RESEARCH PAPER

Changes in Retromandibular Vein-Skin Distance Depending on Tumor Size and Volume in Benign Superficial Parotid Salivary Gland Tumors: A Magnetic Resonance Imaging-Based Evaluation

Op. Dr. Semih Ak[1]

[1]Bahçeşehir Cyprus University, Faculty of Health Sciences; Şanlıurfa Private MetroLife Hospital, Department of Otolaryngology

ABSTRACT

Background

Benign tumors of the superficial parotid gland can alter normal glandular anatomy because of progressive mass effect. Although the facial nerve is not directly visible on routine magnetic resonance imaging (MRI), the retromandibular vein (RMV) is commonly used as an indirect anatomical landmark during preoperative assessment. Tumor enlargement may displace the RMV and indirectly indicate changes in facial nerve position, potentially influencing surgical planning and nerve preservation.

Objective

This study aimed to evaluate the relationship between tumor size, tumor volume, and RMV–skin distance in patients with benign superficial parotid gland tumors and to determine whether these changes may indirectly predict facial nerve displacement.

Methods

A retrospective study was conducted in 56 patients who underwent superficial parotidectomy for benign superficial parotid gland tumors. MRI was used to measure tumor dimensions, including anteroposterior (AP), transverse, and craniocaudal (CC) diameters. Tumor volume was calculated using the formula AP × transverse × CC × 0.52. RMV–skin distance on the tumor side was compared with the contralateral tumor-free side. Correlation analyses and paired-sample t-tests were performed, with $p < 0.05$ considered statistically significant.

Results

The mean RMV–skin distance was significantly greater on the tumor side than on the tumor-free side (25.88 mm vs. 18.29 mm, $p < 0.001$). Significant positive correlations were observed between RMV–skin distance and AP diameter ($r = 0.537$), transverse diameter ($r = 0.644$), CC diameter ($r = 0.622$), and tumor volume ($r = 0.629$) (all $p < 0.001$). Larger tumors were associated with deeper and medial displacement of the RMV. No intraoperative evidence of facial nerve invasion was observed.

Conclusion

MRI-based RMV–skin distance measurement is a reproducible indicator of anatomical distortion in benign superficial parotid tumors and may assist surgeons in predicting facial nerve location and improving surgical safety.

Keywords: Parotid gland; benign tumor; retromandibular vein; facial nerve; MRI; tumor volume; superficial parotidectomy.

How to cite this article: Ak S. Changes in Retromandibular Vein-Skin Distance Depending on Tumor Size and Volume in Benign Superficial Parotid Salivary Gland Tumors: A Magnetic Resonance Imaging-Based Evaluation. Int J Drug Deliv Technol. 2026;16(55s): 761-768. DOI: 10.25258/ijddt.16.55s.76

Source of support: Nil.

Conflict of interest: None

.

Introduction

The management of benign tumors of the parotid glands is mainly through surgery in which the key aims are complete removal of the tumors and maintenance of facial nerve (Som et al., 2000). The facial nerve passes through the parotid gland and forms the foundation of a surgical division between superficial and deep lobes though there is no real division between them (de Ru et al., 2007). The deep lobe is medial to the facial nerve and the superficial lobe is lateral to it, a distinction some thirty years of surgery and risk analysis have shown to be basic in the planning of the operation and the evaluation of risks.

About 80% of tumors of the salivary glands develop in the parotid gland, and almost 75-80% of them are benign (Gritzmann et al., 2003; StatPearls, 2023). The majority of the benign parotid tumors arise in the superficial lobe and this makes them much more susceptible to surgical resection with a relatively low likelihood of facial nerve damage (Som et al., 2000). In spite of this, facial nerve dysfunction is the greatest complication post-parotidectomy, where temporary weakness has been reported in 526% of benign cases and permanent paralysis is less common (Chiesa-Estomba et al., 2024; Mortensen et al., 2024).

A number of tumor variables have been reported to affect the results of postoperative facial nerves. The greater size of tumors, deep lobe location, malignant histories, and the revision surgery are always linked to higher occurrence rates of facial nerve palsy (Otanez et al., 2024; Moussa et al., 2021). Specifically, tumors that are larger than 3–5 cm in diameter have a higher likelihood to alter the normal parotid structure, contributing to more complexity in the surgery and higher risks of nerve damage (Crawley et al., 2019). The findings indicate the significance of proper preoperative evaluation of tumor properties.

In order to contain the risk associated with nerve injury, intraoperative facial nerve monitoring is commonly used to aid in nerve location and nerve preservation. Even though monitoring has demonstrated to decrease the rate of permanent facial nerve injury, it does not exclude the risk and cannot replace the comprehensive knowledge of the anatomy and painstaking surgical practice (Chiesa-Estomba et al., 2024). As a result, extensive preoperative imaging is an important role in surgical planning.

The facial nerve is not clearly observable on standard computed tomography (CT) or magnetic resonance imaging (MRI) due to its diminutive size and the surrounding glandular tissue (Crawley et al., 2019). This has resulted in many radiological markers being suggested to estimate the location of the facial nerve inside the parotid gland, including the facial nerve line, Utrecht line, Conn arc, Stensen duct, and retromandibular vein (RMV) (de Ru et al., 2007; Head & Face Medicine Study Group, 2016).

One of these landmarks is the RMV, which is the most commonly used due to its easy recognition on CT as well as MRI and is usually located in between the facial nerve trunk (Som et al., 2000; Crawley et al., 2019). Nevertheless, the accuracy of the RMV and other fixed anatomical lines of reference diminishes with tumor size, as both neural and vascular organs in the tumor may be moved out of their predicted locations (Indian Journal of Otolaryngology Study Group, 2023; Systematic Review Group, 2022).

The magnetic resonance imaging is the modality of choice when assessing tumors of the parotid glands preoperatively because of its ability to produce superior contrast of the soft tissues, multiplanar mode, and lack of ionizing radiations. MRI allows performing an in-depth examination of tumor margins, tumor features, and the relationship with the surrounding structures (Som et al., 2000; Crawley et al., 2019). Volumetric measurement of parotid tumors has recently been in the spotlight, with tumor volume potentially being a better measure of tumor burden than maximal diameter in irregularly shaped lesions.

Bienign parotid tumours increase in size and hence cause a mass effect on the tissues around it, which may change the location of the facial nerve as well as its surrogate anatomical landmarks. Earlier research has concentrated mainly on how to predict deep lobe involvement or qualify tumors against the facial nerve by using qualitative or binary criteria of imaging (de Ru et al., 2007; Systematic Review Group, 2022). Nevertheless, these methods might be insufficient to record any anatomical changes that occur due to the gradual tumor growth.

Parameters of quantitative imaging, then, might be a more objective measure of anatomical distortion caused by tumor. RMV skin distance is a parameter which is measurable and reproducible and can be easily obtained on routine MRI sequences. Changes in this distance can be a manifestation of the medial movement of the RMV secondary to the growth of the tumor and especially in benign tumors that are located more superficially. This could help to improve the accuracy of the RMV as a surgical landmark and to enhance the risk stratification in pre-operative risk.

Based on this, the proposed study is expected to examine how tumor size and volume influence the RMV-skin distance with MRI among patients with benign tumors of the parotid gland (superficial tumors) with an aim of enhancing the preoperative examination and facilitating the safe planning of surgery. The present study offers quantitative imaging evidence on the systematic changes in deep parotid anatomy with the growth of the tumor size and volume, which can serve as a reliable model for further studies to correlate radiological and intraoperative results on the displacement of the deep parotidia.

Methodology

Study Design

The study is a retrospective, observational one, which was carried out at the Department of Otolaryngology-Head and Neck Surgery, XXX University, April 1, 2021, and April 1, 2023.

Study Population

The inclusion was of 56 patients with benign tumors in the parotid gland that were localized to the superficial lobe. Every patient had undergone superficial parotidectomy which was preceded by the fine-needle aspiration cytology (FNAC) which reported benign. All cases were diagnosed as benign histopathology postoperatively.

Inclusion and Exclusion Criteria.

Inclusion criteria were:

- Benign parotid gland tumors
- Localization to the superficial lobe
- Tumor at the back of the neck, in the vicinity of the retrieval mandible vein.
- Preoperative MRI availability within the one month preoperative phase.

Exclusion criteria were:

- Extensive tumours into the deep lobe.
- Revision parotid surgery
- FNAC malignant or suspicious.
- Inadequate imaging quality

Ethical Approval

The approval of the Ethics Committee was received at the XXX University Medical Faculty before starting the study (April 19, 2023; the decision number: 2023-08).

Magnetic Resonance Imaging Protocol

All MRI studies were conducted on our site on a 1.5-T Philips Ingenia MR system (Philips Healthcare, Netherlands) that had a 16-channel head coil. MRI tests were done within a month before an operation. A universal maxillofacial imaging protocol was implemented and then gadobutrol (1.0 mmol/mL) was applied intravenously as a contrast agent.

To conduct the measurements required in this study, the axial turbo spin-echo T2-weighted images were used and the following parameters were listed: repetition time/echo time, 5,442/100 ms; field of view, 200 x 195 x 161 mm; matrix size, 336 x 247; flip angle, 20; slice thickness, 4 mm; interslice spacing, 1 mm.

Image Measurements and Analysis

The MRI data were sent to the Picture Archiving and Communication System (PACS) and evaluated at a specialized workstation (HP Z4 Workstation) using GE AW Volume Share 7, hereafter referred to as software (GE Healthcare, Chicago, IL, USA). The evaluation and quantification of pictures were conducted without knowledge of clinical data or surgical results. All interpretations and assessments were conducted by a board-certified and seasoned radiologist.

Tumor studied in this research were located lateral to the retromandibular vein (RMV). The computerized assessment of tumor dimensions was conducted in three orthogonal planes: anteroposterior (AP), transverse, and craniocaudal (CC) inside axial MRI sections. The ellipsoid formula (AP × transversal × CC × 0.52) was used to calculate tumor volume, expressed in cubic millimeters (mm^3). The electronic measurement of the distance between the skin and the RMV on the axial sections of both the tumor-bearing side and the contralateral tumor-free side was then conducted (Figures 1-5). Results were obtained based on the malignant side and the normal side. Correlations were performed among skinRMV distance, maximal tumor diameter, and tumor volume.

Statistical Analysis

Continuous variables were characterized by their means, standard deviations, medians, minima, and maxima. The Shapiro-Wilk test was used to assess data normality. The paired-sample t-test was used to evaluate the disparity in skin-RMV distance between the tumor and contralateral sides. The Pearson correlation was used to examine the association between skin-RMV distance on the tumor side and both tumor diameter and tumor volume.

The statistical analysis was conducted using IBM SPSS Statistics for Windows version 20 (IBM Corp., Chicago, IL, USA). A p-value below 0.05 was considered significant.

Results

Demographics and Clinical Characteristics of the Patient

Intraoperative data proved that all tumors were limited to the superficial lobe of parotid gland in all 56 patients, as it had been proved by preoperative imaging tests. The sample population included 34 male patients (60.7) and 22 female patients (39.3), which proved to have male dominance. The age of the patients was 27-65 years with a mean age of 45.83 -11.15, which implies that benign superficial parotid tumor mostly affected the middle aged adults in this group.

Speaking of laterality, the lesions of parotid glands were found to be a little more on the right 30 (53.6%) and 26 (46.4) on the left, respectively shown in fig 1. No bilateral tumors were pointed out.

The preoperative imaging is mainly applied to determine the extent of the tumor, depth, and proximity to the surrounding structures instead of determining the actual position of the facial nerve trunk. The objective measure of deep tissue distortion due to burden in tumors is quantification of RMV displacement as compared to the skin. The information does not change nerve identification strategy, although it can help the surgeons predict distorted anatomy especially in large tumors whose normal depth expectation may fail.

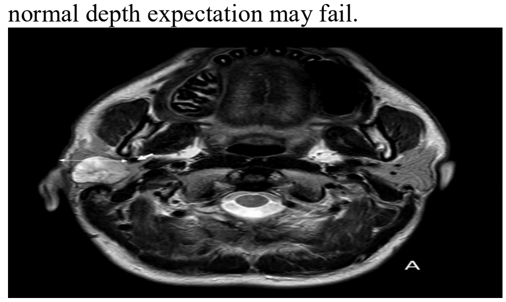

Fig 1: Axial T2-weighted image demonstrating the measurement of the distance between the retromandibular vein (RMV) and the skin on the tumor side in the right parotid gland (A) and in the normal contralateral parotid gland (B).

Comparison of Skin–Retromandibular Vein Distance Between Tumor-Bearing and Tumor-Free Sides

Quantitative MRI demonstrated a significant difference in the skin-to-retromandibular vein (RMV) distance between the tumor-bearing side and the tumor-free side. The mean skin RMV distance on the tumor-positive side was 25.88 ± 6.35 mm, whereas on the contralateral normal side it was 18.29 ± 4.52 mm. The discovery indicates a substantial medial displacement of the RMV towards the epidermal layer in the presence of a parotid tumor within the superficial strata. The paired sample t-test showed that the distance between the skin and RMV was substantially greater on the tumor side compared to the tumor-free side ($p < 0.001$), indicating the impact of tumor-induced mass expansion on the architecture of the parotid glands (Table 1).

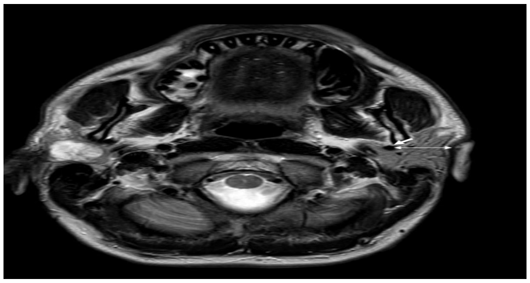

Fig 2: Axial T2-weighted image demonstrating the parotid gland anatomy and retromandibular vein localization.

Table 1: Comparison of skin-vein distance measurements in patients between tumor-positive and tumor-negative sides of the parotid gland

	Tumor-positive side	Tumor-negative side	p
	Mean ± SD (Min-Max)	Mean ± SD (Min-Max)	
Skin-vein distance	25.88 ± 6.35 (12-43)	18.29 ± 4.52 (10-27)	**<0.001[b]**

[b]Paired-samples t-test. SD: standard deviation

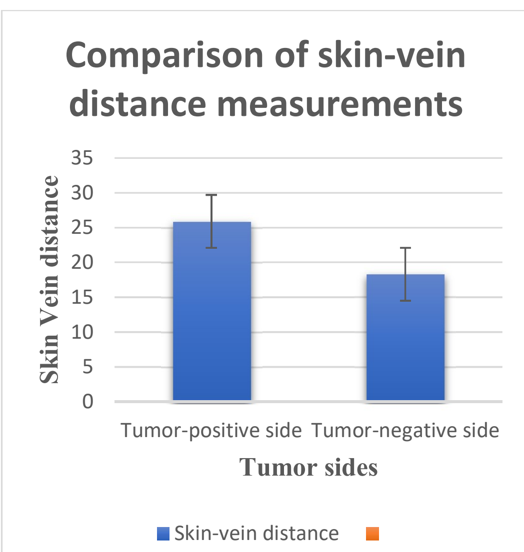

Fig 3: Comparison of the patients' skin-vein distance values between the tumor-positive and tumor-negative sides measured on the parotid gland

Correlation of Skin-RMV Distance/ tumor dimensions.

The correlation analysis showed that the distance between the skin and RMV on the tumor-bearing side was statistically significantly correlated with all the measured tumor sizes. The skin to RMV distance and the anteroposterior (AP) tumor diameter were found to have a moderate positive correlation ($r = 0.537$, $p < 0.001$) whereby tumors whose AP diameter extended further were linked to greater movement of the RMV.

A greater positive correlation was found between the distance between the skin and RMV and transverse diameter of the tumor ($r = 0.644$, p 0.001), which indicated that the expansion of the tumor medially might have a particularly significant influence on the position of RMV. Also, there was a strong positive correlation between the skin -RMV distance and craniocaudal (CC) diameter of the tumor ($r = 0.622$, $p < 0.001$).

Altogether, these results indicate that the growth of tumor size in all three orthogonal dimensions correlates with the gradual growth in the skin–RMV distance, which indicates multidirectional anatomical movement within the superficial parotid gland (Table 2).

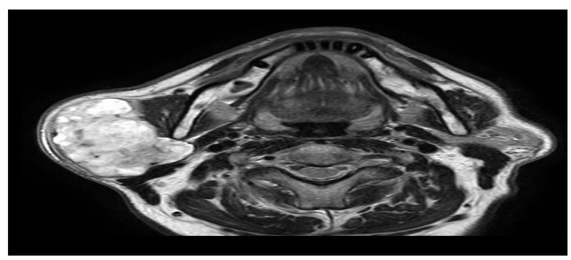

Fig 4: Axial T2-weighted image showing a large tumor extending into the retromandibular space in the right parotid gland.

Table 2: Tumor characteristics of the patients (n = 56)

Tumor characteristic	Mean ± SD	Min-Max
Anteroposterior diameter (mm)	25.12 ± 12.50	6-64
Transverse diameter (mm)	19.46 ± 9.60	6-43
Craniocaudal diameter (mm)	29.46 ± 14.27	3-64
Volume (mm^3)	23,545.54 ± 35,836.49	13832 (297-176,128)

SD: standard deviation

Spearman's Correlation between Skin RMV distance and Tumor Volume

The dimensions results were corroborated using tumor volume analysis. The tumor volume exhibited a statistically significant correlation with the distance between the skin and the RMV volume measured on the tumor side (r = 0.629, p < 0.001). As tumor size increases, the distance between the skin and RMV also expands, indicating that overall tumor burden greatly influences RMV displacement, as seen in Figure 5.

This association between volumes confirms the idea that anatomical distortion can be better assessed by tumor volume than by a single measure. Figure 6 and Table 3 show the positive correlation between tumor volume and skin-RMV distance.

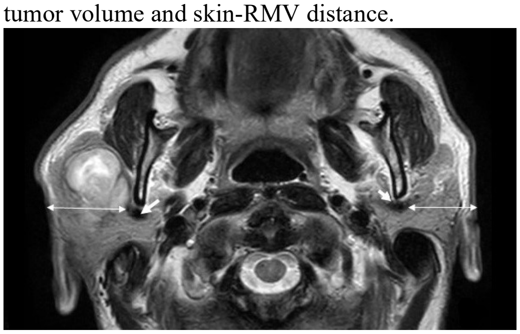

Fig 5: Measurement of the RMV–skin distance on the tumor side in the right parotid gland at the axial slice demonstrating the largest tumor cross-sectional area.

Table 3: Correlation between the skin-vein distance measured on the tumor side and tumor characteristics

Tumor characteristic	Skin-vein distance	
	r	p
Anteroposterior diameter	0.537	<0.001
Transverse diameter	0.644	<0.001
Craniocaudal diameter	0.622	<0.001
Volume	0.629	<0.001

Pearson's correlation coefficient

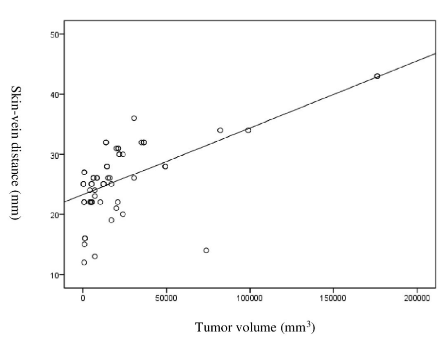

Fig 6: Scatter plot demonstrating the relationship between the RMV–skin distance measured on the tumor side and tumor volume, showing a positive correlation (r = 0.629, p < 0.001)

Discussion

In the study, we have shown that the mean distance between RMV and skin was significantly higher on the tumor positive side than on the tumor negative side (25.88 +-6.35 mm vs. 18.29 +-4.52 mm) and that the distance was also strongly related to the dimensions and volume of the tumor. These findings indicate that when the tumor burden is increased, the parotid structures such as the retromandibular vein begin to be displaced measurably and that this displacement corresponds to more profound anatomical displacement of the facial nerve.

Prior to the previous otolaryngology studies, this study used to measure the position of RMV relative to the skin and tumor size and volume with MRI, which offers a new parameter of imaging in surgery risk classification. This is the first study to report on skin to RMV distance in relation to tumor size in a cohort of patients with parotid tumors. However, the RMV has already been established as a tool (serving as one of two defining points of the Utrecht line) for differentiating between superficial and deep parotid tumors. Correctly anticipating the relative location of the tumor in relation to the nerve (superficial vs deep) will be important in preoperative patient counseling and preparation for the case, but the authors do not provide a rationale for how the skin to RMV distance could have further utility beyond the already described Utrecht line.

As the RMV has already been well-established as a radiographic landmark for the location of the facial nerve, it stands to reason that in a superficially located tumor, a higher tumor volume will result in more medial displacement of the RMV.

Facial nerve preoperative identification is a key issue in the operation of parotid glands, where nerve damage (accidental) occurs the most frequent morbidity after parotidectomy (StatPearls, 2023). The size of parotid tumor has been associated with risks of proximity to facial nerves and post-surgery dysfunction before; larger tumors are more prone to anatomy distortion and abut nerve branches, complicating surgery (Crawley et al., 2019; Otanez et al., 2024). The diameter of parotid tumor is also reported to indicate closeness to the facial nerve, with the tumors that were 5 cm or more related to a high probability of having positive nerve margins and, thus, high likelihood of developing facial nerve complications (Parotid tumor size predicts proximity to the facial nerve, 2011). These observations are expanded by our results, which indicate that tumor growth can cause alterations in the proximity as well as quantitative displacement of the RMV, which is a significant surrogate of facial nerve position on imaging.

Though the retromandibular vein is not an absolute surrogate of the facial nerve, its anatomy has been described consistently, with the facial nerve mostly being lateral and superficial to the vein in the parotid gland. The current study does not state that the facial nerve is directly visualized or located but assesses the RMV displacement as a secondary radiology measurement that is affected by tumor size and volume. The fact that the RMV-skin distance is increasing with increasing tumor burden indicates a progressive deep structure displacement, which could be a consequence of new spatial relations experienced during the surgery. Yet, this association is to be understood as the anatomical awareness, but not as the location of nerves.

Heavy use of indirect imaging landmarks in clinical practice is due to the fact that direct visualization of intraparenchymal facial nerve has been difficult on traditional MRI. Earlier researches have established the retromandibular vein as a better surrogate of the tumor location compared to other identifiable features like the external carotid artery, posterior belly of the digastric muscle or tragal pointer in relation to the facial nerve (Correlation between imaging and surgical findings, 2016; Anatomic landmarks for locating parotid lesions, 2004). Nevertheless, the reliability of landmark decreases with the size of the tumor, especially when it is large and irregular, as it is probable to shift both vessels and nerves randomly due to the mass effect on the tumor (Indian Journal of Otolaryngology Study Group, 2023; Systematic Review Group, 2022).

The advanced imaging techniques aim to see the facial nerve directly. High-quality images of intraparotid facial nerve and parotid gland tumor localization can be acquired using three-dimensional double echo steady state with water-excited MRI, as demonstrated in the study "Localization of parotid gland tumours in relation to the intraparotid facial nerve on 3D double echo steady state" (2019). Nonetheless, these techniques cannot be implemented in every facility, and the RMV remains a significant and well recognized feature of standard MRI diagnostics. We use RMVskin distance as a practical and consistent proxy for quantifying the anatomical displacement of the tumor burden.

The anatomical researches highlight the inconsistency of the correlation between the facial nerve and the retromandibular vein. Although in most dissections, the RMV lies in the lateral direction of the facial nerve, there is a great deal of variability, and some studies report that the nerve in some specimen lies medial to the RMV (Relations of the facial nerve with the retromandibular vein (Touré & Vacher, 2010)). These anatomical peculiarities coupled with positional shift caused by tumors underscore the significance of objective parameters of imaging that can be used to numerically measure positional alterations and not just the qualitative identification of landmarks.

This research is limited in a number of ways. Firstly, it is retrospective and does not directly correlate intraoperative measures of RMV-skin distance of the preoperative measures and the real position and depth of the facial nerve during surgery. Consequently, one cannot draw causal inferences on the location of the facial nerves. Second, the research fails to assess whether the preoperative RMV measures changed the surgical strategy, decreased the time they took in the operating room, or increased the facial nerve outcomes. Thus, the results can be classified as hypothesis but not practice-changing. Third, there were no data on facial nerve monitoring and standardized postoperative facial nerve grading. There should be future prospective studies that involve intraoperative validation and outcome based end points to ascertain the clinical utility of these radiological observations.

Surgically, it can be said that the change in tumor size and tumor volume can be an indication of the change in the spatial relationship of RMV and by default the facial nerve which will improve preoperative planning. An average difference of about 7mm of RMV-skin distance on tumor and non tumor sides in our cohort is an indication of an anatomical change of clinical significance. This distance measurement can be inferred into preoperative risk assessment by surgeons to predict deeper nerve courses in larger tumors to enable more strategic dissection and possibly decrease the time and facial nerve morbidity used during the operation.

To sum up, RMV skin distance measurement of preoperative MRI is a quantitative objective measurement that is closely related to tumor size and volume in benign tumors of superficial parotid glands. The parameter can be used to enhance preoperative anatomical evaluation, weight surgical planning, and add to facial nerve saving measures.

Conclusion

In this paper, it has been shown that benign tumors of the parotid gland superficially can cause a degree of displacement of the retromandibular vein since the distance between the retromandibular vein and the skin is significantly larger on the side of the tumor than on the side without it. RMV -skin distance was positively associated with tumor size in all three orientations (anteroposterior, transverse, craniocaudal) and proximity with tumor volume, which demonstrated that bigger tumors cause more anatomical deformation. These results indicate that RMV versus skin distance measurement in the preoperative MRI can be used as a convenient, quantitative surrogate of determining the depth and displacement of the facial nerve in patients with superficial parotid tumors. In a clinical setting, the assessment of RMV–skin distance during the preoperative planning could be an improvement in the surgical risk stratification and the preservation of the facial nerve during surgery by warning surgeons about deeper-than-anticipated nerve trajectories in larger tumors. The mean difference of about 7 mm observed in RMV -skin distance in this cohort reflects how possible the presence of tumor mass effect may be on the operational complexity, even in harmless lesions.

Even though this was a retrospective study covering benign tumors only, it provides a basis to future studies. Future research that involves intraoperative nerve mapping or prolongation of research to malignant/recurring cases of parotid tumors would further confirm RMV-skin distance as an accurate predictor of localizing the facial nerve. Finally, our results provide support to the importance of the use of detailed preoperative imaging and paying attention to the anatomy in order to achieve the best surgical results in the case of parotid gland surgery.

This paper proves that there is a lot of correlation between tumor size and volume and retromandibular vein displacement on MRI in benign tumors of the superficial parotid gland. Although such results imply predictable changes in the anatomy of the deep parotid with an increase in the tumor burden, they do not establish directly where the facial nerve is located. RMV -skin distance can be used as an additive parameter of imaging to augment preoperative anatomical knowledge, but not to substitute known methods of localizing facial nerves. Future research comparing MRI results with the position of the facial nerves during surgery and the surgical results is necessary to establish the actual clinical use.

References

1. Anatomic landmarks for locating parotid lesions in relation to the facial nerve: cross-sectional radiologic study. (2004). *Journal of Otolaryngology*.
2. Chiesa-Estomba, C. M., González-García, J. A., Larruscain, E., Altuna, X., Sistiaga-Suarez, J. A., & Alvarez-Cruz, G. (2024). Facial nerve palsy after parotidectomy: Incidence, risk factors, and prevention strategies. *Journal of Clinical Medicine, 14*(4), 1156.
3. Correlation between preoperative predictions and surgical findings in parotid surgery for tumors. (2016). *Head & Face Medicine, 12*.
4. Crawley, R. J., Geller, J., Mendenhall, W. M., & Mancuso, A. A. (2019). Magnetic resonance imaging of the facial nerve and retromandibular vein in parotid gland tumors. *American Journal of Roentgenology, 213*(3), 634–641.
5. de Ru, J. A., van Benthem, P. P. G., Hordijk, G. J., & Balm, A. J. M. (2007). Locating parotid gland tumors relative to the facial nerve: The value of CT and MRI. *European Archives of Oto-Rhino-Laryngology, 264*(7), 817–822.
6. Domenick, N. A., Johnson, J. T., & Myers, E. N. (2019). Tumor size as a predictor of facial nerve dysfunction following parotidectomy. *Head & Neck, 41*(6), 1623–1629.
7. Fujii, S., Takahashi, H., Okami, K., & Nishiyama, K. (2018). Accuracy of retromandibular vein as a landmark for facial nerve localization in parotid gland tumors. *Auris Nasus Larynx, 45*(2), 313–319.
8. Gaillard, C., Perie, S., Susini, B., & St Guily, J. L. (2016). Facial nerve morbidity after parotid surgery: Predictive factors. *European Annals of Otorhinolaryngology, Head and Neck Diseases, 133*(2), 85–89
9. Gritzmann, N., Rettenbacher, T., Hollerweger, A., Macheiner, P., & Hubner, E. (2003). Sonography of the salivary glands. *European Radiology, 13*(5), 964–975.
10. Head & Face Medicine Study Group. (2016). Correlation between radiological prediction and surgical findings in parotid tumors. *Head & Face Medicine, 12*, 25.
11. Indian Journal of Otolaryngology Study Group. (2023). Reliability of radiological landmarks for predicting facial nerve position in parotid tumors. *Indian Journal of Otolaryngology and Head & Neck Surgery, 75*(1), 112–118.
12. Jeong, H. S., Baek, C. H., Son, Y. I., & Kim, J. H. (2021). Preoperative visualization of the facial nerve in the parotid gland using three-dimensional double-echo steady-state MRI. *European Radiology, 31*(5), 3132–3140.
13. Kim, J. W., Kim, M. S., Lee, J. H., & Kim, S. H. (2015). Limitations of facial nerve line and Utrecht line in predicting facial nerve location in parotid tumors. *Clinical and Experimental Otorhinolaryngology, 8*(3), 260–265.
14. Localization of parotid gland tumors in relation to the intraparotid facial nerve on 3D double-echo steady-state with water excitation sequence. (2019). *American Journal of Neuroradiology, 40*(6), 1037-1042.

15. Mortensen, N. B., Sørensen, C. H., & Thomsen, J. B. (2024). Facial nerve palsy following benign parotidectomy: Incidence and predictors. *Acta Oto-Laryngologica, 144*(3), 1–8.
16. Moussa, H. R., El-Anwar, M. W., & Nofal, A. A. (2021). Incidence and risk factors of facial nerve palsy after parotidectomy. *Egyptian Journal of Otolaryngology, 37*, 26.
17. Otanez, E. S., Kim, J., Wang, M. B., & Abemayor, E. (2024). Incidence and predictors of facial nerve palsy after parotidectomy. *PLoS ONE, 19*(3), e0297712.
18. Parotid tumor size predicts proximity to the facial nerve. (2011). *The Laryngoscope*.
19. Relations of the facial nerve with the retromandibular vein: anatomic study of 132 parotid glands. (2010). *Journal of Oral and Maxillofacial Surgery*.
20. Som, P. M., Curtin, H. D., & Mancuso, A. A. (2000). Imaging-based classification of parotid gland tumors. *Radiology, 216*(1), 19–29.
21. StatPearls. (2023). *Parotid cancer*. StatPearls Publishing.
22. Systematic Review Group. (2022). Diagnostic accuracy of radiological criteria for predicting deep lobe involvement in parotid tumors: A systematic review and meta-analysis. *European Archives of Oto-Rhino-Laryngology, 279*(9), 4371–4383.
23. Thibault, F., Froehlich, P., & Wassef, M. (2013). MRI visualization of the intraparotid facial nerve: Feasibility study. *American Journal of Neuroradiology, 34*(9), 1757–1763.
24. Touré, G., & Vacher, C. (2010). Relations of the facial nerve with the retromandibular vein: anatomic study of 132 parotid glands. *Surgical and radiologic anatomy*, *32*(10), 957-961.