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HEAD & NECK

A comparative retrospective study: hypoglossofacial versus masseterofacial nerve anastomosis using Sunnybrook facial grading system

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Abstract

Introduction The aim of our study is to compare the functional results between two surgical techniques for reanimation of facial paralysis: hypoglossal-to-facial versus masseteric-to-facial nerve anastomosis.

Methods This is a retrospective study of 13 patients treated for complete facial paralysis in two medical tertiary centers. The patients were classified into two groups. First group: masseteric-to-facial nerve anastomosis. Second group: hypoglossofacial nerve anastomosis. Sunnybrook facial grading system was used to evaluate the functional results. The mean scores were compared using Mann–Whitney test. The correlation between the age at surgery, the delay in time from the onset of the facial paralysis to the time of surgery and the results of Sunnybrook scores was studied using correlation and linear regression.

Results No significant statistical difference was found between the mean of total score of the two groups (first group = 38 ± 4.898, second group = 37.83 ± 4.956). All the patients treated by hypoglossofacial nerve anastomosis presented with hemiglossal atrophy. We found slight superiority for the masseterofacial nerve anastomosis in dynamic movements, whereas at rest the hypoglossofacial anastomosis is slightly better. All the differences were not statistically significant. No correlation was found between the age at surgery (age range included 32–73 years) and post-operative results. No correlation was found between the delays up to 24 months from the onset of the facial paralysis and post-operative results.

Conclusion Our study showed that both types of anastomosis are effective with comparable results. The masseterofacial nerve anastomosis is preferred when possible to avoid the hemiglossal atrophy and its complications.

Keywords Facial paralysis reanimation · Hypoglossofacial nerve anastomosis · Masseterofacial nerve anastomosis

Introduction

Facial nerve paralysis is one of the difficult situations with a lot of impact on the quality of life. Numerous efforts have been done over more than ten decades for facial paralysis reanimation [1–4]. One of the proposed solutions is to anastomose one functional nerve with another nonfunctional injured nerve in an attempt to reactivate the injured nerve. Many types of anastomosis have been described: spinofacial anastomosis [5, 6], hypoglossofacial anastomosis [7–12], masseterofacial anastomosis [13, 14], and phrenicofacial anastomosis [2, 15, 16]. Hypoglossofacial anastomosis has been described by Werner Korte in 1903 [2, 17], which remains the most common type. However; there are some limitations for this type of anastomosis such as donor-site morbidity (hemiglossal atrophy) [14, 18]. In addition, it is necessary to preserve the hypoglossal nerve particularly for patients with deglutition troubles. In spite of that, it remains the preferred type of anastomosis with good functional results [9, 11, 19–21]. To overcome these limitations, the anastomosis of masseteric to facial nerve has been reported as an alternative surgical technique with good success rate [13, 14, 22, 23]. Complete and definitive facial

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nerve paralysis generated by proximal lesion is an indication for a surgical reanimation. This type of surgery should be performed with the delay of less than 4 years from the onset of facial paralysis since there is a risk of advance muscle atrophy generated by longstanding denervation. The objective of our study is to compare post-operative functional results between the two types of anastomosis (hypoglossofacial versus masseterofacial) using a standard validated facial nerve paralysis test such as Sunnybrook facial grading system (SFGS). This comparative study is helpful to decide the best type of anastomosis to be proposed.

Materials and methods

We reviewed retrospectively the operated patients for facial paralysis reanimation in two university hospitals. 13 patients were included, of which 7 patients have been operated with masseterofacial nerve anastomosis (V–VII), and 6 patients have been operated with hypoglossofacial nerve anastomosis (VII–XII). The surgical indication was confirmed with injury of proximal portion of the facial nerve, and complete and definitive facial nerve paralysis with pre-operative House–Brackmann grade VI. The patients in the first group were operated by the same surgeon in one of the two university hospitals, whereas the patients of the second group were operated by another surgeon in the second university hospital. We reviewed all the patients in the outpatient clinic and the post-operative results were reevaluated. The list of the patients has been organized in alphabetical order by the name. Then, to assure the anonymity of the subjects, we removed the names of the patients and each patient assigned with a unique study case number (1–13). To obtain an ideal result and to minimize the bias in the results, we asked seven naïve evaluators (medical doctors) to evaluate each patient separately. All of the figures, names, or signs that can give an idea of the type of anastomosis have been removed; thus each evaluator gave a score of results without knowing the type of anastomosis done for each patient. The photos and videos have been collected in computerized folders, and we gave each folder the same unique case study number which has been given for each subject previously.

Sunnybrook Facial grading System (SFGS) was used in our study like an evaluation test for post-operative results. It consists of three parts: resting symmetry, symmetry of voluntary movement, and synkinesis. Normally in this evaluation system, the abnormal or operated side is compared to the normal side. For resting symmetry score, when there is no difference between the two sides the score is 0. However, when the difference exists the highest score indicates high grade of negative results. In the second part, symmetry of voluntary movement, higher score is more toward the good results. However, the interpretation of the synkinesis score is the opposite. At the end, the total composite score is calculated as the following equation: voluntary movement score–resting symmetry score–synkinesis score. The total composite score should be out of 100 for a normal facial side. Each evaluator has been given 13 copies of non-filled SFGS evaluation form. The photos and videos of the subjects were presented to the evaluators case by case. Then, the evaluation papers for each subject were collected. To minimize the bias and non-reliable evaluations, we have taken in our comparative study the mean of the seven scores given by the evaluators for each patient. All the data in each part of the Sunnybrook facial grading system (total composite score, resting symmetry score, voluntary movement score, synkinesis score, forehead movement, eye movement, smile, snarl, and lip pucker) have been registered in excel data form. All statistical tests and analysis were performed using the statistical software SPSS version 22.0 for windows. All analyses were two-tailed, with p value = 0.05 set as threshold for statistical significance. As we have a small population size, we have chosen the Mann–Whitney test to compare the mean for each group of anastomosis. The linear correlation and regression curves were used to find if there is a correlation between the age of the patient/delay of time to surgery and post-operative results. A written consent has been signed by all of the patients.

Surgical technique

Hypoglossal to facial nerve anastomosis: preauricular incision was extended on cervical region; then dissection of the anterior border of sternocleidomastoid muscle and the posterior belly of the digastric muscle was done. The facial nerve was identified below the cartilage pointer of the external auditory canal. Dissection of the facial nerve was done proximally to its emergence from stylomastoid foramen, and distally to the bifurcation. The hypoglossal nerve was dissected and sectioned distally as far as possible and it was turned back behind the internal jugular vein. The facial nerve was sectioned as proximal as possible at the stylomastoid foramen. End to end type of anastomosis was done using 9-0 nylon stitches.

Masseteric to facial nerve anastomosis: Preauricular incision was extended around the earlobe, and then to the cervical region. Dissection of the anterior border of sternocleidomastoid muscle and the posterior belly of the digastric muscle was done. Skin flap with parotid fascia was elevated to expose the parotid gland. Identification of the facial nerve below the cartilage pointer, and dissection of the nerve proximally to the stylomastoid foramen were done. The superior division the facial nerve (temporofacial trunk) must be identified and dissected to avoid any injury to branches of facial nerve during the dissection through the parotid gland and masseter muscle. The point of locating the masseter nerve was taken as 3 cm in front of the tragus and 1 cm below the zygomatic arch. The dissection was done through the masseter muscle to identify the nerve. Once the masseter nerve was identified, we dissected and sectioned the nerve far distally and turned toward the facial nerve which was sectioned at the level of stylomastoid foramen. End to end type of anastomosis was done without tension with 9-0 nylon stitches.

Results

The cause of facial paralysis in the majority of the cases was surgical excision of cerebellopontine angle tumors (acoustic or facial schwannoma) in 11 cases (Table 1). There were 13 patients included in the study (Table 2); 7 patients in the first group (masseterofacial nerve anastomosis, V–VII), and 6 patients in the second group (hypoglossofacial nerve anastomosis, VII–XII). The mean of patient's age at surgery and the mean of delay in months from the onset of the facial paralysis to the time of surgery are displayed in Table 2. The mean of total SFGS scores for the seven patients in the first group was 38 ± 4.90, compared with the second group which was 37.83 ± 4.96, and we found no significant statistical difference between the two groups ($p = 0.836$) (Table 3). The mean of total voluntary movement score in the first group and the second group was, respectively, 52.41 ± 4.74 and 48.19 ± 6.59. Although the results showed a little higher score for the mean of voluntary movement in the first group, the difference was not statistically significant ($p = 0.224$). We found that the mean of resting symmetry score in the first group (13.36 ± 4.12) was higher than the mean in the second group (8.93 ± 3.40), indicating that the results at rest are better in case of hypoglossofacial nerve anastomosis. For the forehead movement, there was almost no movement for all the patients in both groups. The mean of eye movement score for the first group (3.35 ± 0.86) was quite similar to that in the second group (3.05 ± 0.76). We found better results for mouth movement and smile in the first group (3.14 ± 0.56) than the results of the second group (2.60 ± 0.76). However, that difference in the results was not statistically significant ($p = 0.171$). We observed similar means in both groups for the snarl score (2.29 ± 0.56 for the first group, and 2.36 ± 0.82 for the second group). For the last part in the SGFS, lip pucker score, we noted better mean score in the first group (3.31 ± 0.64) than the mean score in the second group (2.36 ± 0.61).

To find the relation between the age at surgery and the post-operative results, we used the correlation and linear regression test. We found no correlation between the two variables ($R = 0.3017$) (Fig. 1). Likewise for the time delay after the onset of facial paralysis, we observed no correlation with the delay in months and the results post-operatively ($R = 0.044$), taking into consideration the time delay interval tested in our study which is minimum 1 month and maximum 24 months (Fig. 1). All the patients operated with hypoglossofacial anastomosis have hemiglossal

Table 2 Type of anastomosis, sex and age of patients, the delay in time from the onset of the facial paralysis to the time of surgery

	V–VII (masseterofacial)	VII–XII (hypoglossofacial)	*p* value
Group size (*n*)	7	6	
Sex			
Male	4	1	
Female	3	5	
Mean age (year)	49.4	61.7	0.133
Age range	32–72	36–73	
Mean delay in time to surgery (month)	8.7 ± 7.6	11.7 ± 7	0.351
Range of delay (month)	1–24	4–24	

Table 1 Causes of facial paralysis in our study, type of anastomosis and synkinesis post-operation

Cause of PFP	Type of anastomosis	Lingual atrophy	Synkinesis 1
1 Acoustic neuroma	Masseteric–facial	No	Oro-ocular and oculo-oral
2 Temporal bone fracture	Masseteric–facial	No	Oro-ocular and oculo-oral
3 Acoustic neuroma	Masseteric–facial	No	Oculo-oral
4 Tympanojuglar paraganglioma	Masseteric–facial	No	Oro-ocular and oculo-oral
5 Facial neuroma	Masseteric–facial	No	Oro-ocular and oculo-oral
6 Acoustic neuroma	Hypoglossal–facial	Yes	Oro-ocular
7 Facial neuroma	Masseteric–facial	No	Oro-ocular
8 Facial neuroma	Hypoglossal–facial	Yes	Oro-ocular
9 Acoustic neuroma	Masseteric–facial	No	Oro-ocular and oculo-oral
10 Acoustic neuroma	Hypoglossal–facial	Yes	Oro-ocular
11 Facial neuroma	Hypoglossal–facial	Yes	Oro-ocular and oculo-oral
12 Acoustic neuroma	Hypoglossal–facial	Yes	Oro-ocular and oculo-oral
13 Acoustic neuroma	Hypoglossal–facial	Yes	Oro-ocular and oculo-oral

Table 3 Illustrates the comparison between the two groups in terms of the mean of total score and the mean for each part of SFGS

	V–VII	VII–XII	*p* value
Group size	7	6	
Sunnybrook FGS*			
Mean: Total Sunnybrook score	38 ± 4.90	37.83 ± 4.96	0.836
Mean: Resting symmetry score	13.36 ± 4.12	8.93 ± 3.40	0.062
Mean: Total voluntary movement score	52.41 ± 4.74	48.19 ± 6.59	0.224
Mean: Synkinesis score	1.18 ± 1.08	1.47 ± 0.90	0.473
Mean: Forehead movement score	1.04 ± 0.07	1.02 ± 0.06	0.626
Mean: Eye movement score	3.35 ± 0.86	3.05 ± 0.76	0.519
Mean: Mouth movement and smile score	3.14 ± 0.56	2.60 ± 0.76	0.171
Mean: snarl score	2.29 ± 0.56	2.36 ± 0.82	0.886
Mean: lip pucker score	3.31 ± 0.64	2.36 ± 0.61	0.429

* Sunnybrook Facial Grading System

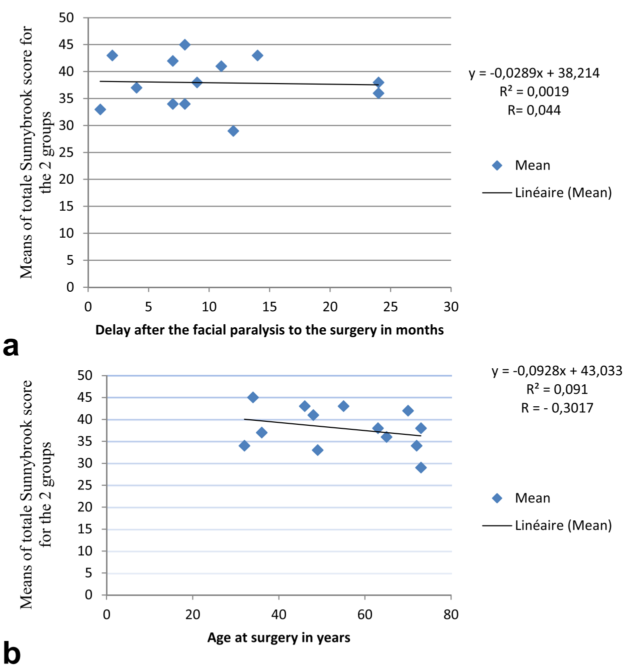

Fig. 1 **a** Demonstrates the correlation between the delay in months and the total Sunnybrook score for all of the patients, **b** demonstrates the correlation between the age at surgery and mean of total sunnybrook score for all of the patients in the study

atrophy. They also experienced a lot of difficulty for eating, drinking and speech articulation (Table 1). Among the patients operated by masseterofacial nerve anastomosis, there were no complaints about the functional impairment of the mastication or trouble of temporomandibular joint. We did not notice any deformation of the mandibular angle region, or non-esthetic atrophy of the masseter muscle. The mean of synkinesis score was quite similar for the two groups (Table 3). Oro-ocular type of synkinesis was present in all of the patients regardless the type of anastomosis, except one patient who presents only oculo-oral type of synkinesis.

Discussion

Hypoglossofacial anastomosis remains the preferred type of anastomosis for facial paralysis. However, it has some limitations such as hemiglossal atrophy and its sequels on the articulation, drinking and even when moving the food aliments in the mouth during mastication. Sometimes, it is difficult for the patients to accept the idea of sacrificing another cranial nerve with principal function (like hypoglossal nerve). In addition, for patients with deglutition problems it is indispensable to preserve the physiological function of the hypoglossal nerve. Fournier et al. and Brenner et al. described anatomically the possibility of anastomosing the masseter to facial nerve [24, 25]. Brenner et al. demonstrated that the masseter nerve consists of more than two branches in 75% of cases [25], thus using one of its terminal branches will not compromise totally its function. Even so, its function will be compensated by other muscles of mastication on ipsilateral and contralateral sides. Bermudez et al. in 2004 published a case report of masseterofacial nerve anastomosis [26]. Then, many case series have been published in the literature with good success rate [13, 14, 22, 23, 27–29]. In our opinion, the decision of sacrificing of the hypoglossal nerve is difficult since the importance of its physiological function. On the other hand, it is less horrifying and more accepted for the patients to sacrifice the masseter nerve since it leaves more or less no sequels. Thus, the aim of the study was to search if there is a difference in the results between both surgical techniques to find the more suitable and convenient techniques for the patient. An ideal comparison should be done with a well-calibrated, reliable, and readily applied in either the clinic or the research laboratory [30]. House in 1983 has proposed grading system for facial paralysis [31], which has been modified later by Brackmann and Barrs [30, 32, 33]. However, this grading system is not the ideal one for the clinical research because it gives a wide range of facial movement in each grade; for some patients, the dysfunction in one region fits into one grade but it falls into a different grade for another region [30]. Ross et al. in 1996 proposed another more reliable grading system that evaluates the different regions of facial muscle expression separately [34]. It has been selected as a validated, reliable and properly sensitive outcome measure [35–37]. Nelly et al. in 2010 have confirmed its reliability and compared it with HBGS [35]. Hontanilla et al. has published a study of comparison using HB and Facial Clima Evaluating System [38]. Another comparison has been done by Socolovsky et al., in which the authors used HB scale and their own designed scale [39]. To our knowledge, in the literature we found no comparison between two types of anastomosis using a validated grading system such as SFGS which has been published.

To have an optimal result and to be away from the bias, the evaluations were done by different evaluators, and then the mean of these evaluations has been taken in comparison. By doing this, we have also avoided the inter-evaluator influence. Based on our results, there was no correlation between the age of the patient at surgery and the results of anastomosis post-operatively (Fig. 1b). Socolovsky et al. found in their study a negative impact of delay since injury on the results of facial reanimation surgery [39]. In our study, we found also no significant correlation between the delay in time to surgery (between 1 and 24 months) and the final composite score for both groups (Fig. 1a). According to that, we expect more or less same post-operative results if the delay in time to surgery is up to 24 months. Figure 2a shows the total Sunnybrook score for both groups which is almost symmetric; this means that in general both surgical techniques have almost same efficacy on reanimating the paralyzed face. However, at the rest we found a higher score thus less convenient for post-operative results in first group (V–VII). This will have a negative influence on the total score for masseterofacial anastomosis. Socolovsky et al. found the same thing in their study, less facial animation at rest for the masseterofacial anastomosis [39]. For the voluntary movement, the mean score is slightly higher

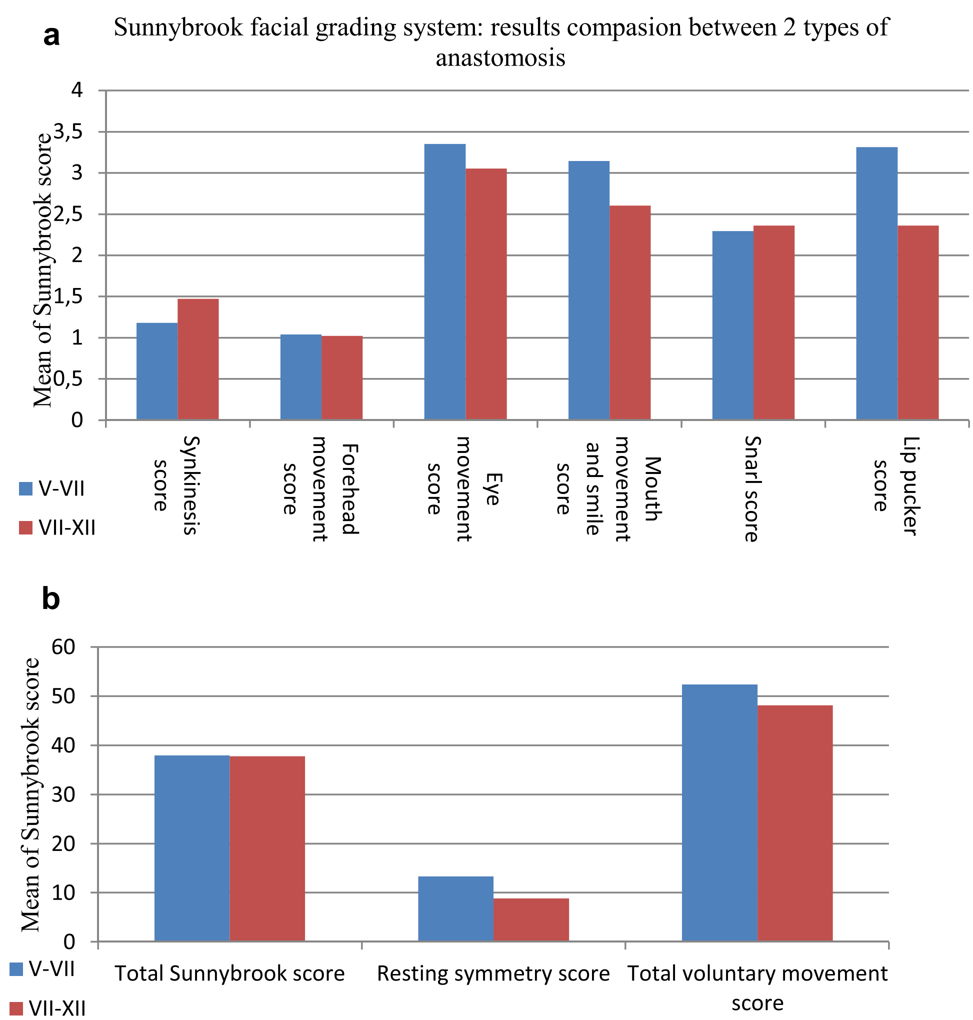

Fig. 2 **a** Comparison between the mean score of total Sunnybrook score, resting symmetry score, and total voluntary movement score for the each group, **b** illustrates the comparative results between the mean score of synkinesis, forehead movement, eye movement, smile, snarl and lip pucker for each group

(52.41) post-masseterofacial anastomosis compared with hypoglossofacial anastomosis (48.19) (Fig. 2b; Table 3). This slight difference remains not statistically significant. When we compared each movement we found some differences between the groups (Fig. 2a; Table 3). For the forehead movement, obviously the mean score is almost around 1 symmetrically for both groups. This indicates the non-efficacy of both types of anastomosis for reanimating the forehead muscles. For the eye movement, smile and lip pucker, the masseterofacial anastomosis was slightly superior in post-operative results than hypoglossofacial anastomosis. This result is supportive to what have been found by Hontanilla et al. in their study [38], but Socolovsky et al. in 2016 have opposite results [39]. On the other hand, we found a slightly higher score for snarl movement in the second group (VII–XII), which remains statistically insignificant ($p = 0.886$). These results indicate a comparable functional results and efficacy for both surgical treatments (Figs. 3, 4).

Synkinesis is one of the inconvenient results for the surgeon. Moreover, the patients always feel impressive because of synkinesis. In our study, we categorized the synkinesis in two groups based on the type of contraction and associated synkinesis to simplify the understanding of the results. Oro-ocular synkinesis: involuntary ocular movement when the patient was asked to move the oral muscles. Oculo-oral synkinesis: involuntary oral movement when the patient was asked to move the ocular muscles. Table 1 shows that both groups may have more or less similar type of synkinesis. However, all the patients in the second group (VII–XII) complained of ocular synkinesis when masticating, yawning, or even sometimes speaking. On the other hand, no one from the second group complained of same thing. This indicates the superiority of masseterofacial anastomosis in this point of comparison.

Hypoglossofacial anastomosis over decades remains the preferred surgical technique for facial reanimation. Our study showed that the functional results and efficacy of treatment by masseterofacial anastomosis are not inferiorly estimated when compared with hypoglossofacial anastomosis. Each technique has advantages over the other, e.g. masseterofacial anastomosis has better results in reanimating mid face and perioral region and, however, the hypoglossofacial anastomosis has better results at rest. All of the patients treated by hypoglossofacial anastomosis

Fig. 3 Results obtained with the masseterofacial anastomosis for left facial paralysis (**A** at rest, **B** smile, **C** eye closure movement), and hypoglossofacial anastomosis (**a** at rest, **b** smile, **c** eye closure movement)

Fig. 4 Results obtained with the masseterofacial anastomosis for left facial paralysis (**D** snarl, **E** lip pucker), and hypoglossofacial anastomosis (**d** snarl, **e** lip pucker)

have tongue atrophy. In terms of synkinesis, we found the masseterofacial anastomosis is better than hypoglossofacial anastomosis. We think that it will be always better if we can avoid the sacrifice of hypoglossal nerve and then hemiglossal atrophy. Thus, we will avoid also the problems of articulation, speech and swallowing. These results gave us the choice to propose either surgical technique to the patient and will help the patients also for choosing the surgical technique in terms of post-op results and sequels.

The strong points of our study are that we have used the Sunnybrook facial Grading system like a scale of comparison, which is a validated, reliable, and properly sensitive for research purposes. In our study, we did some sort of randomization for the list of patients which was showed to the evaluators to avoid the bias in the results. We admit that our study has limitation, being a retrospective study, with small population number. This study allows continuing the work toward another prospective study for reinforcing the results by augmenting the sample size.

Conclusion

Hypoglossofacial and masseterofacial anastomoses have comparable post-operative functional results. Each technique has superiority in some aspects of post-op results. However, this difference is minimal and not statistically significant. Thus in our opinion, both techniques are feasible, with preference of masseterofacial anastomosis to avoid the hemiglossal atrophy and its sequels.

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Compliance with ethical standards

Conflict of interest The authors (Nasser Al Tamami, Sandra Zaouche, and Delphine Vertu-Ciolino) have no conflict of interest.

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