

Research Paper

New Anatomical Findings to Identify the Facial Nerve in Parotid Surgery



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Citation Nemati Sh, Akbari M, Okhovvat A, Zia-Ziabari S, Mashayakhi N, Yaghoubi-Hamgini M, et al. New Anatomical Findings to Identify the Facial Nerve in Parotid Surgery. *Iran J Neurosurg*. 2026; 12:E9. <http://dx.doi.org/10.32598/irjns.12.9>

doi <http://dx.doi.org/10.32598/irjns.12.9>

Article info:

Received: 21 Oct 2025

Accepted: 14 Feb 2026

Available Online: 28 Mar 2026

ABSTRACT

Background and Aim: Facial nerve injury during parotid surgery is a feared complication that can result in facial paralysis with serious implications for the patient's quality of life (QoL). Recognition of the key landmarks of the facial nerve trunk in the parotid gland is required for safe surgery. This study aimed to investigate two new anatomical findings in parotid surgery reported at a university hospital in Rasht and Isfahan, Iran.

Methods and Materials/Patients: This cross-sectional study included 93 patients who underwent parotidectomy surgery. Our study evaluated the frequency of tail and vascular signs in parotid surgery as two new anatomical findings. Statistical analyses were performed using SPSS software, version 19 (Kolmogorov-Smirnov test, independent t-test, Mann-Whitney U test). The level of significance was set at $P < 0.05$.

Results: Ninety-three patients were enrolled in this study, with an average age of 49.48 years, of whom 48(51.7%) were men and 45(48.3%) were women. Of the 93 patients in the study, vascular signs were observed in 70(75.2%) and tail signs were observed in 60(64.5%) patients. Both signs were present in 55 cases (59.1%). McNemar's test showed a significant difference between the presence of vascular and tail signs. The diameter of the facial nerve was 2.612 ± 0.4341 mm, and the diameter of the greater auricular nerve was 2.654 ± 0.4345 mm.

Conclusion: Given the relatively high prevalence of these two anatomical findings and the importance of preserving the facial nerve during parotid surgery, using markers and landmarks in the surgical field will greatly aid in locating and preserving it. Further studies are needed to investigate the extent of these two anatomical findings and their importance in locating and preserving the facial nerve.

Keywords:

Facial nerve trunk, Facial nerve paralysis, Landmarks, Parotid surgery, Parotidectomy

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Highlights

- Vascular and tail signs were observed in many patients undergoing parotid surgery.
- Vascular and tail signs may serve as useful landmarks in parotid surgery.
- These signs may help surgeons identify and preserve the facial nerve.
- Future studies should compare these signs with landmarks and assess racial differences.

Plain Language Summary

Salivary glands may become massed. The preferred treatment for most parotid tumors is surgical removal (parotidectomy). Injury to the seventh cranial nerve (facial nerve) during parotid surgery is a frightening complication and can lead to facial paralysis with serious consequences for the patient's quality of life. A key point in parotid surgery is the identification of the main trunk of the facial nerve and its branches. This becomes even more challenging when mass lesions divert their course. Identification of key landmarks of the facial nerve trunk in the parotid gland is essential for safe surgery. In this article, we report two new anatomical findings in patients from two hospitals in Isfahan and Rasht who underwent parotid surgery that may be helpful in identifying this nerve, which are the tail sign and the vascular sign. Of the 93 patients studied, vascular signs were observed in 70 cases (75.2%) and tail signs in 60 cases (64.5%). Fifty-five cases (59.1%) had both signs simultaneously. In the present study, vascular and caudal signs were observed in a relatively large number of patients. Considering the importance of preserving the facial nerve in parotid surgery, the use of markers and landmarks in the surgical field will greatly help in finding and preserving it.

1. Introduction

The parotid gland is the largest of the major salivary glands and is located deep in the skin and subcutaneous tissues in the preauricular region [1]. Salivary glands comprise an enormous spectrum of non-neoplastic (infections, autoimmune, inflammatory) and neoplastic disorders (benign and malignant). Salivary gland tumors are divided into malignant and benign tumors [2]. The most common location of salivary gland tumors is the parotid gland (70%), followed by the submandibular gland, the minor salivary glands, and the sublingual gland [3].

The preferred treatment for most parotid tumors is surgical excision (i.e. parotidectomy). Facial nerve (CNVII, the seventh cranial nerve) injury during parotid surgery is a feared complication and can result in facial paralysis with serious implications for the patient's quality of life [4]. The facial nerve courses through the body of the parotid gland, creating a unique relationship that, requires focused attention during parotidectomy or other surgery in the region [5]. According to previous studies, 14–64% and 0–9% of patients report permanent facial nerve weakness following parotidectomy [6]. A key point in parotid surgery is the recognition of the

facial nerve main trunk and its branches. This becomes more challenging when mass lesions distort their course. These lesions are mostly benign, and involve the superficial lobe. Therefore, there is always a practical chance of post-operative facial paresis during superficial or partial superficial parotidectomy. Branches of the lower trunk, such as the marginal mandibular, are more susceptible to injury [7]. The incision is feasible only if the surgeon identifies the facial nerve and moves along its branches [8]. Recognizing the key landmarks of the facial nerve trunk in the parotid gland is required for safe surgery [9]. Janes [10] described the exposure of the main trunk at its origin for the first time. Since then, various surgical landmarks have been described to identify the facial nerve. These include the stylomastoid foramen, stylomastoid artery, tympanomastoid suture, posterior belly of the digastric muscle, tragal pointer, retromandibular vein, transverse process of the atlas, styloid process, mastoid process, and external auditory canal. Using several landmarks to identify the facial nerve reveals a lack of consensus regarding the safety and reliability of each landmarks [11].

We examined two new anatomical findings in parotid surgery, the tail sign and vascular sign. Based on our experience and practice during numerous parotidectomy surgeries, we observed that a part of the superficial lobe

of the parotid gland, just before the place where the facial nerve trunk enters it, has spread back on the facial nerve trunk as a tail-like appendage, which we termed "tail sign". Also, we encountered a fine vascular plexus just superficial to the facial nerve in nearly every cases of parotidectomy, and we named this the "vascular sign".

Due to the stressful conditions of surgery, the risk of facial nerve injury, the complications of paralysis, and the impact on the patient's quality of life, along with limited evidence from a small number of previous studies, this research investigated two new anatomical findings in parotid surgery.

2. Methods and Materials

Study design and participants

This cross-sectional study included 43 patients at Al-Zahra (Isfahan) Hospital and 50 patients at Amir-Almomenin (Rasht City, Iran) Hospital in 2013-2015 who underwent parotidectomy. Patients with a previous history of parotid surgery were excluded due to site manipulation and the possibility of altered nerve anatomy, and the inability to evaluate the nerve. Informed written consent was obtained from all patients participating in this study.

Data collection

An anatomical graph was provided after incisions at the parotid site, showing the facial nerve, tail sign, greater auricular nerve, and vascular sign. We aimed to demonstrate these landmarks in patients. Our study evaluates the tail sign and vascular sign in parotid surgery as two new landmarks. The ratio of the diameter of the facial nerve to the greater auricular nerve was detected. The diameter of the greater auricular nerve trunk was measured with a compass with a precision of 0.5 mm after the incision of the platysma muscle in the vicinity of Erb's point, and other landmarks, such as the tail and vascular signs, were recorded after finding the facial nerve.

Statistical analysis

Data were entered into IBM SPSS software, version 19 and analyzed. Quantitative variables, including facial nerve diameter, trunk diameter of the greater auricular nerve, and ratio of facial nerve diameter to trunk diameter of the greater auricular nerve, were expressed as Mean $\pm$ SD. Qualitative variables, such as presence or absence of tail sign and vascular sign, were reported

as frequency and percentage. The normality of the distribution of quantitative data was assessed using the Kolmogorov-Smirnov test. Also, an independent t-test was used for normally distributed data, and the Mann-Whitney U test was used for non-normally distributed data. $P<0.05$ was considered statistically significant.

3. Results

Ninety-three patients were enrolled in this study with an average age of 49.48 ± 11.26 , of which 48(51.6%) were men and 45(48.4%) were women. Body mass index (BMI) was evaluated in both quantitative and qualitative terms. Quantitatively, the average BMI was 25.87 ± 3.96 ; qualitatively, 43(46.2%) had normal weight, 33(35.4%) were overweight, 8(8.6%) had obesity, and 9(9.7%) were thin.

In 93 cases with parotidectomy surgery, 59(63.4%) cases had tumors on their right side, whereas 34(36.6%) had tumors on their left side. In 73(78.5%) cases, tumor sites were the superficial lobes of the parotid gland and in 20(21.5%) cases, the deep lobes (Table 1). Facial nerve involvement was observed in three cases.

Of the 93 patients in the study, vascular signs were observed in 70 cases (75.2%), and tail signs were observed in 60 cases (64.5%). Fifty-five cases (59.1%) had both signs simultaneously. McNemar's test showed a significant difference between the presence of vascular signs and tail signs ($P=0.004$). The relationship between the tail and vascular signs and the largest length of the operated masses was not statistically significant by the Mann-Whitney U test and Kruskal-Wallis test ($P>0.05$). Tumor size did not affect the presence or absence of these two anatomical findings. Tail and vascular signs frequency were similar in both sexes ($P=0.52$ and $P=0.15$, respectively). The frequency of both signs was not influenced by tumor size in histological samples from the tail sign, and no histological differences were observed with another part of the parotid gland.

The diameter of the facial nerve was 2.61 ± 0.66 mm; range: 1.7-5 mm. The diameter of the greater auricular nerve was 2.54 ± 0.77 mm; range: 1-5 mm. By paired t-test, no significant difference was observed between the diameter of the facial and greater auricular nerves. No significant differences in sex or, tumor side were observed between the two groups with and without tail and vascular signs using the independent t-test (Table 2).

Table 1. Demographic information in patients (n=93)

Variables		No. (%) / Mean $\pm$ SD
Sex	Male	48(51.7)
	Female	45(48.3)
Age (y)		49.48 $\pm$ 11.26
BMI (kg/m ²)		25.87 $\pm$ 3.96
Tumor side	Right	59(63.4)
	Left	34(36.6)
Tumor site	Superficial	73(78.5)
	Deep	20(21.5)

4. Discussion

Parotid surgery still has a high risk of facial nerve paralysis. The risk of temporary facial paralysis is between 10% and -50%, and 0.5% for permanent facial paralysis. While the injuries associated with the facial nerve are still at these rates, the main purpose of parotid surgery is to remove the tumor safely without nerve injury [12]. During surgery, surgeons rely on certain anatomical landmarks to identify the location of vital structures [5]. Good landmarks should be easy to identify and, palpate, and remain in a relatively constant position throughout surgery, allowing safe and rapid identification of anatomical structures [13]. In our study, we focused on two of these landmarks, called the “tail and vascular sign”. A university pathologist examined studies related to the histology of the tail sign region and observed, an average of 25% serous acini, 15% collecting ducts, and 15% fat tissue in the prepared slides. Generally, there was no difference between

the mentioned area and other parts of the parotid. This sign is a part of the parotid tissue, similar to the Zuckerkandl tubercle in the thyroid. The posterolateral lobe of the thyroid gland, which is located caudal to Berry's ligament, is called the Zuckerkandl tubercle. This tubercle crucial and reliable landmark for the recurrent laryngeal nerve during thyroid surgery [14, 15].

In our study, the average diameter of the facial nerve trunk was 2.61 mm. Pereira et al. [16] calculated the average diameter of the facial nerve trunk to be 1.42 mm. Seventy-nine cadavers were investigated by making a three-centimeter incision in the lower center of the triangle, between the temporomandibular joint, and the angle of the mandible and the mastoid process, and going so deep to reach the trunk of the facial nerve. Perhaps this difference is related to the fact that the measurement of the diameter of the nerve trunk in our study was performed on patients, whereas they calculated it in cadavers.

Table 2. Frequencies of vascular sign and tail sign based on sex and tumor side

Variables		No. (%)		P	No. (%)		P
		Sex			Tumor Side		
		Male	Female		Right	Left	
Vascular sign	Positive	37(52.8)	33(47.2)	0.151	40 (67.8)	16(47.1)	0.009
	Negative	11(47.2)	12(52.8)		19(32.2)	18(52.9)	
Tail sign	Positive	34(56.6)	26(43.4)	0.526	38(64.4)	19(55.9)	0.602
	Negative	14(42.4)	17(56.6)		21(35.6)	15(44.1)	
Vascular and tail sign	Positive	29(52.7)	26(47.3)	0.142	-	-	-
	Negative	19(47.3)	17(52.7)		-	-	

This study showed no significant difference or fixed ratio between the average diameter of the trunk of the face and the greater auricular nerve. Okhovvat et al. [9] reported on a subset of (43 patients) who underwent parotid surgery in Al-Zahra and Kashani hospitals in 2017. They found a similar ratio among the facial and greater auricular nerves, and 76.7% of cases had differences less than 0.5 mm. This reveals that grafting of the greater auricular nerve is a substitution for the facial nerve. They also indicated that “vascular sign” can be used as a good indicator of the facial nerve.

A significant inverse relationship was observed between the average diameter of the trunks of the facial and greater auricular nerves and patients’ age. This means that with increasing age, the diameter of the nerve trunk decreases. A stronger relationship was observed between the facial nerve and age, but the correlation between the ratios of these two with age is not significant. Also, no significant relationship was observed between the average diameter of the trunk of the facial nerve and the greater auricular nerve and weight. However, the correlation of the height of the researched samples with the diameter of the facial and greater auricular nerve was marginally significant. Our study showed that the mass size did not affect the indicators of our study (including, the diameter of the trunk of the face, diameter of the trunk of the greater auricular nerve, vascular sign, and tail sign). Upile et al. [17] prospectively observed 100 consecutive routine parotidectomies, noting the presence and variations of the stylomastoid artery. The stylomastoid artery is similar to the “vascular sign” in our study. They identified the stylomastoid artery as a supplying vessel. This vessel, when supplemented by the other more commonly known anatomical landmarks and intra-operative facial nerve monitoring, further reduces the risk of iatrogenic facial nerve damage and operative time.

Akil et al. (2021) studied 30 patients. They proposed the tragomastoid groove as a landmark in parotid surgery. The mean distance of the tragomastoid groove to the facial nerve trunk, the mean depth of the tragomastoid groove, and the mean superficial part of the tragomastoid groove were measured [12].

In a study by Liu et al. [4], the lateral aspect of the face and neck was exposed in five cadaveric heads (10 sides). The relationship between the posterior auricular artery (PAA) and the facial nerve was studied and recorded, and descriptive measurements were taken. They demonstrated that the PAA could be used as a landmark for facial nerve identification.

5. Conclusion

In the present study, vascular and tail signs were observed in a relatively large number of patients. Considering the importance of preserving the facial nerve in parotid surgery, using markers and landmarks in the surgical field will greatly help in finding and preserving it. Further studies are needed to investigate the extent of these two anatomical findings and their importance in finding and preserving the facial nerve, determine the complications of parotidectomy, and compare the results of tail and vascular signs with current landmarks. Also, future studies should consider other parameters, such as race.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of [Guilan University of Medical Sciences](#), Rasht, Iran and adhered to the tenets of the World Medical Association Declaration of Helsinki. A part of this study (43 cases in [Al-Zahra Hospital](#) (Isfahan) was reported in the Iranian Journal of Neurosurgery.

Funding

This study was extracted from the general medical doctorate thesis of Seyyed-Mostafa Zia-Ziabari, approved by the School of Medicine, [Guilan University of Medical Sciences](#), Rasht, Iran (Thesis No.: 1394.1747).

Authors' contributions

Conceptualization, study design, data analysis and interpretation: Shadman Nemati and Ahmadreza Okhovvat; Data collection: Shadman Nemati, Ahmadreza Okhovvat, Rouhollah Gazor, Seyyed-Mostafa Zia-Ziabari, Nasim Mashayakhi, Hooshang Gerami, Maryam Yaghoubi-Hamgini, Mostafa Hashemi, Hamidreza Abtahi; writing the original draft: Maryam Akbari; Review and editing: Shadman Nemati; Final approval: All authors.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgements

The authors thank the staff of [Amir Almomenin](#) (Rasht City), [Al-Zahra](#) (Isfahan City) hospitals, Iran, and patients for their cooperation during this study.

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