33patients AHI declined from 60.2to 28.8 with a surgical success rate of 45.5% [30]. Nelson performed UPPP at level of the palate and radiofrequency tongue base reduction on 10 patients AHI declined from 29.5to 18.8 with a surgical success rate of 50% [31]. Vilaseca et al., performed UPPP at level of the palate and genioglossus advancement with hyoid suspension at level of tongue base on 20 patients AHI declined from 60.5to 44.6 with a surgical success rate of 35% [32]. Neruntarat performed palatal flap at level of the palate and genioglossus advancement with hyoid suspension at level of tongue base on 46 patients AHI declined from 47.9to 18.6 with surgical success rate of 65.2% [33].

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Our surgical success rate was 81%based on a reduction of AHI postoperatively >50% of preoperative value or below figure 20 apnoea/hour. It's higher than in previous studies. This could be due to a number of factors, including the fact that we used ALA pharyngoplasty rather than UPPP in previous surgeries. ALA pharyngoplasty dilates the retropalatal area in an antro-posterior diameter by suturing the posterior part of the PPM with adjacent muscularis uvulae, then advancing them to be hitched up to the LVP muscle, and we also dilate the lateral pharyngeal wall by suspending the PPM to SCP and to pterygopalatine raphe. Second, the MGGA approach, which eliminates the majority of the disadvantages of earlier techniques. We performed a wide osteotomy, which allowed us to capture the entire genioglossus and geniohyoid muscle attachments, resulting in an increase in retrolingual anteroposterior diameter and hypopharyngeal area, which was reflected in a significant increase in airway volume postoperatively, which was correlated to a decrease in AHI. Finally, radiofrequency was employed to treat the tongue base, which resulted in tissue reduction and a further increase in retrolingual airway space.

Nineteen [19]% of patients, although there were clinical improvements and changes in polysomnographic parameters like reduction in AHI and increase in LOS but these improvements were not satisfactory enough to fulfill the criteria of surgical success.

Pain and difficult swallowing were measured by VAS, the pain was significantly high on the first day postoperative. Dysphagia was significantly high on the 3rd day postoperative with the start of a soft diet. Both decrease at the first week postoperative. No pain or dysphagia were recorded at 4 weeks postoperative.

No serious complications occurred in our study (i.e no mandibular fracture, no significant postoperative oedema or hemorrhage that requires surgical intervention), the most frequent complications were transient lip paresthesia, mild edema in the floor of the mouth, and superficial tongue base ulcer that improved nicely with medications.

In conclusion, modified genioglossus advancement with radiofrequency tongue base reduction combined with anterolateral advancement pharyngoplasty in a single session is well tolerated and safe procedure in the treatment of multilevel OSA patients. It is helpful in decreasing respiratory parameters and subjective symptoms of OSA, but a bigger sample size and longer follow-up period are needed to determine the technique's long-term efficacy.

Declaration of competing interest

We have no conflicts of interest to disclose.

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