



Efficacy of SMAS flap technique to prevent Frey's syndrome and aesthetic outcomes.

A retrospective cohort analysis

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Efficacy of SMAS flap technique to prevent Frey's syndrome and aesthetic outcomes. A retrospective cohort analysis.

AIM: The aim of this retrospective cohort study was to evaluate the efficacy of Superficial Musculoaponeurotic System (SMAS) flap technique to prevent Frey's Syndrome (FS) and improve aesthetic outcomes following superficial parotidectomy.

MATERIALS AND METHODS: A total of 140 patients were treated between January 2003 and December 2018 at the Maxillofacial Unit of Magna Graecia University of Catanzaro with Superficial Parotidectomy (SP) for benign tumor and divided in two groups: Group 1 (78 patients) underwent SMAS flap reconstruction of the parotid lodge through a modified facelift incision and Group 2 (62 patients) underwent to SP without the use of SMAS interposition through a Redon type incision.

RESULTS: Significant statistical difference concerning FS, transient facial nerve injury, facial paralysis, salivary fistula, haematoma and skin deepness were found between Group 1 and Group 2, (0,00% vs 6,45% [$p < 0,036$], 2,56% vs 16,12% [$p = 0,005$], 0,00% vs 9,67% [$p = 0,006$], 1,28% vs 9,67% [$p = 0,044$], 1,28% vs 19,35% [$p = 0,0002$]) respectively. No significant statistical differences between the two groups were observed about wound infections (3,84% vs 8,06% [$p = 0,466$]).

DISCUSSION: SP represents the gold standard for the surgical treatment of benign tumors of the parotid gland greater than 3,5 cm in size involving superficial portion of the gland, for the low rate of recurrences over time and lower incidence of transient or permanent facial paralysis to which this technique leads. However, SP is not free from other complications such as FS, haematoma, salivary fistula and aesthetic results like facial contour deformity due to surgical site depression and visible scar. A reconstructive technique to reduce the impact of complications after SP is the SMAS flap because its preparation is easy, contextual to the parotidectomy and increases a little the surgical time.

CONCLUSIONS: This study highlights the advantages of SMAS flap technique in reducing complications following parotid surgery, particularly FS, and in improving the quality of life.

KEY WORDS: Frey's Syndrome, Minor test, Parotid benign tumor, SMAS flap, Superficial parotidectomy

Introduction

Salivary glands tumors arise for 70% from parotid glands, the remaining 8% originates from submandibular glands

and 22% from the minor salivary glands^{1,2,3}. Parotid tumors for 75% are benign and most are located in the superficial portion of the gland, while more than 50% of submandibular gland tumors and even more than 80% of minor salivary gland tumors are malignant³. The most frequent parotid benign tumor are pleomorphic adenoma (PA) in 60% of cases, cystoadenolymphomas in 20% of cases and other various types for the remaining 20%^{4,5}. Surgical treatment depends on the size and the localization of the tumor in the parotid gland. The first choice treatment in case of benign tumor with a diameter greater than 3,5 cm located in the superficial portion of

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the parotid gland is SP^{6,7}. However SP is not free from complications: salivary fistula, transient or persistent facial nerve palsy, capsule rupture and FS are the most frequent complications^{8,9}. FS or auriculo-temporal nerve syndrome was first described by Lucy Frey in 1923 and is characterized by the onset of transient flushing, pain, sweating and warmth in the parotid region following gustatory stimulation. It is caused by aberrant regeneration of damaged postganglionic secretomotor parasympathetic re-linking with fibers of auriculo-temporal nerve after parotidectomy^{10,11}. There are objective and subjective assessment methods to diagnose of FS. Subjective methods are based on the patient's symptoms, although not always clinically evident. Objective evaluation is performed using some tests such as Minor starch-iodine test¹². Various medical like botulinum type A toxin injection^{13, 14} and surgical techniques are used to treat patients with FS however none of these techniques is completely effective. The SMAS flap is the technique most performed to avoid the onset of FS and to ensure good aesthetic results after SP.

The aim of this retrospective cohort study was to evaluate the benefits of SMAS flap technique comparing the post-operative data of patients treated at Maxillofacial Surgery Unit of Magna Graecia University of Catanzaro from January 2003 to December 2018 underwent to SP for benign tumor of parotid glands and reconstruction of the lodge with or without SMAS flap.

Material and Methods

We carried out a retrospective cohort study of patients affected from benign tumours of the parotid gland treated at our Maxillofacial Unit of Magna Graecia University in Catanzaro between January 2003 and December 2018.

Inclusion criteria were:

– diagnosis of benign parotid tumour (pleomorphic adenoma and Warthin's tumor);

- tumor size > 3.5 cm on echography (US), computed tomography (CT) or magnetic resonance (MRI);
- tumor located to superficial portion of the parotid gland;
- indication for SP;
- possible reconstruction of the lodge using SMAS flap.

Exclusion criteria were:

- benign tumour recurrences ;
- previous history of parotid surgery;
- radiation treatment to the head and neck region;
- other type of benign tumour.

All patients underwent pre-operative exams to assess the disease. The diagnosis was established by US, CT or MRI, and fine needle aspiration cytology (FNAC).

The study protocol, submitted to the Ethical Committee of the Magna Graecia University of Catanzaro, was conducted in accordance with the "Ethical Principles for Medical Research Involving Human Subjects" described in the Helsinki Declaration. All patients gave their informed consent for participation in the study and to store their data.

The patients were divided in two groups according to the technique used: Group 1: patients treated with SP through a facelift incision and SMAS flap reconstruction of the parotid lodge; Group 2: patients treated with SP through a Redon incision and no SMAS flap reconstruction.

The choice to use or not SMAS flap for reconstruction of the parotid lodge was carried out random.

Surgical incision was closed in layers with 3-0 or 4-0 resorbable sutures and with 4-0 or 5-0 monofilament sutures non resorbable cutaneously. A suction drainage was inserted before wound closure.

Patients had a minimum follow-up of 24 months and a maximum of 60 months. The onset of FS was assessed objectively by Minor starch iodine test and the degree of severity was assessed on the basis of symptoms entity.

All patients were screened for scarring and facial nerve

TABLE I - Survey scores about degree satisfaction of cosmetic results of the surgical area

1. How much the wound scar appearance satisfied you?	
I'm not satisfied	1
I'm a little satisfied	2
I'm very satisfied	3
2. How much the skin deepness satisfied you?	
I'm not satisfied	1
I'm a little satisfied	2
I'm very satisfied	3
3. Does asymmetry between the operation side and the other side considerable?	
It is very uncomfortable	1
It is a little uncomfortable	2
It is not relevant	3

functionality. A questionnaire was administered to each patient one month after surgery to evaluate the subjective degree of postoperative cosmetics satisfaction (scar appearance, skin depression, asymmetry) on a visual analogue scale from 1 (not satisfied) to 3 (highly satisfied) (Table I).

The onset of FS was assessed using the Minor starch iodine test. A solution including 10% polyvinyl pyrrolidone iodine complex was topically applied and, once dried, cornstarch was applied on the surgical site and the nearest areas (preauricular, postauricular, temporal and ear lobule); therefore patients were asked to drink a lemon saltwater mixture for 20 minutes. The blueblack discoloration obtained was defined as a positive outcome and the clinical results was recorded with photographs before ingestion and at one, five, ten and twenty minutes after ingestion. Particularly the severity of the results was been interpreted as mild in case of a discoloration area smaller than 2 cm², moderate if the discoloration area was between 2 and 4 cm² and severe in case of a discoloration area greater than 4 cm².

STATISTICAL ANALYSIS

Statistical analysis was carried out with GraphPad prism 8 Software; in particular we used Fisher's exact test to

evaluate complications and cosmetic results subjective satisfaction rates between the two groups. The significance level was set at $p < 0,05$ for all comparisons.

SURGICAL SMAS FLAP TECHNIQUE

The SMAS is a layer of muscle and connective tissue located between the parotid fascia and the skin. Its function is to transmit, distribute and amplify the activity of all facial muscles. The SMAS continues anteriorly with the zygomatic muscles, upon the zygomatic arch with the temporoparietal fascia and below to the neck with platysma. T

he preparation of the SMAS consists of two incisions: vertical and horizontal one. The vertical incision is made in the preauricular region adjacent to the root of the helix and continues along the posterior portion of the platysma until finding a point 5 cm distant from the bottom of the mandibula.

The horizontal incision is made 1 cm below the zygomatic arch, using the tragus point as a landmark until the malar eminence.

Once the SMAS flap is set up, it is possible to perform parotidectomy and then to reconstruct the lodge with the SMAS flap by suturing the SMAS on the zygomatic periosteum and the parotid masseteric fascia.

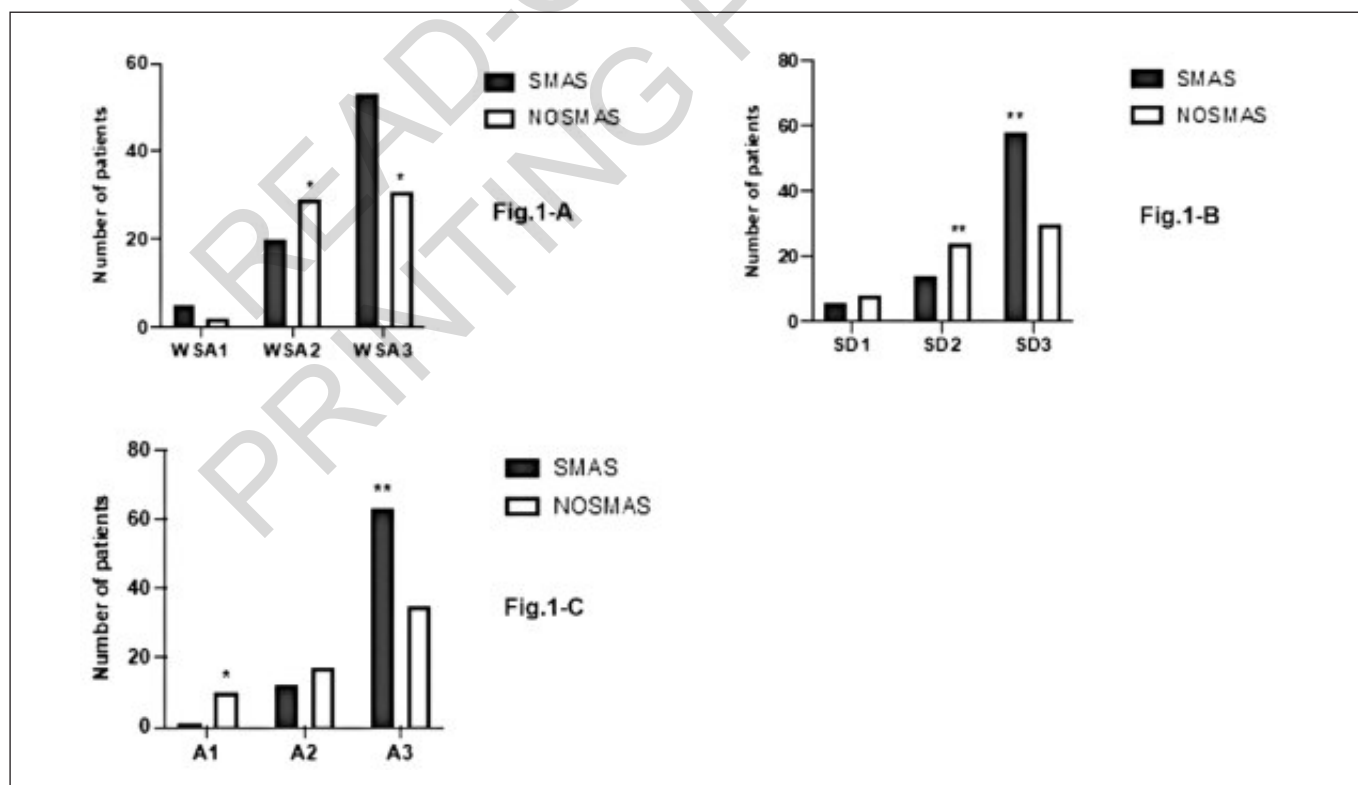


Fig. 1: (A) Cosmetic satisfaction between SMAS and NO SMAS groups about wound scar appearance, (B) skin deepness, (C) and asymmetry.

Results

A cohort of 140 patients was included, 67 men (47.86%) and 73 women (52.14%) with mean age of 51,44 years. Among them 81 PA and 59 cystadenolymphomas were diagnosed on histopathological exam. All the patients underwent SP under general anesthesia. The average follow-up time was 2,6 years (range 24 to 60 months). No tumor recurrences were observed during the follow-up period.

The patients were divided in two groups according to the technique used; Group 1: 78 patients (55.71%) treated with SP through a facelift incision and SMAS flap reconstruction of the parotid lodge; Group 2: 62 patients

(44.29%) treated with SP through a Redon incision and no SMAS flap reconstruction.

Between the two groups no statistically significant differences were found about patient's characteristics, such as age, gender and side of the lesion (Table II). We assessed the onset of FS performing the Minor's starch-iodine test which resulted positive in 2.85% of all patients and in particular in 6.45% of no SMAS group patients.

About post-operative complications, in Group 1 there were no cases of SF, facial paralysis and salivary fistula; we found two cases of transient facial nerve injury, one case of haematoma and skin depression and three cases of wound infection; in Group 2 we found 4 FS cases,

TABLE II - Patient data

Characteristics N. of patients	Group 1 (Smas Flap) 78	Group 2 (No Smas Flap) 62
Age (years)	48.7	54.8
Sex		
Male	33	34
Female	45	28
Histologic Diagnosis		
PA (Pleomorphic Adenoma)	43 (PA)	38 (PA)
WT (Warthin's Tumor)	35 (WT)	24 (WT)
Side tumor		
right	46	30
left	32	32
Size tumor	> 3.5 cm	> 3.5 cm
Follow-up months	24-60 months	24-60 months

TABLE III - Results of Fisher's exact test on post-operative complications in group 1 vs group 2.

Type of Complication	Group 1 (SMAS Flap) n.78	GROUP 2 (NoSMAS Flap) N.62	P Value <0.05
Frey's syndrome (FS)	0 (0.00%)	4 (6.45%)	0.036
Transient facial nerve injury	2 (2.56%)	10 (16.12%)	0.005
Facial paralysis	0 (0.00%)	4 (6.45%)	0.036
Salivary fistula	0 (0.00%)	6 (9.67%)	0.006
Haematoma	1 (1.28%)	6 (9.67%)	0.044
Dip skin	1 (1.28%)	12 (19.35%)	0.0002
Wound infection	3 (3.84%)	5 (8.06%)	0.466

TABLE IV - Severity classification of Frey's syndrome.

Grade	Subjective evaluation	Objective evaluation (minor test)	Group 1 (Smas flap)	Group 2 (No smas flap)
Mild	Sporadic Sweating and flushing after meal. Not social discomfort.	Discoloration area smaller than 2 cm ²	–	1 (1.61%)
Moderate	Frequent sweating and flushing after some meals. Not social discomfort.	Discoloration area between 2 and 4 cm ²	–	2 (3.22%)
Severe	Frequent sweating and flushing after every meal and social discomfort.	Discoloration area greater than 4 cm ²	–	1 (1.61%)

TABLE V - Cosmetic results subjective satisfaction.

Type of Surgical Outcome	Score	Group 1 (Smas) 78 Patients			Group 2 (No Smas) 62 Patients			P Value <0.05
		N°	Sex	Mean Age	N°	Sex	Mean Age	
Wound scar appearance	1	5	(2F 3M)	≅ 57 aa	2	(1F 1M)	≅ 41,5 aa	0,46
	2	20	(12F 8M)	≅ 53.1aa	29	(9F 20M)	≅ 56.4 aa	0.26
	3	53	(31F 22M)	≅ 46.3aa	31	(18F 13 M)	≅ 54.1aa	0.047
Skin deepness	1	6	(2F 4M)	≅ 61.5 aa	8	(5F 3M)	≅ 59.3 aa	0.39
	2	14	(10F 4M)	≅ 59.1aa	24	(10F 14M)	≅ 54 aa	0.07
	3	58	(33F 25M)	≅ 46.2aa	30	(17M 13F)	≅ 54.2 aa	0.01
Asymmetry	1	3	(1F 2M)	≅ 64 aa	10	(6F 4M)	≅ 49.1aa	0.01
	2	12	(7F 5M)	≅ 54.6aa	17	(8F 9M)	≅ 51.8aa	0.20
	3	63	(37F 26M)	≅ 46.9aa	35	(14F 21M)	≅ 57.9 aa	0.008

10 cases of transient facial nerve injury, 4 cases of facial paralysis, 6 cases of salivary fistula and haematoma, 12 cases of skin depression and 5 cases of wound infection (Table III). Shows results of Fisher's exact test compared between the two groups. Except for wound infection that have similar incidence between the two groups, the rate of the other complications was higher in Group 2. The rate occurrence of FS was 6.45% in group 2 vs 0.00% in group 1 with a, [p value < 0.05]; transient facial nerve injury and skin deepness were more frequent in Group 2 with a rate occurrence respectively of 19.35 % and 16.12% in group 2 vs respectively 1.28% and 2.56% and 1.28% in Group 1. Salivary fistula and haematoma were also more frequent with a higher rate of 9.67 % in Group 2; facial paralysis was more frequent in Group 2 with a rate of 6.45% and no cases in Group 1. For all complication type except wound infection the difference of results was statistically significant with p value < 0.05 (Table III).

We classified the entity of FS signs and symptoms on the basis of frequency of sweating and flushing after eating, the social implications and the objective results of Minor's starch iodine test. Among the 4 cases of FS in Group 2, there was one case of mild, two cases of moderate and one case of severe FS appeared within 24 months (Table IV). Regarding the questionnaire submitted on subjective aesthetic satisfaction the results are as follows.

About wound scar appearance 5 patients with mean age of 57 years in Group 1 compared to 2 patients with mean age 41.5 years were little satisfied in Group 2 were not satisfied; 20 patients with mean age 53.1 years of Group 1 compared to 29 patients of Group 2 with mean age 56.4 years were little satisfied; 53 patients of Group 1 with mean age 46.3 years compared 31 patients of Group 2 with mean age 54.1 years were very satisfied. Results were statistically significant (p value <0.05) except for Groups with not satisfied and little satisfied patients.

Concerning skin deepness results, 6 patients of Group 1 with mean age 61,5 compared to 8 patients with mean age 59.3 years of Group 2 were not satisfied; 14 patients with mean age 59.1 years of Group 1 compared to 24 patients with mean age 54 years of Group 2 were little satisfied; 58 patients with mean age 46.2 years of Group 1 compared to 30 patients with mean age 54.2 years of Group 2 were very satisfied. Results were statistically significant (p value <0.05) except for Groups with not satisfied and little satisfied patients.

About asymmetry results, 3 patients with mean age 64 years of Group 1 compared to 10 patients with mean age 49.1 years of Group 2 were not satisfied; 12 patients with mean age 54.6 years of Group 1 compared 17 patients with mean age 51.8 years of Group 2 were little satisfied and 63 patients with mean age 46.9 years compared to 35 patients with mean age 57.9 years of Group 2 were very satisfied. Results were statistically significant (p value <0.05) except for Groups of little satisfied patients.

Furthermore, assessing the data based on age and gender, we noticed that young patients, especially women, underwent to SMAS flap reconstruction (Group 1), were very satisfied for the good cosmetic results obtained on the surgical area. This means that face-lift incision in SMAS group has positive impact especially on the aesthetic result of the surgical scar (Table V).

Discussion

Nowadays SP, introduced by Patey e Thackeray^{15,16}, represents the gold standard for the surgical treatment of benign tumors of the parotid gland greater than 3.5 cm in size involving superficial portion of the gland, for the low rate of recurrences over time and lower incidence of transient or permanent facial paralysis to which this technique leads. However, SP is not free from other

complications such as FS, haematoma, salivary fistula and aesthetic results like facial contour deformity due to surgical site depression and visible scar which led the surgeon to adopt reconstructive techniques to reduce the impact of complications through interposition of tissue in post-surgical cavity after SP¹⁷.

Introduction of facelift incision by Appiani and Delfino in 1984^{18,19} had already contributed to avoid very visible scars, especially in women; however, this surgical approach alone could not remove the post-surgical depression responsible for the asymmetry of the face with uncomfortable aesthetic results. Furthermore the absence of a layer between the residual muscle-aponeurotic parenchyma and the skin above predisposes to the onset of salivary fistula and FS. FS is characterized by several symptoms like sweating, erythema, heat during the meal or even just watching food, which develops because of the aberrant reinnervation between the residual parotid tissue and the sweat glands of the skin. Pathophysiology was first described by Lucia Frey as a result of innervation between the post-ganglionic parasympathetic secretomotor nerve fibers of the parotid gland and the ramifications of the post-ganglionic sympathetic system of the cutaneous sweat glands.

Several authors have tried to define the risk factors related to the onset of FS: surgical technique, tumor size, histopathological type, skin thickness, age, sex, but none of these studies have been able to determine a significant risk factor for the development of FS²⁰⁻²⁴.

FS incidence rates increase proportionally to the extent of surgery, a comparison of rates in non-homogeneous groups produces unreliable results and therefore in our study we only considered SP and benign neoplastic pathology. This complication usually develops after a variable period (4-6 months) or sometimes with a late onset; from a study conducted by Bremerich²⁵ on 372 patients undergoing surgery for benign tumors of the parotid gland, SF had developed in 50% cases within 12 months after operation and in about 20% cases after 24 months.

Our study with a follow-up time until 60 months is quite wide; in this sense it offers a valid contribution to literature.

FS causes discomfort situations in social settings particularly when eating lead to sever erythema and profuse sweating. According the literature only 5% to 10% of FS patients undergoes to any treatment for this reason, so it is important to avoid the onset of this complication.

Different technical tricks were adopted over the years to limit the incidence of FS. Some of these methods concern the preparation and repositioning of flaps like SCM flap^{20,22}, SMAS^{20, 21,26,27,28}, temporoparietal fascia temporalis muscle^{29,30} and free fat grafting^{31,32} to interpose between the remaining gland and the skin with different results²⁴. The use of temporoparietal fascia flap despite causing a significant reduction in the incidence

of FS, can cause complications such as facial paralysis, hematoma, alopecia and the presence of surgical scar in the temporal region, as well as greatly increase surgical times.

One of the most commonly used and described flaps in the literature to prevent FS, especially for its vascularization which facilitates the preparation, is the SCM flap, used for the first time by Kornblut³³, whose results of the study indicated that the muscle flap, although by improving the cosmetic defects associated with surgery, it is unable to inhibit the onset of FS. Its use is still the subject of controversy: in fact, several authors report a low incidence of occurrence of FS^{34,35}, as well as cosmetic benefits have been reported by other Authors^{36,37}. Sanabria in a 2012 study conducted in randomized controlled trials (RCTs) or cohort studies with patients who had undergone parotidectomy with preservation of the facial nerve between 1996 and 2010 concluded that the reported evidence is inconclusive regarding the use of the SCM flap as an intervention to prevent Frey syndrome following parotid surgery³⁸.

Thanks to the use of SMAS flap introduced by Rappaport and Allison in 1985, there was a reduction in cosmetic and functional post-parotidectomy complications¹⁹, mainly in FS.

The SMAS flap is a biological barrier that fills the post-surgical cavity after tumor removal. We decided to use the SMAS flap because its preparation is easy, contextual to the parotidectomy and increases a little the surgical time (about 15 minutes); after the facelift incision has been made, the flap from the parotid fascia is separated and easily prepared to rebuild the cavity in a short time. Once the flap has been placed under tension over the defect and sutured to the sternocleidomastoid muscle, it creates a membrane that separates the gland tissue from the overlying skin tissue, avoiding the onset of haematoma or salivary fistula. This technique has several aesthetic advantages in association to facelift incision³⁹; it fills the parotid defect after surgery allowing the reconstruction of facial contour deformities and asymmetry caused by cheek volume loss. Bianchi et al²⁰ reported the use of the superficial musculoaponeurotic system, and the sternocleidomastoid muscle flap could further improve aesthetic outcome.

The main goals of benign parotid tumor surgical treatment consist to obtain complete resection of the tumor avoiding recurrences and functional and aesthetic complications. Our study confirms the advantages of use SMAS flap to restore the parotid lodge reducing the onset of FS.

Furthermore we obtained good aesthetics results especially in young people who have expressed through a subjective questionnaire their satisfaction after surgery. SMAS flap reconstruction of parotid lodge through a modified facelift incision is effective to improve both functional and aesthetic outcomes after superficial parotidectomy confirming the literature data.

Riassunto

La parotidectomia superficiale rappresenta il gold standard per il trattamento chirurgico dei tumori benigni della porzione superficiale della ghiandola parotide di dimensioni superiori a 3,5 cm per il basso tasso di recidive nel tempo e per la minore incidenza di paralisi facciale transitoria o permanente. Tuttavia tale tecnica chirurgica non è esente da altre complicanze quali Sindrome di Frey, ematoma, fistola salivare e danni estetici (depressione del sito chirurgico, cicatrice cutanea visibile). Una delle tecniche ricostruttive per ridurre l'impatto delle complicanze dopo parotidectomia superficiale è il lembo del Sistema Muscolo aponeurotico Superficiale (SMAS) perchè la sua preparazione è facile, contestuale alla parotidectomia ed aumenta solo di un poco il tempo chirurgico. Lo scopo di questo studio di coorte retrospettivo è stato quello di valutare l'efficacia della tecnica del lembo SMAS per prevenire la Sindrome di Frey e migliorare i risultati estetici dopo la parotidectomia superficiale. Un totale di 140 pazienti, sottoposti, tra gennaio 2003 e dicembre 2018 presso l'Unità di Chirurgia Maxillo-Facciale dell'Università "Magna Graecia" di Catanzaro, ad intervento chirurgico di parotidectomia superficiale per tumore benigno, sono stati divisi in due gruppi: Gruppo 1 con 78 pazienti sottoposti a ricostruzione della loggia parotidea con lembo SMAS attraverso un'incisione modificata e Gruppo 2 con 62 pazienti sottoposto a parotidectomia superficiale senza l'uso dell'interposizione dello SMAS attraverso un'incisione di tipo Redon. Si sono osservate differenze statistiche significative riguardanti Sindrome di Frey, lesione transitoria del nervo facciale, paralisi facciale, fistola salivare, ematoma e depressione cutanea tra il Gruppo 1 e il Gruppo 2, (0.00% vs 6.45% [p <0.036], 2.56% vs 16.12% [p = 0.005], 0.00% vs 9.67% [p = 0.006], 1.28% vs 9.67% [p = 0.044], 1.28% vs 19.35% [p = 0.0002]) rispettivamente. Non sono state osservate, invece, differenze statistiche significative tra i due gruppi sulle infezioni della ferita (3.84% vs 8.06% [p = 0.466]). Questo studio, dunque, evidenzia i vantaggi della tecnica del lembo SMAS nel ridurre le complicanze dopo la chirurgia parotidea, in particolare la Sindrome di Frey e nel migliorare la qualità della vita.

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