Evaluating the Efficacy of a Sternocleidomastoid Flap via Galvanic Skin Responses in Superficial Parotidectomy

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Abstract In the present study, we evaluated the efficacy of flaps via measurement of galvanic skin responses (GSR) in patients who had undergone superficial parotidectomy either with or without sternocleidomastoid (SCM) muscle flaps. Retrospective study design was used. The setting included University of Uludag School of Medicine Department of Otorhinolaryngology. Eleven patients who had undergone superficial parotidectomy for benign diseases in our clinic between June 2003 and August 2006 were included in the study. SCM muscle flaps were used in four patients. The GSR of the patients were measured using a *MP 30 System*. The Mann–Whitney U test was used for the analysis of data. There were complaints that resembled Frey’s syndrome in three patients in whom flaps had not been performed. Patients with flaps had no complaints. In patients with flaps, no significant GSR changes were observed between the control and operated sides ($P > 0.05$). In patients without flaps, the GSR levels were significantly higher on the operated side compared to the control side ($P < 0.05$). GSR values on the control side did not show any differences between patients with and without a flap. However, there were significantly higher GSR values for the operated side in patients without flaps compared to patients with flaps ($P < 0.05$). Application of

a SCM flap is an efficient method by which to prevent Frey’s syndrome, and the GSR test is beneficial both in diagnosing and determining the severity of the disease as well as evaluating the efficacy of surgical techniques used to prevent Frey’s syndrome.

Keywords Frey’s syndrome · Galvanic skin response · Superficial parotidectomy

Introduction

The first parotidectomy was defined by Bernard in 1823 [1]. Although equipment and techniques concerning this procedure have developed over time, certain complications persist, such as facial nerve paralysis, post-operative disfigurement due to a lack of volume developed by excised tissue, and Frey’s syndrome.

Frey’s syndrome was first defined by Duphenix in 1757. In 1923 Lucy Frey, a French neurologist, published a case of sweating during eating which developed as a result of a bullet wound in the parotid gland. Thinking that the auriculotemporal nerve plays an important role in the pathogenesis of this event, Frey named this syndrome auriculotemporal syndrome [2]. Subsequently, the syndrome appeared in the literature as Frey’s syndrome. Frey’s syndrome develops as a consequence of abnormal anastomosis of the secretory parasympathetic nerve fibers of the parotid gland with cutaneous sweat glands after parotidectomy and manifests as sweating in the preauricular and temporal regions as well as flushing during eating.

The incidence of Frey’s syndrome has been reported in varying frequencies between 6 and 96% [3]. While some studies have been conducted using objective methods, other studies have used subjective methods, and this is the basis

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for the different frequencies [3]. In studies with subjective methods, patients are questioned about symptoms found in Frey's syndrome. In studies with objective methods, the starch-iodine test, which was defined by Minor, is used most often [4]. The starch-iodine test is used to verify the diagnosis of patients with sweating symptoms in the periauricular and temporal regions, and it identifies patients with asymptomatic Frey's syndrome. However, this test does not provide precise information about the severity of the disease [4]. Since the starch-iodine test detects patients with subclinical symptoms, it increases the 10–48% frequency from detection of Frey's syndromes [5] to 96% [6].

The variation in the amount and content of sweat gland secretions is reflected in the skin as alterations in electrical resistance. Galvanic skin responses (GSR) are obtained by measuring the resistance and sudden changes in resistance. In recent years, GSR has been used as a new technique, especially to rapidly measure the sympathetic activity of the body. GSR changes are used as a biofeedback method to enhance the intended control of muscles by athletes. During exercise, athletes learn to control muscle tension and direct it according to their will by watching GSR changes on a monitor.

Many techniques have been developed to prevent Frey's syndrome. These techniques are commonly based on the formation of a barrier between the facial nerve and the skin. One technique is the use of a sternocleidomastoid (SCM) muscle flap. In the present study, we evaluated the efficacy of a flap via GSR measurement in patients who had undergone superficial parotidectomy with or without SCM flaps in our clinic. In this study, the GSR test in the diagnosis of Frey's syndrome as a pilot study is planned for the first time used. GSR measurement was used because instantaneous, numerical variations in sweat glands are available, the results are obtained in a short time, and the technique is simple and non-invasive.

Materials and Methods

In the present study, 11 patients who had undergone superficial parotidectomy in our clinic for benign diseases between June 2003 and August 2006 were included. These patients were between 28 and 66 years of age (mean 46.18 years, 5 female and 6 male). A SCM muscle flap was performed in four patients, and seven patients underwent a superficial parotidectomy without a SCM flap. The post-operative period was between 6 and 42 months (mean 19.09 months).

The GSR of the patients was measured using a *MP 30 System* (Biopac Co.[®], Goleta, California, USA). The test was performed bilaterally, and patients who did not undergo surgery were designated as the control group.

Two probes measuring GSR were placed on the skin along the course of the facial nerve. Lemon was used to

stimulate salivation. Records of each patient for 14 s (7 s prior to and 7 s after lemon stimulation) were obtained.

The area below the curve was calculated by the Trapezius method [7] to determine the change between pre- and post-lemon stimulation. The area change below the curve was calculated in each patient as percentages for the control and operated sides separately. The Mann–Whitney *U* test was used for analysis of the data.

The approval of the Ethical Committee of Uludag University Medical Researches, as well as informed consent of all patients, was obtained for the study.

Results

There were complaints suggestive of Frey's syndrome in three patients in whom flaps were not performed. No such complaints were made in patients with flaps. While there were no significant differences in the change in GSR between the control and operated sides in patients with flaps ($P > 0.05$), GSR levels were observed to be significantly increased on the operated side compared to controls in patients without flaps ($P < 0.05$). The GSR values were not different between patients with and without flaps on the control sides. Significantly higher GSR values were obtained in patients without flaps compared to patients with flaps on the operated sides ($P < 0.05$). In patients with flaps, the GSR values changed between -7 and 5% (mean, 0.5%) on the operated side, whereas increases varied between 2 and 47% (mean, 23%) in patients without flaps. When three patients with Frey's syndrome were excluded from this ratio, the mean increase was calculated to be 10.75% . GSR increases of 47 , 45 , and 26% were shown in three patients with Frey's syndrome (mean, 39.33% ; Fig. 1).

Discussion

During the review of the literature, it was determined that the starch-iodine test of Minor is often used as an objective test for the diagnosis of Frey's syndrome. In the study performed by Taylor et al. [3], the rate of symptomatic

Fig. 1 Galvanic skin responses changes (as percentages with respect to the control side) in patients with flaps, without flaps, and with Frey's syndrome

Fig. 2 Galvanic skin responses curve of a patient without signs of Frey's syndrome (a slight increase in the galvanic skin responses value with lemon stimulation)

Fig. 3 Galvanic skin responses curve of a patient with signs of Frey's syndrome (the galvanic skin responses value is higher than normal with lemon stimulation)

patients with Frey's Syndrome was 42.8%, but with the starch-iodine test it was 64.3%. In other studies, the starch-iodine test generally had higher rate of detection than the clinical symptoms of Frey's syndrome [1–6, 8–10, 12–14, 17, 18]. Patients with Frey's syndrome can be detected with the starch-iodine test; however, the test might also be positive in asymptomatic patients. In the present study, we recorded significantly higher GSR values by the GSR test in three patients with Frey's syndrome. Nonetheless, GSR values were lower in asymptomatic patients. Although the number of patients in the present study was limited and the test duration was short, significant results were obtained from the GSR technique (Figs. 2, 3).

Various surgical techniques are used to prevent the development of Frey's syndrome in patients who undergo parotidectomy. The common feature of these techniques is the use of various materials or tissues to prevent contact of the facial nerve with the skin [8–15]. In the present study, the SCM flap covered the facial nerve. There are several studies in the literature that prove the efficacy of a SCM flap to prevent the development of Frey's syndrome [4, 16–18]. In the study by Filho et al. [2, 16], four patients with SCM flaps and 19 patients without SCM flaps, who had undergone subtotal and total parotidectomies, were compared. Minor's starch iodine test has been used for flap efficacy and for the diagnosis of Frey's syndrome. Frey's syndrome was not observed and the starch-iodine test was negative in patients with flaps. Symptoms of Frey's syndrome occurred in 9 (47.4%) patients without flaps. The test was positive in seven of those patients. In a study by Asal et al. [12, 17], patients with and without flaps were compared. Symptoms of Frey's syndrome did not occur in any of the patients. While the starch-iodine test is positive

in roughly half of the patients without flaps, it is negative in all patients with flaps. In a study by Sood et al. [2, 18], two patients, 11 with SCM flaps and 11 without flaps, were evaluated. Although there were no patients with symptoms of Frey's syndrome in the group with flaps, the starch-iodine test was positive in two patients. Although two patients had symptoms of Frey's syndrome in the group without flaps, the starch-iodine test was positive in nine patients [18]. When the results of these studies were evaluated, it was concluded that SCM flaps are an effective method for the prevention of Frey's syndrome. In the present study, no significant difference in GSR was determined between the control and operated sides in patients with flaps. Also, no symptoms of Frey's syndrome were observed in any patients with flaps. Symptoms of Frey's syndrome were observed in three of seven patients without flaps, and GSR was significantly higher in those patients.

Conclusion

As a result, the application of a SCM flap is an effective method to prevent Frey's syndrome, and the GSR test is beneficial both in the diagnosis and determination of severity of Frey's syndrome. The GSR test can also be used to evaluate the efficacy of surgery to prevent Frey's syndrome.

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