STERNOCLEIDOMASTOID MUSCLE FLAP IN PREVENTING FREY'S SYNDROME AFTER PAROTIDECTOMY: A SYSTEMATIC REVIEW

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Abstract: *Background.* Parotidectomy is a common procedure and Frey's syndrome (gustatory sweating) is a common side effect. The current literature was assessed concerning the effectiveness of the sternocleidomastoid muscle (SCM) flap to prevent Frey's syndrome after parotidectomy.

Methods. A bibliography search was conducted for studies published between 1966 and 2010 and included randomized controlled trials (RCTs) or cohort studies with patients undergoing parotidectomy with facial nerve preservation. The outcome measures of particular interest were the incidence of Frey's syndrome and cosmetic impairment.

Results. In all, 12 studies were selected (1 meta-analysis of all interventions to prevent Frey's syndrome, 2 RCTs, and 9 cohort studies). The trials were too heterogeneous to perform a meta-analysis on the effect of the SCM flap. The results reported by the authors of each study suggest an objective decrease in Frey's syndrome when the SCM flap was used, but there was no difference in the patients' subjective reporting of symptoms. However, this conclusion is prone to the biases inherent in these studies, and thus overall it is impossible to make any recommendation.

Conclusion. Current reported evidence is inconclusive as to the use of SCM muscle flap as an intervention to prevent Frey's syndrome following parotid surgery. © 2011 Wiley Periodicals, Inc. *Head Neck* **34:** 589–598, 2012

Keywords: parotidectomy; Frey's syndrome; muscle flap; sternocleidomastoid muscle; gustatory sweating

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Parotidectomy is a common surgical procedure whose indications are mainly primary salivary gland neoplasms and metastatic skin cancer. Salivary gland tumors are most often benign neoplasms, and in that long-term patient survival is to be anticipated, consequent long-term postoperative complications may lead patients to present for advice and treatment. One of the most common late complications following parotid surgery is the auriculotemporal nerve syndrome or gustatory sweating, also known as Frey's syndrome, in honor of Łucja (Lucie) Frey, who described its nosology in 1923.[1–3]

Andre Thomas[4] in 1927 and later Ford and Woodhall[5] in 1938 postulated the theory of aberrant regeneration of the sectioned parasympathetic fibers that regrow to innervate the vessels and sweat glands of the skin overlying the parotid to explain the symptoms. Injury to the auriculotemporal nerve fibers and/or parasympathetic fibers in the facial nerve during parotidectomy probably damages the secretomotor activity of the parotid gland. In the process of nerve regeneration, parasympathetic secretomotor fibers may become misdirected and grow along distal cut ends of sympathetic fibers to the skin vessels and sweat glands. A new salivary reflex is made possible and gustatory stimulus produces sweating and flushing. This regeneration process takes a certain amount of time, suggesting a latent period between

intraoperative auriculotemporal nerve injury and the onset of Frey's syndrome. The reported incidence of gustatory sweating after parotidectomy is highly variable (2% to 80%) and "depends on the diligence with which it is sought and the time-interval from surgery."[1] Many surgeons accept that most patients will have a positive Minor's test but also a minority will look for specific treatment of symptoms. In most reports, this interval ranges from 2 weeks to 2 years, although latency periods of >8 years have been reported.[6] The majority of patients suffering from this phenomenon will have symptomatic Frey's syndrome at 12 months following surgery, that is, gustatory sweating in 80%, skin erythema in 40%, and reported increased skin temperature in 20%.[7,8] In 1 study, 40% of the symptomatic patients had 2 or more symptoms, but fewer than 10% sought treatment.[7] However, 96% of patients who were objectively tested for gustatory sweating (objective Frey's syndrome shown by a starch-iodine test or Minor's test) tested positive, and the total area of sweating covered a mean area of 18 cm^2.[7] Once present, the gustatory sweating and flushing seems to remain unchanged, even after many years.[9] Studies have shown that the clinical severity of Frey's syndrome correlates with the surface area involved[7,10] and the extent of the parotid surgery (superficial or total).[11] There has also been an ongoing debate on the role of the thickness of the flap raised prior to parotidectomy,[12] suggesting that a thicker flap will be more effective, but this has not been substantiated by other authors.[7,13] It is agreed by clinicians that some patients suffer from considerable social embarrassment and social incapacity arising from profuse flushing and sweating when eating, and some have attempted to measure these effects,[14] although there is for now no globally recognized standardized questionnaire for quality of life in Frey's syndrome.[2] Because not all patients develop gustatory sweating after parotidectomy, and even among those who do, not all complain or require treatment; thus, selection of patients for appropriate use of preventative surgical measures is problematic.[2] A recent publication suggests that surgeons should engage patients in a dialogue of the operative risks, benefits, and alternatives relating to the use of surgical techniques to prevent Frey's syndrome. The uncertainty regarding the significance of Frey's syndrome postoperatively makes the informed consent process and preoperative decision making complex.[15]

Many authors have tried to assess different surgical procedures to avoid the onset of this complication. The most common recommended procedures are the interposition of musculoaponeurotic flaps between the skin and the parotid bed, to interrupt the aberrant innervation of the skin.[16–29] These flaps can use the superficial musculoaponeurotic system (SMAS) flap, the temporoparietal flap, or the sternocleidomastoid muscle (SCM) flap. Although there are many studies analyzing this question, they provide contradictory results and have small samples sizes with consequently low statistical power. Other strategies have been reported in the literature to prevent Frey's syndrome. In the United States, the use of allogenic acellular dermis or free or vascularized fat grafts to provide a barrier is popular and is widely used.[30–32]

The aim of this study was to assess the effectiveness of the SCM flap to prevent Frey's syndrome after parotidectomy. The use of the SCM flap has many advantages over the SMAS flap, as a potential decrease in the cosmetic defect, less risk of skin injuries during flap design, minimal risk of late skin necrosis, an ability to provide a larger width and length of muscle tissue that can be interposed, and ease with flap design and axis of rotation after parotidectomy.

MATERIALS AND METHODS

A bibliography search on MEDLINE and EMBASE databases for studies published from January 1966 to August 2010 using the terms *parotidectomy, Frey's syndrome, complications, parotid gland, surgery*, and *gustatory sweating*. An expanded search was used with each relevant article using Boolean operators. References were explored to identify other articles. We included only studies published in the English language.

Study Selection. After a preliminary search, all abstracts were reviewed by the authors, and those that dealt with operative procedures to prevent Frey's syndrome were selected for further analysis. Criteria for inclusion of studies in the review were: randomized controlled trials (RCTs) or cohort designs that included patients with benign or malignant parotid tumors who underwent partial or total parotidectomy with facial nerve preservation. Studies that included patients with previous surgical procedures in the parotid area or with previous radiotherapy were excluded. Interventions analyzed were SCM flaps (added or not to SMAS flap) compared with no flap. The main outcome was incidence of Frey's syndrome, determined with subjective or objective measures, with individual analysis of each outcome. Methods of detection of Frey's syndrome (objective or subjective) and time to follow-up were specifically recorded. The secondary outcome was cosmetic impairment that was noted when they were reported in the studies.

Investigators acquired data about sample size, patients characteristics, surgical procedures, outcome evaluation methods, and frequency of Frey's syndrome. The methodologic quality of each study was assessed in accord with Cochrane Collaboration guidelines for RCTs (details of randomization method, allocation concealment, blind evaluation of outcomes, intention to treat analysis, and loss to follow-up), giving a qualification of risk of bias. For cohort designs, we used the guidelines of the STROBE[33] initiative (eligibility criteria, variables and confounders, and

length and loss to follow-up). Methodologic and clinical weaknesses were discussed.

Data from each study were extracted by reviewers for calculation of odds ratio (OR) using a 2 × 2 table. Stratification by design and quality of the studies were made to analyze the main outcome. If clinical and methodologic heterogeneity was not found, a meta-analysis of results was attempted. In the other cases, heterogeneity was explained. Recommendations were classified in accord with level of evidence and GRADE[34] methodology.

RESULTS

The initial search gave 236 articles. In all, 63 studies were excluded because they were not published in English. After reviewing the abstracts, 12 were selected for this review,[8,13,16–21,23,35–37] resulting in only 1 meta-analysis and 2 RCTs.[8,10] The other studies were nonrandomized clinical trials. Table 1[8,16–21,23,35–37] shows the characteristics of each primary study.

Nonrandomized Clinical Trials. The first study was reported by Kornblut et al[37] with a similar incidence of objective Frey's syndrome (97% in the flap group vs 91% in the no flap group) and a higher incidence in subjective Frey's syndrome for the flap group (40% vs 14%). This study retrospectively selected a random sample of patients but did not report inclusion or exclusion criteria. They clearly reported a selection bias, and age and sex were not reported. The article described that the flap was designed to cover the branches of the auriculotemporal nerve. In accord with the technique of the flap, the figures and the text suggest that the flap could be shorter than needed "but it was primarily placed to cover the branches of the auriculotemporal nerve emerging from the retromandibular fossa," leaving some peripheral branches of the facial nerve without coverage, which theoretically allows a contact between the nerve and the subcutaneous tissue and skin. Kornblut et al[37] present graphics adjusted by year of presentation. Most objective Frey's syndromes were classified as minimal (58%), and subjective complaints occurred primarily in patients objectively classified as moderate or severe. There was no information about complications associated with the flap.

The second study was reported by Casler and Conley,[23] which does not describe either the clinical characteristics of the patients or the methods of selection of patients or flap indications, which introduces an important selection bias. The authors showed a lower risk of subjective Frey's syndrome in the flap group (12.5% vs 47.1%), without objective measures, and state that there was "no functional defect of moving the SCM muscle, nor was there a cosmetic deformity in the neck" and no complications.

The third study was made by Sood et al.[20] There were no reported criteria for inclusion or reasons to select patients for the flap. They excluded patients with conditions that could confound the evaluation of Frey's syndrome (as malignancy, diabetes, previous surgery, and medicaments) and selected those with >12 months of follow-up. This is the first study to include an objective measurement of the outcome using Minor's starch-iodine test, but evaluators were not blind to the intervention. They found a lower incidence of objective Frey's syndrome (18.2% vs 81.8%; $p<.05$) and subjective Frey's syndrome (0% vs 18.2%) for patients undergoing SCM flap interposition. The study reported no complication in the flap group, but did not show objective measures.

The fourth study by Kim and Mathog[21] included only benign or low-grade malignancies. They also included a subjective measure of the face contour with a severity scale as a cosmetic outcome. However, the authors did not report the clinical characteristics of the patients, and flap interposition was based on patient acceptance of the procedure. Together with the SCM flap, the surgical technique added a wide SMAS flap including the platysma muscle. The incidence of subjective Frey's syndrome was lower for the flap group (22% vs 50%). The contour appearance reported by patients was normal in 4 of 9 patients (44%) (1 hardly noticeable) in the flap group compared with 5 of 10 patients (50%) in the no flap group (7 moderate or hardly noticeable). There was no report about complications with the flap.

The fifth study by Gooden et al[19] gave no clear inclusion or exclusion criteria, and had a rate of recruitment of 43%. This fact could introduce an important selection bias. The authors used subjective evaluation of cosmetic appearance by the patient and an objective measurement using an observer-rated disfigurement scale with blind evaluators. The incidence of objective Frey's syndrome was similar between groups (31% vs 31%) but the incidence of subjective Frey's syndrome was higher in the flap group (31% vs 23%). The subjective report of cosmetic satisfaction (54% vs 54%) and the objective rating by external examiners was similar for patients (13 patients in the no flap group vs 12 in the flap group had a score <3).

The sixth study by Filho et al[17] had a recruitment rate of 31%. The only inclusion criteria were benign tumors and agreement to participate, but there was no information about other selection criteria or indications to perform a SCM flap; however, the study also included malignant tumors. Clinical characteristics of the patients were not reported. The muscle covered the whole defect. The incidence of objective Frey's syndrome (0% vs 36.8%) and subjective Frey's syndrome (0% vs 47.4%) was higher in the no flap group.

The seventh study be Fee and Tran[36] had as inclusion criteria living close to Stanford University, total parotidectomy, benign or low-grade malignant tumor, and acceptance to participate. However, the authors included patients undergoing revision

Table 1. Characteristics of the included studies.

Study	Patient characteristics	Follow-up	Surgical procedures	Method to assess outcome	Cosmetic impairment
Kornblut et al[37]	70 patients (35 per group) who underwent total (30%) or partial (71%) parotidectomy for benign tumors. Age and sex not reported	12–72 mo	Parotidectomy without information about the great auricular nerve. Modified Blair incision. Sterno-cleidomastoid flap in the upper third of the muscle with upper rotation axis.	Short questionnaire	Not reported
Casler and Conley[23]	120 patients (16 patients with sternocleidomastoid flap compared with 104 patients without a flap) who underwent parotidectomy. Age and sex not reported.	24 mo	Total parotidectomy without information about the great auricular nerve. Modified Blair incision. Sternocleidomastoid flap in the upper third of the muscle with upper rotation axis.	Short questionnaire and starch-iodine test classified as mild (punctuate), moderate (<2 cm), or strong (>2 cm)	Not reported
Kim and Mathog[21]	19 patients who underwent partial (68%) or total parotidectomy, excluding patients with recurrent tumors, suspicious of high-grade malignancies and facial weakness after 6 weeks. % women not reported, age not reported, 10% malignancy.	10–64 mo	Total or partial parotidectomy sacrificing the great auricular. nerve. Modified Blair incision. Sternocleidomastoid flap in the upper third of the muscle with lower rotation axis.	A telephone questionnaire for symptoms of Frey's syndrome after surgery, non starch-iodine test	Questionnaire
Sood et al[20]	22 patients who underwent partial parotidectomy, matched for sex, age, date of surgery, postoperative irradiation, and pathology. % women not reported, age range: 29–70 y.	42–44 mo	Parotidectomy with visualization of all branches of the facial nerve. No information about the great auricular nerve. Sternocleidomastoid flap in the upper third of the muscle with upper rotation axis.	Short questionnaire and starch-iodine test, classified as positive if an area >1 cm^2 showed discoloration	Not reported
Gooden et al[19]	26 patients from a cohort of 60 who underwent partial parotidectomy, matched for sex, age, date of surgery, postoperative irradiation, and pathology. Patients with previous radiotherapy or simultaneous lymph neck dissection were excluded. 69% women, age range: 56–63 y.	>12 mo	Not specifically reported.	Short questionnaire and starch-iodine test, classified as positive if an area >1 cm^2 showed discoloration	Questionnaire
Kerawala et al[18]	36 patients who underwent parotidectomy for benign or malignant tumors, with no exclusion criteria reported. 75% women, age range: 26–81 y, 14% malignancy.	12–60 mo	Total or partial parotidectomy, with no information about the great auricular nerve. Modified Blair incision. Sternocleidomastoid flap in the upper third of the muscle with lower rotation axis.	Short questionnaire and starch-iodine test, classified as positive if discoloration of any grade	Questionnaire in visual analogic scale going from 0 (good) to 10 (bad)

(Continued)

Table 1. (*Continued*).

Study	Patient characteristics	Follow-up	Surgical procedures	Method to assess outcome	Cosmetic impairment
Fee and Tran[36]	24 patients who underwent total parotidectomy, excluding patients with recurrent tumors, suspicious of high-grade malignancies. 75% women, age not reported.	3–60 mo	Total parotidectomy, with no information about the great auricular nerve. Modified Blair incision. Sternocleidomastoid flap in the upper third of the muscle with lower rotation axis.	Short questionnaire and starch-iodine test	Questionnaire and objective evaluation by the surgeon
Filho et al[17]	43 patients with parotid tumors from a cohort of 138 patients who underwent partial or total parotidectomy. Patients with previous radiotherapy or simulta-neous lymph neck dissection were excluded. 63% women, age range: 60–67 y, 15% malignancy.	12–90 mo	Parotidectomy with visualization of all branches of facial nerve. No information about the great auricular nerve. Sternocleidomastoid flap in the upper third of the muscle with upper rotation axis.	A subjective clinical questionnaire and starch-iodine test, considered positive if an area >1 cm^2 showed discoloration	Not assessed
Asal et al[16]	24 patients with benign parotid tumors who underwent partial parotidectomy. Patients with previous radiotherapy or simultaneous lymph neck dissection were excluded. 50% women, age range: 29-71 y.	9–48 mo	Parotidectomy with visualization of all branches of facial nerve. No information about the great auricular nerve. Sternocleidomastoid flap in the upper third of the muscle with upper rotation axis.	Short questionnaire and starch-iodine test classified as mild (punctuate), moderate (<2 cm), or strong (>2 cm)	Questionnaire
Rustemeyer et al[8]	372 patients with parotid tumors who underwent partial or total parotidectomy. No exclusion criteria reported. 63% women, age range: 39–61 y. neous lymph neck dissection were excluded. 63% women, age range: 60–67 y, 15% malignancy.	>36 mo	Conservative parotidectomy. No information about the great auricular nerve. Sternocleidomastoid flap in accord with the Rausch technique.	Interview at intervals of 3–6 mo	Not assessed
Zhao et al[35]	226 patients who underwent total parotidectomy for benign tumors, excluding those patients with previous surgery or radiation therapy. 64% women, age range: 12–79 y, 0% malignancy.	6–24 mo	Total parotidectomy with preservation of the great auricular nerve. Modified Blair incision. Sternocleidomastoid flap in the upper third of the muscle with lower rotation axis.	Short questionnaire and starch-iodine test, classified as mild (punctuate), moderate (<2 cm), or strong (>2 cm)	Measurement of the concavity from a line going from the angle of the mandible to the mastoid, and classified as unsatisfactory (>1.5 cm), moderately satisfactory (1.0–1.5 cm), satisfactory (0.5–1.0 cm), and very satisfactory (<0.5 cm)

surgery. They included a subjective evaluation of cosmetic appearance and an evaluation by blind examiners on a scale from 1 to 10. They reported that the flap was fixed to the zygomatic arch and masseter muscle. There is no clear indication about the coverage of the surgical bed, but the photograph suggests it covered the entire defect. The incidence of objective Frey's syndrome was similar between groups (20% vs 22%) but the subjective incidence was higher in the no flap group (13% vs 44%). The cosmetic evaluation showed higher values for the reconstruction group (8.7 vs 7.7 for the frontal view and 8.3 vs 6.2 for the oblique view). There was no difference in facial paresis rate (4.8% for the flap group vs 7.2% for the no flap group), but there was more numbness in the territory of the great auricular nerve in the flap group (100% vs 78%).

The eighth study by Zhao et al[35] did not offer information about other inclusion or exclusion criteria. Photographs showed a complete coverage of the surgical bed. Cosmetic appearance was assessed using the depth of the postoperative concavity. The incidence of objective Frey's syndrome was higher for the flap group (45% vs 37%), although subjective Frey's syndrome was similar between groups (25% vs 22%). Concavity measurements were higher for the no flap group (19–28 mm vs 5–6 mm). Complications were not different between the groups.

The ninth study by Rustemeyer et al[8] did not offer information about the SCM flap indications. Patient clinical characteristics and the type of surgery were included. The incidence of subjective Frey's syndrome was similar between groups (24.1% vs 21.9%). There was no report of objective Frey's syndrome or complications.

Randomized Controlled Trials and Meta-analysis. The first RCT was published by Kerawala et al[18] in 2002. The authors did not offer information about inclusion or exclusion criteria. The randomization method by odds and evens carried a high risk of bias. There was no information about allocation concealment. The analysis was made per protocol with a high risk of bias. Clinical characteristics of patients were reported. The flap covered the entire surgical defect. Cosmetic appearance was assessed with a visual analog scale by the patients and physicians blind to the intervention (range 0=normal appearance to 5=severe asymmetry). The incidence of objective Frey's syndrome was higher in the flap group (90% vs 73%; $p=.21$), but the incidence of subjective Frey's syndrome was higher in the no flap group (38% vs 60%; $p=.31$). Patient evaluation of cosmetic appearance was 1.5 for the flap group versus 2.6 for the no flap group and physician evaluation found 2.8 versus 3.5, respectively, but the differences were not statistically significant. There were no differences regarding the rates of facial nerve paralysis.

The second RCT published by Asal et al[16] appeared in 2005. There was no other information about inclusion or exclusion criteria. Clinical characteristics of the patients were clearly reported. Information about randomization and allocation concealment was lacking. Evaluation of the outcomes was made by physicians blind to the intervention. The analysis was made by intention to treat. They compared the addition of an SCM flap to an SMAS flap. Cosmetic appearance was assessed subjectively by patients and the physicians, but the methods were not clearly reported. The incidence of objective Frey's syndrome was higher in the no flap group (0% vs 50%), but the incidence of subjective Frey's syndrome was similar between groups (0% vs 0%). The evaluation of cosmetic appearance by patients and physicians (a score of 50% for the flap group vs 58% for the no flap group) was similar between groups. Complications were stated to be similar but without objective data.

The only existing meta-analysis was published in 2009 by Curry et al[13] and included 15 prospective and retrospective studies with 1078 patients, but with different surgical techniques (SCM flap, SMAS flap, temporoparietal fascia, parotid gland fascia, dura mater, polyglactin, or Vycril and polytetrafluoroethylene or GoreTex interposition). The authors concluded that patients' complaints or symptoms of Frey's syndrome (subjective evaluation) and the results of skin staining using the Minor starch-iodine test (objective evaluation) were successfully prevented by the interposition of any tissue with an OR of 3.88 (95% confidence interval [CI] 2.81–5.34) and 3.66 (2.32–5.77), respectively. This study has important methodologic weaknesses, however. First, it included observational and experimental studies, which can bias results because of intrinsic flaws of the design. There is no evaluation of the internal validity of each study and the clinical characteristics of patients and surgical procedures were highly heterogeneous (64% to 73%).

Individual results are shown in Table 2[8,16–21,23,35–37] and Figures 1[8,17,19,20,23,35–37] and 2.[17,19,20,35–37] Results of the trials were too heterogeneous for a meta-analysis to be possible. Results of the trials suggest a better objective response with the SCM flap, but without a difference in subjective response. However, this conclusion is very prone to bias, making it impossible to make a recommendation based on statistical evidence.

DISCUSSION

The pathophysiology of Frey's syndrome was described in 1927.[4] The most accepted explanation for this syndrome is the aberrant regeneration of the fibers of the auriculotemporal nerve that go through the facial nerve to the parotid gland, and that grow to innervate the sweat glands and blood vessels of the skin, producing the characteristics of sweating and flushing of the parotid region during eating. Accepting this pathophysiology, many surgical

Table 2. Incidence of Frey's syndrome measured objectively and subjectively.

		No. of patients with SCM flap						No. of patients without SCM flap					
		No. of patients with SMAS flap			No. of patients without SMAS flap			No. of patients with SMAS flap			No. of patients without SMAS flap		
Trial	Year	Total	Subjective	Objective	Total	Subjective	Objective	Total	Subjective	Objective	Total	Subjective	Objective
Kornblut et al[37]	1977				35	14	34				35	5	32
Casler and Conley[23]	1991				16	2					104	49	
Kim and Mathog[21]	1999	9	2					10	5				
Sood et al[20]	1999				11	2	2				11	0	9
Gooden et al[19]	2001				13	4	4				13	3	4
Kerawala et al[18]	2002				21	8	19				15	9	11
Fee and Tran[36]	2004				15	2	3				9	4	2
Filho et al[17]	2004				24	0	0				19	9	7
Asal et al[16]	2005	12	0	0				12	0	6			
Rustemeyer et al[8]	2008				203	49					169	37	
Zhao et al[35]	2008	42	2	17	33	17	17	94	5	19	57	28	37

Abbreviations: SCM: sternocleidomastoid muscle; SMAS: superficial musculoaponeurotic system.

procedures have been proposed to interpose any tissue between the parotid bed and the skin, such as SCM, temporoparietal, platysma, and derma flaps, to prevent the aberrant innervation.[18,38–40]

The most common procedures performed today are the SCM flap, the SMAS flap, and the use of acellular dermis. The SCM flap is commonly used because it is easy to rotate into the parotid region without another incision, the flap is long enough to cover all the branches of the facial nerve, the flap decreases the depression of the surgical area after parotid gland resection, there is a low risk of necrosis of the flap because of its vascularization, and there is a low risk of complications, primarily, spinal accessory nerve injury. However, there is no strong evidence supporting the use of this procedure to prevent Frey's syndrome. Some authors do not recommend it,[41] whereas others use it currently[36] based on results of their own studies. In the era of evidence-based medicine,[42] it is necessary to support most surgical interventions with strong information about its effectiveness and security. Furthermore, other factors such as satisfaction related to cosmetic appearance and costs should be assessed because the introduction of a new procedure

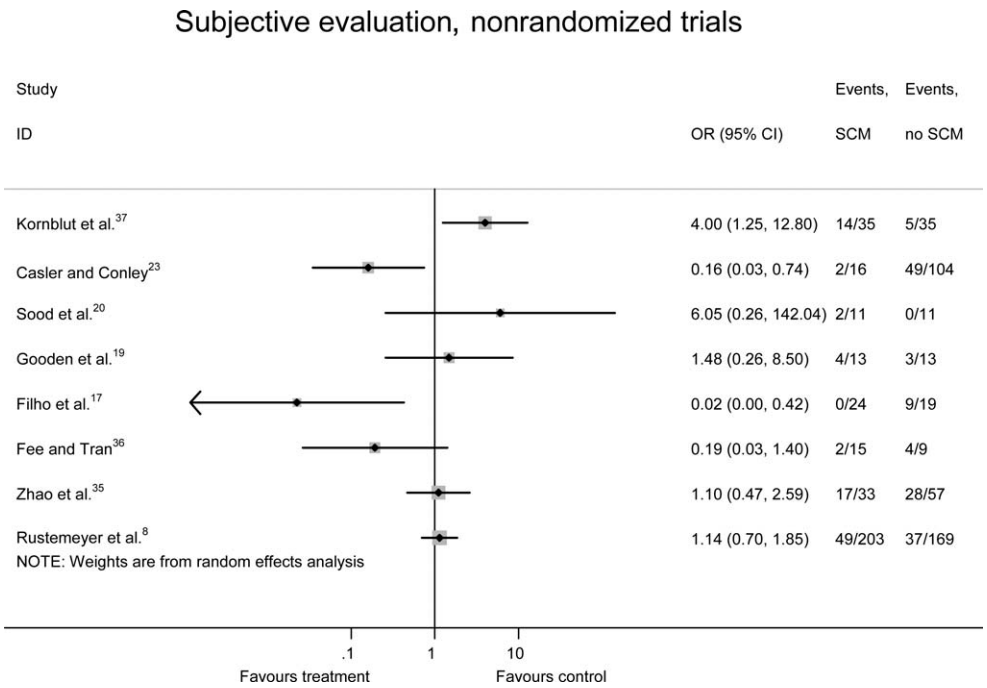

FIGURE 1. Results of subjective measurements of Frey's syndrome in nonrandomized clinical trials. SCM, sternocleidomastoid muscle; SMAS, superficial musculoaponeurotic system.

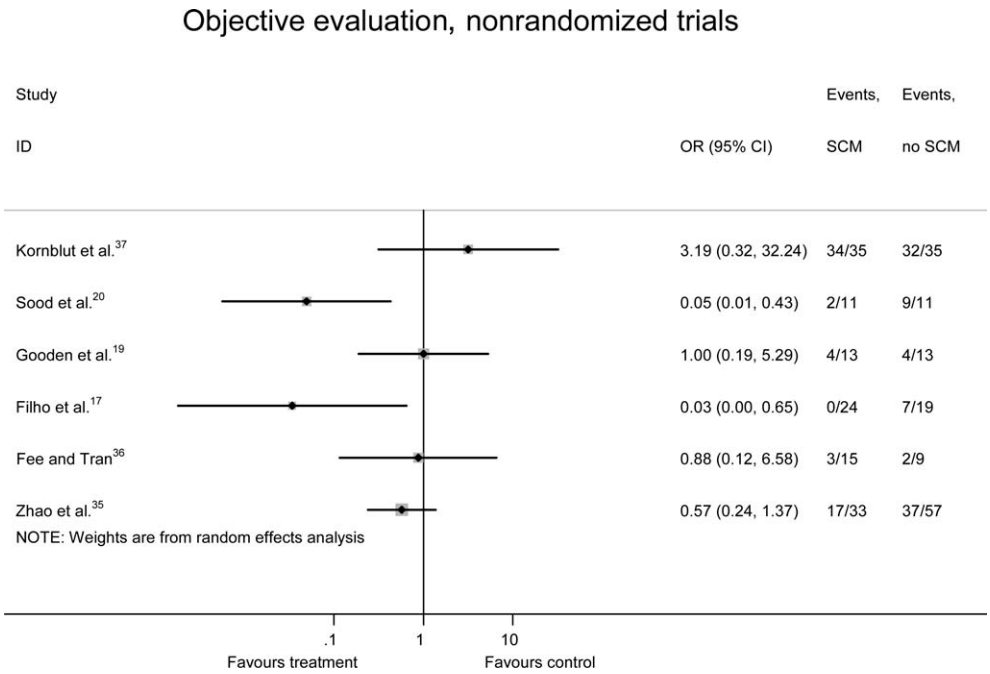

FIGURE 2. Results of objective measurements of Frey's syndrome in nonrandomized clinical trials. SCM, sternocleidomastoid muscle; SMAS, superficial musculoaponeurotic system.

could increase operating room time and use of other resources.[43]

Our study attempted to identify all studies about this subject and found 11 studies: 9 observational, 2 RCTs, and 1 systematic review. Curry et al[13] published a meta-analysis in 2009, concluding that operative techniques, including the SCM flap, decrease the rate of Frey's syndrome after parotidectomy. However, this study has important methodologic weaknesses, such as combining different surgical techniques, differing populations and study designs, and, importantly, performing a meta-analysis even after having found a high heterogeneity, which is not recommended by the Cochrane Collaboration.[44] In our opinion, the clinical and statistical heterogeneity of these studies makes it impossible to combine their results in a pooled one, precluding the use of a meta-analysis to evaluate the SCM flap as a measure to avoid Frey's syndrome.[45]

Most heterogeneity among the studies can be explained by clinical and methodologic differences. Many studies are retrospective and cover a long length of time, with the corresponding risk of recall bias and the obvious modification in surgical technique that could confound results.[46] This fact is connected with another factor: the follow-up time. It has been shown that there is a latency of approximately 6 months before appearance of Frey's syndrome. If studies do not have a long enough follow-up the rate of Frey's syndrome would be underestimated. However, it is also probable that patients with longer follow-up could have developed a tolerance to the syndrome, considering it less important, and thus reporting relatively lower subjective symptoms. Interposition of SCM forms a barrier between the parotid gland and the overlying skin. It is not clear if this barrier inhibits or only delays aberrant reinnervation of the skin by parasympathetic nerve fibers. In different series follow-up is variable and may be too short to answer this question. If follow-up is short and no Frey's syndrome occurs it could wrongly be concluded that SCM prevents gustatory sweating instead of delaying it. Therefore, long-term follow-up is needed to answer the question if interposition of SCM avoids Frey's syndrome or just delays it.

Most studies did not establish clear inclusion and exclusion criteria. This weakness, named "selection bias" in the epidemiologic literature, is 1 of the most important biases affecting these studies.[44] The inclusion of patients based on nondefined criteria can produce the imbalanced selection of patients, making final results inexact. The inclusion of patients based in their agreement to participate allows the inclusion of certain patients, commonly those with a less severe condition, underestimating the final incidence of the syndrome. A reporting bias is also associated with sex, age, and other clinical characteristics of patients.[47]

Another factor involved the method to detect the gustatory sweating. The Minor's or postoperative iodine-starch test[37] is considered the gold standard to detect objective Frey's syndrome. However, there is no reliable information standardizing the technique or providing the rate of true and false positives. Some studies report the incidence of Frey's syndrome based on subjective complaints, whereas others used the more objective method. In accord with the philosophy

of outcomes research[43] that considers predominantly outcomes relevant to patients, it is correct to think that the real incidence should be based on the symptoms perceived by the patients because these cases are those that need specific treatment. Other important outcomes such as cosmetic results were measured in only few studies, and the methods used were highly subjective and heterogeneous between studies.

Another variable in these studies is the surgical technique. We chose to evaluate only the SCM flap. SMAS flaps cannot be used in cases in which the oncologic margin includes its resection.[25] The SMAS flap offers the possibility of a better cosmetic result in terms of decreasing the postoperative depression. Other flaps such as the temporoparietal flap[38] require a wider dissection in the temporal area, including an extension of the incision and a higher risk of damaging the frontal branch of the facial nerve. The surgical techniques to design the SCM flap used in the previous studies were heterogeneous, and it was hard to identify the details that could standardize the technique. Some authors used an inferior based flap, whereas others used a superior-based flap. The studies are ambiguous about the necessary length of the flap and the need to cover all of the branches of the facial nerve, avoiding connection with the skin. Kim and Mathog[21] used only the superficial layer of the SCM in their platysma muscle–cervical fascia–SCM flap. Details about the thickness of the flap and its vascular pedicle(s) were not adequately described in most studies. These weaknesses stem from a lack of standardization of the surgical procedure and thus a bias in the uniformity of results.

Finally, sample sizes are too small. Lack of statistical power has been widely discussed in the medical literature.[48] This refers to obtaining a negative conclusion when it is really positive, the product of a small population. Most studies included in this review suffer from lack of power.

Results from this review do not allow any conclusions about the effectiveness of the SCM flap to prevent Frey's syndrome, which is not the same as saying that it is not useful. The most important reason is the lack of enough RCTs, which are considered the highest level of evidence to make decisions. Most information is taken from observational studies that are prone to bias. Data about objective measurements suggest a protective effect, but subjective data are not conclusive. The cosmetic effect seemed to be more pronounced in the flap group. Nonetheless, systematic reviews such as ours offer an opportunity not only to identify weaknesses on actual evidence but also to provide guidelines to design and develop trials that could help to solve the problems identified. Any study that will solve the question about the utility of the SCM flap as an intervention to avoid or prevent Frey's syndrome should be multicenter, with a randomized design, a standardized surgical technique and experienced surgeons, and clearly defined methods of evaluation of the syndrome, whether objective with the Minor's test (bilateral for intra-individual comparison) with clear categories to consider it mild, moderate, or severe or subjective with validated scales and a long-term follow-up. Because cosmetic appearance is an important outcome, it should also be assessed using validated tools, including multiple evaluators (patients, physicians, and a third party) to determine the true effect. All these measures must be assessed in a blind fashion by surgeons not involved in the surgical procedure. This trial should also have a sample size that could answer this question definitively and avoid a lack of power. This sample size could be calculated based in the subjective outcome, in accord with the new suggestions of outcomes research, because this is what really determines patients' outcomes. The minimum follow-up should be of 12 months, and the comparison of outcomes should be made after the same follow-up time for all patients to avoid recall bias.

In conclusion, the evidence reported on the use of the SCM muscle flap remains inconclusive, when used as an intervention in parotid surgery to prevent Frey's syndrome, and its effectiveness as a prevention can be resolved only by a well-constructed and controlled RCT.

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