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Schedule	Received	14 July 2014
	Revised	
	Accepted	13 October 2014

Abstract	Great auricular nerve (GAN) is frequently sacrificed during parotid surgery. GAN preservation during parotidectomy is advised to avoid complications such as sensitive disorders, but debate still exists. In this study, our experience is reported on the matter. From a cohort of 173 parotidectomies carried out in the period 2005–2010, we studied 60 patients: 20 patients in which we preserved only the posterior branch of GAN (group A), 20 patients in which we preserved also the lobular branch (group B) and 20 patients in which the main trunk of GAN was sectioned (group C); we evaluated tactile sensitivity in all the skin supplied by GAN at 1 week, 1 month, 6 months and 1 year after surgery. Group B is the best in terms of loss and recovery of sensitivity after 1-year post-surgery, followed closely by group A, on the contrary group C confirmed to be the worst. Results suggest that saving as many branches of the GAN as possible during parotid surgery could be useful for reducing hypo-disestesia. Preserving posterior and lobular branches of the GAN, when possible, improves the sensitivity of the preauricular area with better quality of life for the patient.

Keywords (separated by '-')	Great auricular nerve - Parotid surgery - Sensory disorders - Disestesia
Footnote Information	

Eur Arch Otorhinolaryngol
DOI 10.1007/s00405-014-3342-6

HEAD AND NECK

Great auricular nerve preservation in parotid surgery: rationale and long-term results insights

Antonio Moretti · Leonardo Citraro · Anna Grazia Petrucci · Pamela Di Giovanni · Roberta Di Mauro · Pier Giorgio Giacomini

Received: 14 July 2014 / Accepted: 13 October 2014

Abstract Great auricular nerve (GAN) is frequently sacrificed during parotid surgery. GAN preservation during parotidectomy is advised to avoid complications such as sensitive disorders, but debate still exists. In this study, our experience is reported on the matter. From a cohort of 173 parotidectomies carried out in the period 2005–2010, we studied 60 patients: 20 patients in which we preserved only the posterior branch of GAN (group A), 20 patients in which we preserved also the lobular branch (group B) and 20 patients in which the main trunk of GAN was sectioned (group C); we evaluated tactile sensitivity in all the skin supplied by GAN at 1 week, 1 month, 6 months and 1 year after surgery. Group B is the best in terms of loss and recovery of sensitivity after 1-year post-surgery, followed closely by group A, on the contrary group C confirmed to be the worst. Results suggest that saving as many branches of the GAN as possible during parotid surgery could be useful for reducing hypo-disestesia. Preserving posterior and lobular branches of the GAN, when possible, improves the sensitivity of the preauricular area with better quality of life for the patient.

Keywords Great auricular nerve · Parotid surgery · Sensory disorders · Disestesia

Introduction

Parotidectomy is a common surgical procedure for the treatment of several parotid diseases, such as benign or malignant neoplasms, inflammatory or autoimmune conditions [1]. Aims of conservative parotidectomy are removal of the disease, prevention of facial nerve weakness or palsy and avoidance of aesthetical defects.

During superficial or total parotidectomy great care is taken to preserve the facial nerve, not the same attention is used to preserve other structures such as the great auricular nerve (GAN) [2], a sensory nerve that serves the skin of the postero-inferior region of the auricle, the mastoid region and the lower half of the parotid-masseteric region. GAN originates from the anastomotic loop between the second and third cervical nerves; after its origin, it passes around the sternocleidomastoid muscle and it ascends along the muscle until it divides into branches near the mandibular angle [3]. GAN has three branches: the anterior branch which leads to the parotid gland; the lobular branch which goes to the auricular lobule; and the posterior branch which goes to the posterior-auricular area. In most patients the lobular branch has a common trunk with the posterior branch and with different anatomical presentations; only in a minority of cases the main trunk of GAN divides into three branches directly [1]. GAN is frequently sacrificed in parotidectomy to allow the mobilization of the parotid inferior pole but this maneuver results in sensory disorders

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Journal : Large 405 | Dispatch : 16-10-2014 | Pages : 6
Article No. : 3342 | ☐ LE | ☐ TYPESET
MS Code : EAOR-D-14-00882 | ☑ CP | ☑ DISK

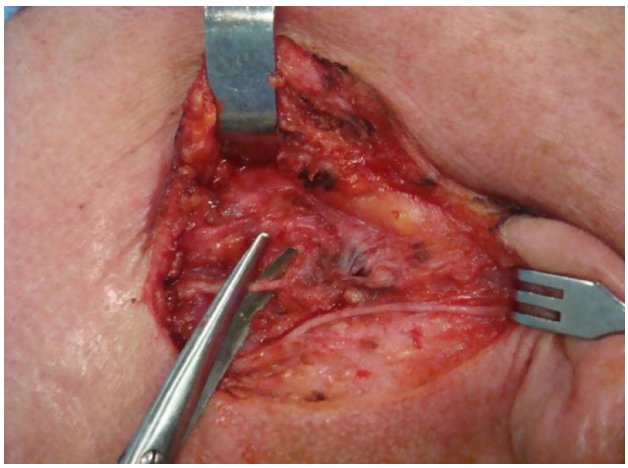

Fig. 1 Group A: preservation only the posterior branch of the GAN

such as: numbness, discomfort when wearing earrings or shaving and suffering a burn [4, 5]. To avoid these complications, GAN preservation during parotidectomy has been advised but controversy about the efficacy of this practice still exists because of the feeling that until one or two years a partial sensory recovery takes place.

This report presents our experience about the preservation of GAN branches during parotidectomy and the sensory outcome in patients with and without GAN preservation. The real effects of GAN sparing vs its sacrifice in the long-term are tested, statistically scrutinized and highlighted to give a rationale for the surgeon to apply this procedure and to clarify the functional results that may be expected in order of sensitivity preservation in the auricular region.

Materials and methods

This is a perspective study, the data from the patients were not always available the patients with missing data were discarded from follow-up. We studied 173 parotidectomies performed in our departments from January 2005 to December 2010 for primitive or secondary tumors of the parotid gland. Patients with pre-operative suspicion of malignancy and those with mental disability were excluded from this study. 121 patients with pre-operative diagnosis of benign parotid lesions were drawn. GAN preservation was determined by its objective feasibility and by surgeon's preference; the risks of parotidectomy were explained to all patients, including those related to sacrifice of GAN or one of its branches. We preserved the posterior and/or lobular branches of GAN in 81/121 patients. We did not take into account the preservation of the anterior branch of GAN because generally during skin flap elevation it is necessary to divide it. In 40/121 patients the GAN was sacrificed. Patients were divided into three groups: group A (39 patients with preservation of the posterior branch—Fig. 1), group B (42 patients with preservation of the posterior and lobular branches—Fig. 2) and group C (40 patients with total section of GAN—Fig. 3). From this cohort, 20 patients from each group were randomly selected by generation of random numbers in Microsoft Excel software (version 2007) with use of the RAND function. The total number of subjects in each group was decided on the basis of the current English Literature in which a sample size of 10–33 patients in each group is considered representative [1–3].

Parotidectomies were performed using a standard surgical technique through traditional or "face-lift" incision (particular care was taken in female and young patients) [6]. An anterior skin flap was prepared superficially to the platysma and the Superficial Muscular Aponeurotic System (SMAS). The main trunk of the great auricular nerve was identified taking as a reference point its intersection with the anterior margin of the sternocleidomastoid muscle 4–5 cm beneath the earlobe [7]. The course of the nerve was followed until it trifurcates into the anterior branch, posterior branch and lobular branch approximately 0–2 cm above the angle of the jaw. Attempts at preservation were made when there was not any direct contact between nerve and disease. When preservation was selected the saved branches were retracted backwards and isolated before proceeding with surgery. When nerve preservation was judged to be inappropriate or dangerous to the facial nerve, the main trunk of GAN was divided at the lower border of the parotid. The parotid gland was then removed while preserving the trunk and main branches of the facial nerve.

We evaluated tactile sensitivity in all the skin supplied by GAN, subdivided into five areas: the pre-auricular region (area 1) between the anterior border of the auricle and the anterior border of the masseter muscle; the superior auricular region (area 2) corresponding to the superior half of the auricle; the inferior auricular region (area 3) corresponding to the inferior half of the auricle; the posterior auricular region (area 4) located between the posterior auricular insertion and the hairline; and the infra-auricular region (area 5) between the auricle and the angle of the mandible (Fig. 4). The tests were performed pre-operatively and post-operatively (1 week, 1 month, 6 months and 1 year after surgery). The examiner was not informed of GAN preservation to avoid possible bias. Tactile sensitivity was evaluated using a brush gently applied in each area; patient gave a signal as soon as any sensation was felt. The patients were requested to close their eyes during the tests. Each test was repeated four times for each area and it was scored using a Visual Analog Scale (VAS): grade 0 of the VAS indicated no sensation of the examined

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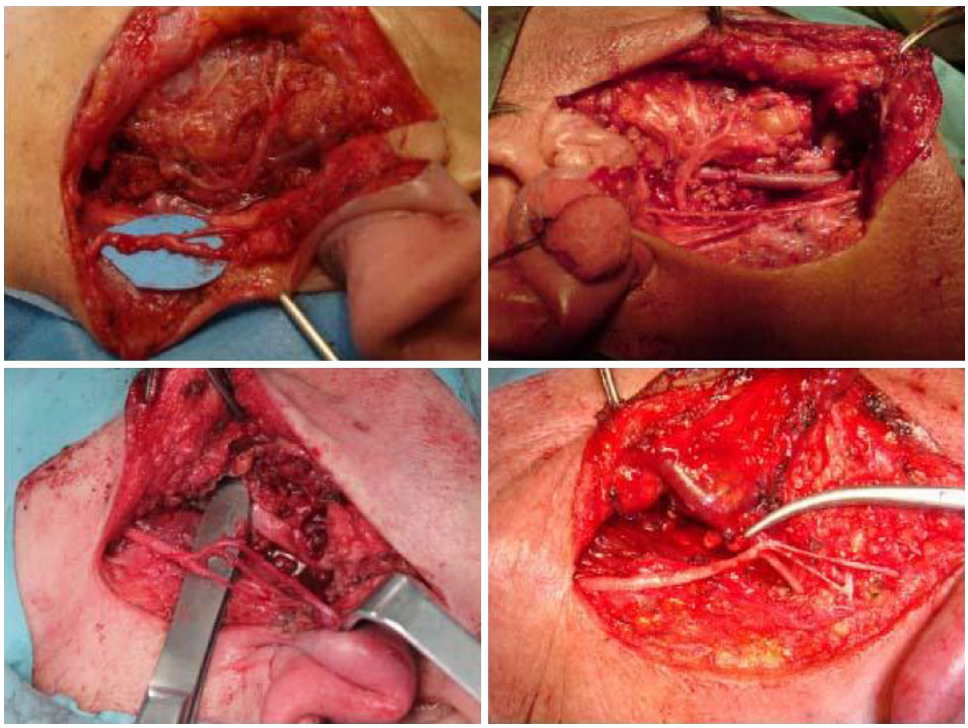

Fig. 2 Group B: preservation of the lobular and posterior branches of the GAN. Different anatomical presentations

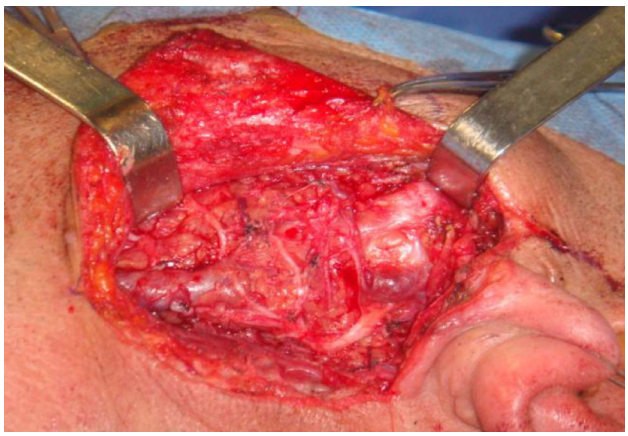

Fig. 3 Group C: total section of the GAN

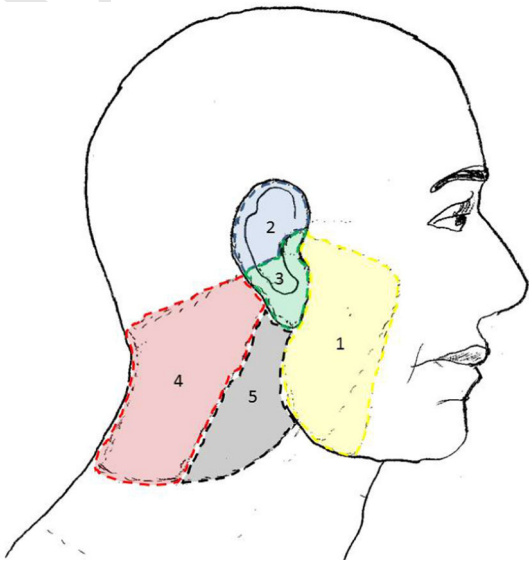

Fig. 4 Schematic representation of the tested areas

area and grade 100 indicated no difference in sensation of the area compared with the contro-lateral corresponding one.

Statistical analysis

Subject characteristics were summarized by mean and standard deviation (SD) for continuous variables and by percentage for categorical variables. Statistical analysis was performed using Chi-square test, *t* test, one-way ANOVA and post hoc comparisons. Statistical significance was accepted at a value of $p < 0.05$. All statistical analyses were performed with SPSS version 13 (SPSS Inc., Chicago, IL, USA).

Results

The study population consisted of 60 subjects, 29 male (48.3 %) and 31 female (51.7 %). Patient's age ranging

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Table 1 Distribution (mean ± SD) of VAS scores in groups A, B and C stratified by area and period of observation

	Group A	Group B	Group C
Area 1			
Pre-operative	98.5 ± 3.2	99.5 ± 1.5	99.2 ± 2.4
1 week*	73.5 ± 8.5	82.2 ± 6.3	78.2 ± 4.6
1 month*,+	79.5 ± 6.6	86.2 ± 5.3	84.0 ± 3.0
6 months*,§	87.5 ± 4.1	93.0 ± 3.4	88.5 ± 2.8
12 months§	94.2 ± 4.6	97.2 ± 2.5	92.2 ± 4.7
Area 2			
Pre-operative	99.5 ± 2.2	98.7 ± 3.1	99.2 ± 2.4
1 week	78.5 ± 6.5	76.5 ± 6.5	81.0 ± 5.7
1 month*,+	87.0 ± 5.7	81.5 ± 5.4	82.7 ± 4.9
6 months+,§	90.7 ± 3.7	90.2 ± 4.7	84.0 ± 4.7
12 months+,§	96.7 ± 2.9	95.0 ± 3.2	90.5 ± 3.9
Area 3			
Pre-operative	100.0 ± 0	100.0 ± 0	99.7 ± 1.1
1 week*	40.0 ± 9.4	49.2 ± 7.1	42.5 ± 10.3
1 month*,§	43.5 ± 9.4	62.0 ± 4.1	44.5 ± 8.5
6 months*,§	48.0 ± 7.8	77.5 ± 3.0	45.2 ± 7.6
12 months*,+,§	51.2 ± 6.8	90.0 ± 4.2	45.2 ± 7.6
Area 4			
Pre-operative	99.7 ± 1.1	99.2 ± 2.4	100.0 ± 0
1 week*,+,§	74.0 ± 6.8	63.0 ± 9.6	50.0 ± 7.2
1 month+,§	82.5 ± 4.1	79.7 ± 5.9	51.5 ± 6.3
6 months+,§	87.7 ± 4.1	86.7 ± 3.7	51.7 ± 6.1
12 months+,§	95.0 ± 3.9	92.7 ± 3.0	57.0 ± 4.7
Area 5			
Pre-operative	100.0 ± 0	99.5 ± 1.5	99.7 ± 1.1
1 week	53.0 ± 9.7	50.2 ± 8.6	49.5 ± 7.2
1 month+,§	65.7 ± 6.9	69.5 ± 5.3	51.7 ± 5.6
6 months+,§	79.7 ± 4.7	82.5 ± 4.1	57.5 ± 4.7
12 months+,§	87.7 ± 4.1	90.7 ± 4.0	69.7 ± 4.7

* There is significant difference among group A and group B

\+ There is significant difference among group A and group C

§ There is significant difference among group B and group C

from 39 to 88 years, (mean age 63.2 ± 10.6). There was no significant difference among three groups in sex ($p = 0.63$) and age ($p = 0.82$) distribution.

No significant differences between groups in pre-operative tests results for each area (area 1, $p = 0.43$; area 2, $p = 0.66$; area 3, $p = 0.37$; area 4, $p = 0.30$; area 5, $p = 0.36$) were recorded.

Significant difference between the groups in tests performed after surgery were recorded as summarized in Table 1.

Briefly for area 1 (pre-auricular) and area 4 (post-auricular) in group A the degree of recovery is similar (94.2 vs 95.0); in group B, area 1 resulted to show better sensitivity recovery and in group C it is similar to area 2 that is the region with better recovery. In area 2 (supero-auricular) in group B, this area presented a minor loss at 1 week after surgery when compared to the other areas (area 3 = −50.7; area 4 = −36.2; area 5 = −49.2 vs area 2 = −22.2); furthermore, it presented a very good recovery at 12th month. In group C, unexpectedly area 2 presented only a small sensory loss (−18.2) that was inferior than that of other two groups (group A = −21.0; group B = −22.2), on the other hand recovery at 1-year was suboptimal but lower than group A and group B. The tests in area 3 (ear lobule) showed that the patients with the lobular branch preserved (group B) recovered more quickly and almost to normal level than those ones without (group A and C). In fact, subjects in group A only had a partial recovery of sensitivity in area 3 (VAS score = 51.2) and so they complained of mild discomfort, while subjects in Group C complained of an important numbness (VAS score = 45.2). Regarding area 5 hyper/disestesia was almost the same as area 3 in group B (VAS score = 90.7) but significantly higher in group A (VAS score = 87.7). The group C recovered poorly (VAS score = 69.7) as shown by the differences with the other two groups both statistically significant (Fig. 5). GAN preservation combined with a certain technique of operation?

Standard parotidectomy through traditional or "face-lift" incision was uniformly performed in our patients. We did not evaluate the impact of incision type on greater auricular nerve function outcome; anyway we did not find literature data pointing out such a correlation.

Discussion

During a standard parotidectomy it is necessary to cut the posterior branch of GAN to obtain an adequate clearance of lower pole of parotid gland. The side effects of GAN sacrifice is hypoesthesia in the area of skin supplied by this nerve, with subsequent discomfort when wearing earrings, pain and dysesthesia. In the mid-eighties, many Authors suggested to preserve the posterior branch of the GAN if the tumor did not involve the proximity of the nerve to avoid these complications. In 1989, Brown and Ord [7] were the first who gave data in favor of preservation of posterior branch. In Christensen and Jacobsen's [8] opinion the posterior branch could be preserved in 71 % of patients, because it protracts the operating time of only about ten minutes and it also gives the possibility to have a graft to repair facial nerve injury during surgery. On the contrary, Porter and Wood [9] did not support GAN preservation: until one or two years, generally, there is a partial sensory recovery, which is related to neuronal regeneration coming from auriculo-temporal nerve, mandibular branch of trigeminal nerve, lesser

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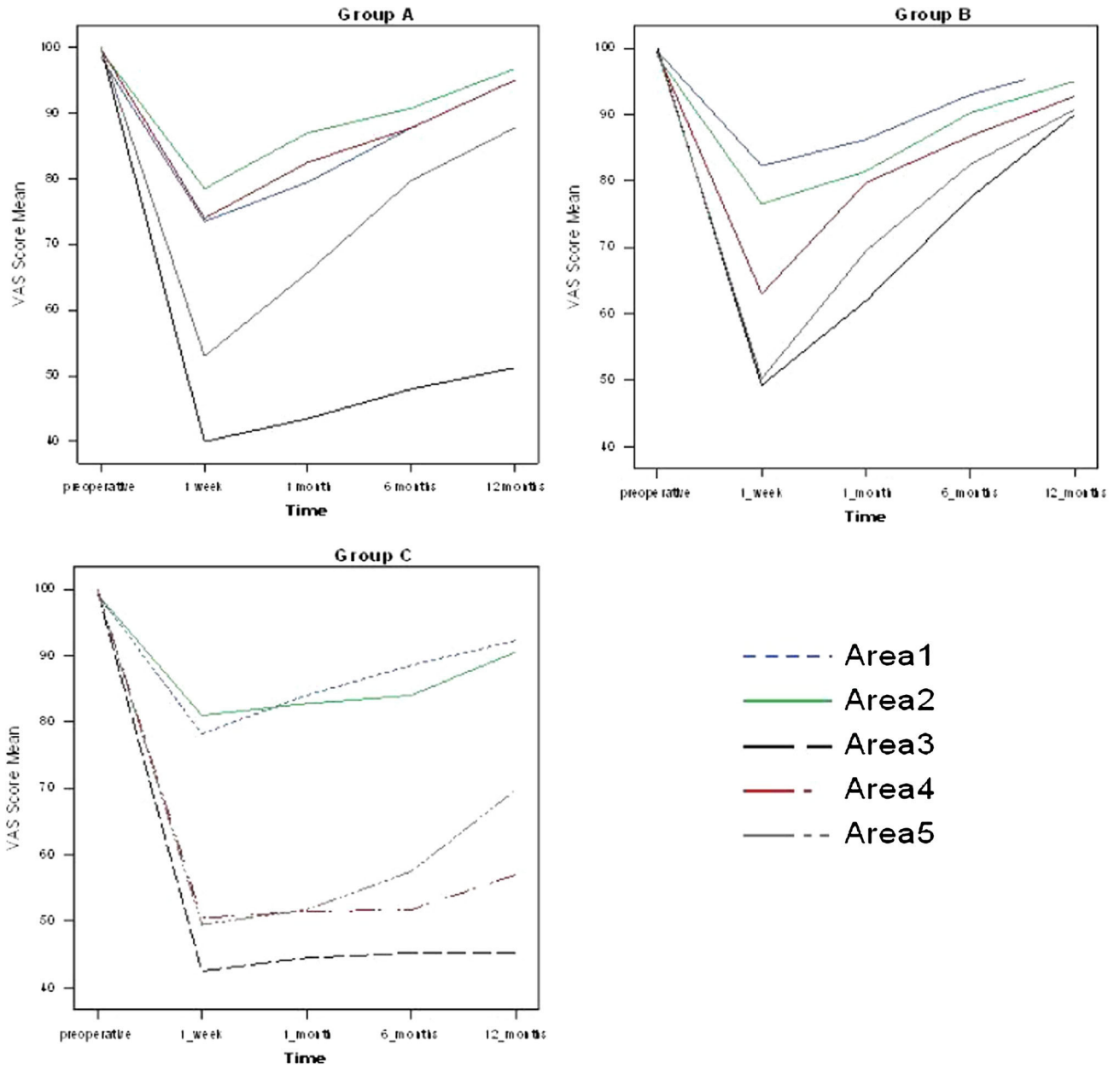

Fig. 5 Results: graphical representation

occipital nerve or from transverse cutaneous nerve of the neck.

In this study, the preservation of posterior and lobular branches of GAN was technically feasible when they did not go to the parotid lesion. We did not take into account the preservation of the anterior branch of GAN because generally during skin flap elevation it is necessary to divide the anterior branch. In spite of that, we reported that sensitivity in the pre-auricular region (area 1) recovered almost to the normal level in each group between 6 months and 1-year, postoperatively. In fact, as reported in Table 1, this is probably due to the presence of collateral innervation from the mandibular branch of the trigeminal nerve and to the presence of an accessory anterior branch that splits up before going into the parotid gland [2, 3].

We obtained excellent results in every group also for the superior auricle area (area 2).

The greatest sensory loss occurred in the ear lobule (area 3), followed by the infra-auricular region (area 5) and the posterior auricular region (area 4), according to Literature data [1]. The results in area 4 showed a sensory recovery almost to normal level in group A and B and a partial sensory recovery in group C, in which GAN was totally sacrificed. Several mechanisms have been reported to

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explain this recovery: regeneration of nerve fibers, collateral innervation by the lesser occipital nerve.

We noted that in terms of loss of sensitivity in the immediate postoperative period, area 5 is second only to area 3 (Table 1). Nevertheless, the recovery at 12 months was better when compared to that of area 3.

Some attention must be addressed to the fact that the extensive preparation on very small nerves and consecutive scar formation can lead to dysfunction. Possible unfavorable issues are the anatomical variability of the GAN that is considerable and outlined in the introduction section and the scarring process: both are unpredictable and possibly influencing factors of the final recovery. Based on our experience no significant variation of the functional recovery time linked to anatomy and scarring is expected: recovery time is always shorter when sparing the GA nerve than after section of it [10].

Quality of life was not evaluated by specific questionnaires in the present paper, this is a very controversial topic, a recent review on the matter reports: "There is level Ib evidence that preservation of the greater auricular nerve minimizes the postoperative sensory disturbance and should be considered whenever tumor clearance is not compromised" [11].

Conclusions

Our results show that preservation of the posterior and lobular branches of GAN (defined as group B in our study) warrants the best results in terms of loss and recovery of sensitivity after 1 year post-surgery, followed closely by preservation of the posterior branches (group A). Total section of GAN (group C) leads to the worst outcome in terms of residual sensitivity in the long-term.

Based on our data saving as many branches of the GAN as possible seems to be very useful for maintaining a good sensitive function in the auricular area in parotidectomy patients.

The ear lobule sensitivity it is definitely more important in female patients: it is commonly felt that females (mainly younger ones) are more sensitive to facial scars due to aesthetical concerns; moreover, the ear lobule sensitivity seems even more important to be maintained for the common use of earrings in such patients. Regarding the ear lobule (area 3) results clarifications have to be made the lobule presents the worst clinical outcome; in fact it represents the area with the highest loss and the lowest recovery, in spite of posterior and lobular branches preservation (group B).

It seems therefore necessary to inform the patient that even if the lobular branch were saved, a certain discomfort or a certain alteration of sensitivity, limited to ear lobe, could be present. Nevertheless, neural preservation gives a better tactile sensitivity also in the lobule.

Finally, it must be underlined that the best candidates for GAN preservation are patients with benign tumors not involving the nerve.

In conclusion, the real long-term effects of GAN sparing vs its sacrifice have been highlighted and the rationale for the surgeon to apply this procedure given. The functional results that may be reasonably expected in order of sensitivity preservation of the auricular region are shown. It seems then that the maximal GAN preservation, when feasible, may offer a better quality of life after surgery to the patient.

Conflict of interest Antonio Moretti and co-authors have no conflicts of interest to declare.

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