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RESEARCH

A novel Endoscopic Approach to Identify Parapharyngeal Segment of the Internal Carotid Artery

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Abstract

Objective This anatomical study proposes a novel endoscopic approach for the superior part of the parapharyngeal segment of the internal carotid artery.

Methods An endoscopic technique involving blunt dissection between the levator veli palatini and the salpingopharyngeal fold was utilized in five fresh-frozen cadavers. Following the excision of the fatty tissue and the incision of the stylopharyngeal fascia, the distances between the levator veli palatini, the salpingopharyngeal fold, the nares, and the parapharyngeal segment of the internal carotid artery at the nasal floor level were measured.

Results The average distance between the posterior edge of the levator veli palatini and the parapharyngeal segment of the internal carotid artery was measured to be 14.4 mm. The salpingopharyngeal fold demonstrated an average distance of 12.4 mm. Furthermore, the mean distance from the nares to the parapharyngeal segment of the internal carotid artery was ascertained to be 89.1 mm.

Conclusions This approach provides a novel method and a different corridor for accessing the parapharyngeal segment of the internal carotid artery, particularly the superior portion located above the nasal base. It emphasizes the levator veli palatini and the salpingopharyngeal fold as critical anatomical landmarks. Fatty tissue and the stylopharyngeal fascia act as protective barriers. Further clinical investigation is necessary to substantiate its practical application in human tissue samples**.**

Keywords Parapharyngeal · Internal carotid artery · Endoscopic · Levator veli palatini · Salpingopharyngeal

1 Introduction

The parapharyngeal space (PPS) is a potential cavity that is both complex and deep, located between the great horn of the hyoid bone and the skull base. It resembles an inverted pyramid, situated between the medial pterygoid muscle and the superior pharyngeal constrictor [1–3]. Interventions for infectious, tumoral, and trauma-related pathologies in the PPS are of great importance in the domain of head and neck surgical practice [4]. In the domain of otolaryngology, a multitude of surgical approaches to PPS have been delineated. The aforementioned approaches encompass a variety of routes, including those traversing the neck, the skull base, and the nasal cavity [5, 6]. Furthermore, a series of technical enhancements were implemented. These enhancements included endoscope-assisted dissection. These improvements aimed to minimize surgical complications while ensuring the completeness of the resection. [7, 8]. Treating lesions in the upper parapharyngeal space is difficult and often necessitates a more extensive approach to prevent damage to nearby neurovascular structures especially parapharyngeal segment of internal carotid artery (pICA) [9].

Increasing literatures have presented the application of endoscopic endonasal surgery in managing lesions involving the upper PPS, with the advantage of reducing the incidence of functional and cosmetic morbidity related to open approaches [7].

Recent advancements in endoscopic surgical techniques have enabled the development of novel surgical approaches for accessing the PPS and the pICA. Current literature

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demonstrates the efficacy of combining inferomedial maxillectomy, pterygopalatine fossa mobilization, pterygoid plate removal, and eustachian tube removal in this context. This combination of surgical procedures is collectively referred to as the endoscopic endonasal transpterygoid approach, as detailed in numerous publications [7, 10–14].

It has been asserted that the most severe complication that may ensue during these endoscopic endonasal approaches is the potential for damage to the pICA. This is attributed to the fact that its course differs from that of other segments [15, 16].

The objective of this anatomical pilot dissection study is to describe a novel endoscopic endonasal surgical corridor for exposing the pICA. This pathway offers an alternative to the transpterygoid approach and anatomical landmarks previously detailed in the literature.

2 Materials and Methods

Dissections were carried out within the nasal passages of five fresh-frozen cadavers. Rigid endoscopes with a 4 mm diameter and a 0 or 45-degree bend were utilized, along with an endovision unit and a recording system (Storz Endoscopy, Germany). It is important to note that no coloring process was applied to the vascular structures in these freshly frozen cadavers. The pICA was also exposed through neck dissection, confirming that the vascular structure extending from the nasal passage was the pICA. Photography was conducted concurrently with the recording. The distances of the pICA at the level of the nasal floor from the levator veli palatini muscle(LVPM), salpingopharyngeal fold, and nares were measured. The measurements were obtained using a rigid measuring ruler with numerical values. The mean and standard deviation values were calculated using the Statistical Package for the Social Sciences (SPSS) version 24.0 software.

2.1 Endoscopic Endonasal Surgical Technique

The inferior nasal concha was excised to facilitate a more comprehensive evaluation of the nasal cavity and nasopharynx. This approach enabled the visualization of the mucosal folds that envelop the eustachian tube, the salpingopharyngeal fold, and the LVPM (Fig. 1).

The LVPM was exposed through a procedure that involved elevating the mucosa superficial to the LVPM and starting from the nasal floor. Subsequently, by continuing with blunt dissection between the salpingopharyngeal fold and the LVPM, the fatty tissue of the PPS was reached. Upon excision of the fatty tissue, the stylopharyngeal fascia (SPF) was encountered (Figs. 2 and 3).

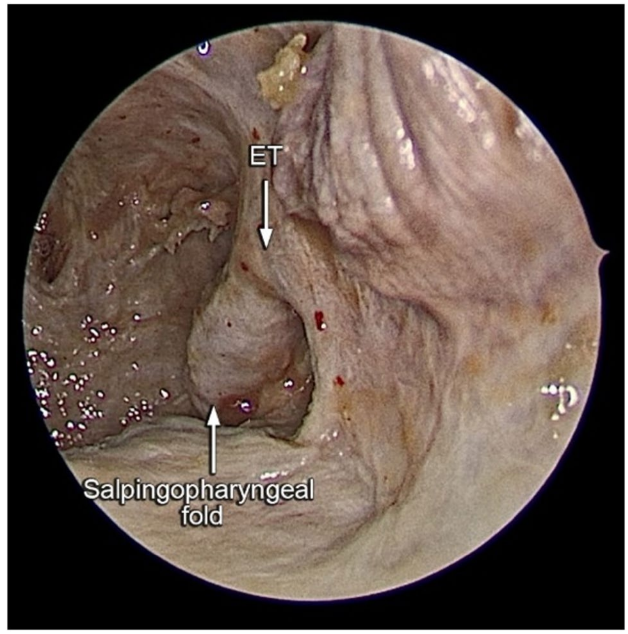

Fig. 1 Endoscopic view of surgical field ET: Eustachian Tube, Left side

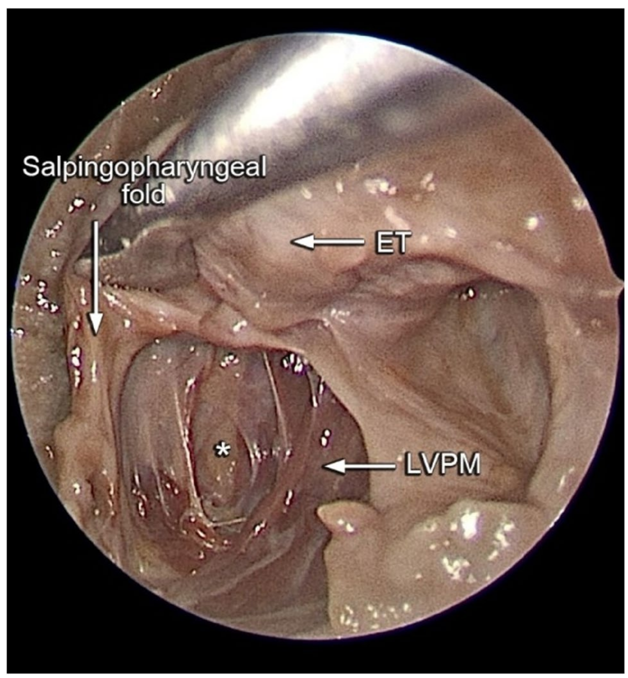

Fig. 2 Blunt dissection between the salpingopharyngeal fold and the levator veli palatini. *ET* Eustachian tube, *LVPM* Levator veli palatini muscle, *Fatty tissue, Left side

Blunt dissection was performed in the plane between the salpingopharyngeal fold and the levator veli palatini, which enabled the removal of the fatty tissue of the PPS. Following

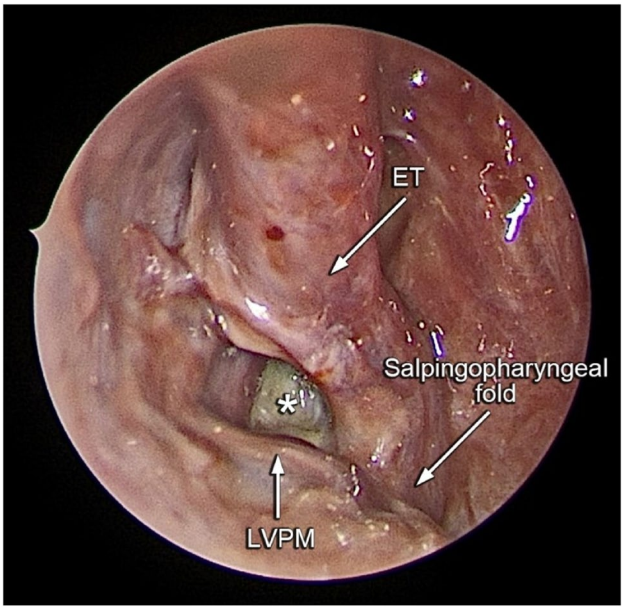

Fig. 3 Fatty tissue of parapharyngeal space. *ET* Eustachian tube, *LVPM* Levator veli palatini muscle, *Fatty tissue, Right side

this procedure, the SPF was accessed without the sacrifice of any bone or soft tissue. The pICA was exposed through the incision of the SPF (Fig. 4).

After this stage of dissection, the PPS was reached in all cadavers using the transparotideal transcervical approach. The SPF encountered in this area was incised, and the neurovascular structures located medially to this fascial layer were identified. Thus, it was subsequently confirmed that the vascular structure revealed by the endoscopic approach was the pICA. Consequently, the pICA was confirmed from the neck and followed towards the skull base. Subsequent endoscopic examination of the nasal cavity provided definitive confirmation that the identified arterial structure corresponded to the pICA (Figs. 5, 6).

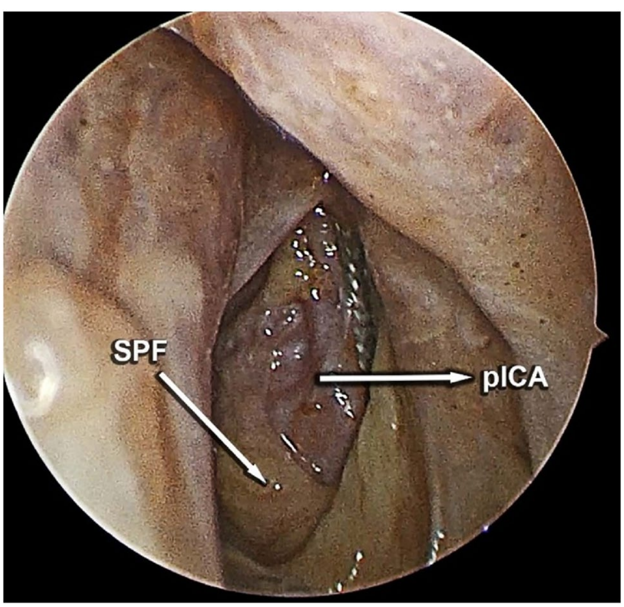

Fig. 4 Incision of the stylopharyngeal fascia and exposure of the pICA. *pICA* Parapharyngeal segment of the internal carotid artery, *SPF* Stylopharyngeal fascia, Right side

3 Results

After the excision of the fatty tissue of the PPS, measurements were taken by incising the SPF (Fig. 7). The average distance between the mucosal fold of the LVPM (anterior border) and the pICA was measured at the level of the nasal floor, and the results indicated an average distance of 22.6 mm (mm) (maximum: 25 mm, minimum: 19 mm). Similarly, the average distance between the posterior border of the levator veli palatini and the pICA was measured, and the results indicated an average distance of 14.4 mm (minimum: 11 mm, maximum: 17 mm).

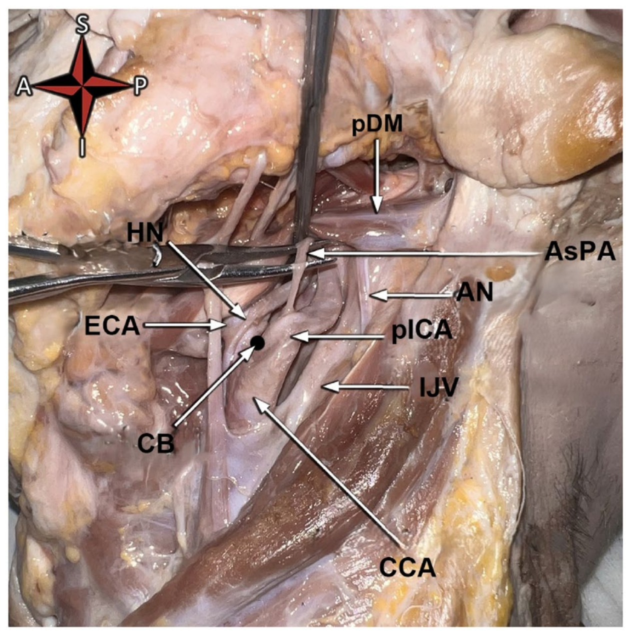

Fig. 5 The surgical approach that was employed was a transparotideal transcervical incision, following the incision of the SPF. The presence of neurovascular structures is indicated. The investigation revealed that only one side of the cadaver's ascending pharyngeal artery exhibited an origin from the internal carotid artery subsequent to the carotid bifurcation. This image was employed to illustrate this rare anatomical variation, *AsPA* Ascending pharyngeal artery, *AN* Accessory nerve, *CB* Carotid bifurcation, *CCA* Common carotid artery, *ECA* External carotid artery, *HN* Hypoglossal nerve, *IJV* Internal jugular vein, *pICA* parapharyngeal segment of internal carotid artery, Left side.

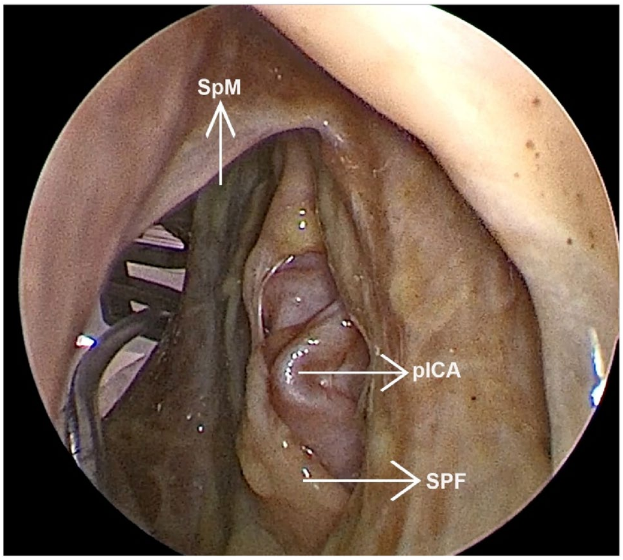

Fig. 6 It has been observed that the endoscopic endonasal corridor is combined with the dissection field performed from the neck. The pICA is encountered deep within the incised SPF. The stylopharyngeal muscle, which is exposed in the neck, is visible posterior to the endoscopic dissection field. *SPF* Stylopharyngeal fascia, *SpM* Stylopharyneus muscle,, *pICA* Parapharyngeal segment of internal carotid artery, Right side

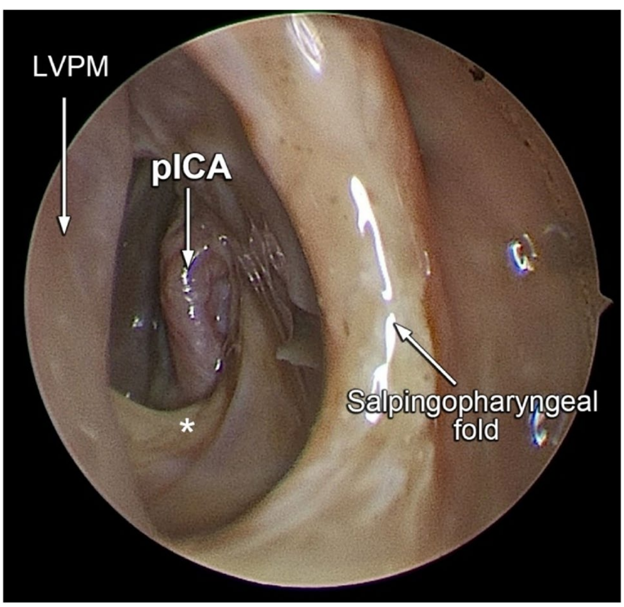

Fig. 7 Salpingopharyngeal fold and the course of the internal carotid artery. *LVPM* Levator veli palatini muscle, *pICA* Parapharyngeal segment of the internal carotid artery, *Fatty tissue, Right side

Furthermore, the mean distance between the salpingopharyngeal fold and the pICA was determined to be 12.4 mm (min: 9 mm, max: 15 mm). In addition, it was ascertained that the salpingopharyngeal fold is situated within the same sagittal plane as the pICA when employing a 45-degree endoscope (Fig. 7).

The mean distance between the nares and the pICA was measured to be 89.1 mm (min: 86 mm, max: 93 mm) (Table 1).

It was observed that the SPF covered the pICA in all 10 side dissections of the 5 cadavers, and adipose tissue was located superficially to this fascial layer during both transcervical and endoscopic approaches.

4 Discussion

The parapharyngeal segment of the internal carotid artery (pICA) is the portion of the internal carotid artery surrounded by soft tissues between the carotid bifurcation and the carotid canal. Thereby soft tissue markers considered significant for the pICA are noted: the eustachian tube, the rosenmüller fossa, tensor veli palatini and the levator veli palatini [17, 18]

In the context of endoscopic endonasal transpterygoid approaches, the exposure of the pICA is achieved through the lateralization of the contents of the pterygopalatine fossa. This is accomplished by the resection of osseous structures, including the pterygoid process, lateral plate, and medial plate [17, 19–21].

Looking more closely at studies based on the endoscopic transpterygoid approach in the literature, Fang et al. achieved access to the pICA between the levator veli palatini and stylopharyngeus muscles [16]. In another study, the SPF serves as a significant anatomical barrier protecting the pICA [21]. Furthermore, Battaglia et al. indicated that, through the 'tensor vascular styloid fascial plane' between the pterygoid muscles and the tensor veli palatini, access to the fatty tissue of PPS is possible, emphasizing that this fatty tissue serves as a significant landmark for the pICA. They also mentioned that the depth of the pICA may vary inferiomedially to the eustachian tube [19]. Beside this Xu et al., observed that the levator veli palatini muscle is the closest and most consistent anatomical landmark anterior to the pICA along the entire length of the PPS [20].

Our recent study, pICA was encountered medial to the fatty tissue, covered by the SPF, through blunt dissection performed between the salpingopharyngeal fold and the posterior edge of the LVPM, without sacrificing any osseous or soft tissue structures. After excising the fatty tissue of the PPS, the SPF was incised, and the measurements revealed that the average distance between the anterior mucosal fold of the LVPM and the pICA at the level of the nasal floor was 22,6 mm. The average distance between the posterior edge of the levator veli palatini and the pICA was measured to be 14,4 mm. The average distance between the salpingopharyngeal fold and the pICA in our study was measured to be 12,4

Table 1 Endoscopic measurements LVPM: Levator veli palatini muscle, pICA: Parapharyngeal segment of internal carotid artery

pICA	Minimum (mm)	Maximum (mm)	Mean (mm)	Std. Deviation	N
LVPM anterior border	19,00	25,00	22,60	2,06559	10
LVPM posterior border	11,00	17,00	14,40	1,89737	10
Salpingopharyngeal fold	9,00	15,00	12,40	1,95505	10
Nares	86,00	93,00	89,10	2,51440	10

mm and it was observed that this fold is in the same sagittal plane as the pICA. No precise numerical value pertaining to this parameter was identified within the existing literature. According to our study, the average distance between the nares and the pICA at the nasal floor level was measured to be 89,1 mm. Xu et al., reported a safe distance of 90 mm for this measurement [20].

In the literature, it is noted that due to the variability in the course of the pICA beneath the inferomedial aspect of the eustachian tube, this region is susceptible to injuries. Battaglia et al. mentioned that access to the pICA can be achieved by resecting osseous structures lateral to the pICA. However, due to potential difficulties in recognizing these structures due to pathologies in this area during dissection, complications may arise affecting the neurovascular structures [19].

In our study, it was possible to achieve access to the pICA through a blunt dissection from medial to lateral without encountering any neurovascular structures in a very short period of time, without the need for any bone-cutting tools, and without resecting any anatomical structures except for the inferior nasal concha. This surgical corridor, created by dissecting from medially to laterally, is not yet described in the literature. During this dissection, the salpingopharyngeal fold, not previously described in the literature, was observed in close alignment with pICA. The levator veli palatini, the fatty tissue of the PPS, and the SPF are regarded as significant anatomical landmarks for safeguarding the pICA as in other studies in the literature [16, 19–21].

While achieving access to PPS while preserving the eustachian tube and muscles is functionally advantageous, we believe that securing the pICA through this surgical corridor enables the safe conduct of any surgeries at PPS not only nasopharynx carcinoma.

In the literature, surgical corridors involving the resection of osseous structures like the pterygoid plates, sacrificing or lateralizing the contents of the pterygopalatine fossa, require more time, a variety of surgical instruments, and a more experienced surgeon to access the pICA. Complications that may arise involving the neurovascular structures.

Based on our recent anatomical study, further advanced clinical studies supported by imaging techniques are necessary to ascertain the applicability of the described surgical approach in living human tissues. We also believe that this surgical corridor could be safely combined with transservical transparotideal lateral approaches for PPS pathologies to ensure comprehensive surgical management. In addition, we believe that deep neck abscesses located in the PPS can be endoscopically drained through this surgical corridor without making an incision in the neck, while preserving the pICA and avoiding other neurovascular structures. In addition, during endoscopic approaches to recurrent nasopharyngeal carcinomas, although there are changes in soft tissue landmarks and measurements due to recurrence and radiotherapy, it may be possible to expose and secure the pICA using this corridor.

In our study, a limited number of freshly frozen cadavers were used due to ethical concerns. Although our laboratory lacks imaging methods, the location of the pICA was confirmed in the surgical corridor by exposing it from the neck to the skull base. As this is a pilot anatomical study, its applicability in live tissue has not been demonstrated initially due to ethical concerns. We believe that with further studies, verification of this area through imaging and more precise measurements will make the application of this pilot study in live tissue possible.

5 Conclusions

In summary, the present study proposes a novel endoscopic surgical corridor for accessing the upper portion of the pICA that obviates the necessity for resecting osseous structures or extensive dissection. This approach, which preserves key anatomical landmarks such as the levator veli palatini and the salpingopharyngeal fold, offers a potentially safer and easier method for accessing the pICA. While the present findings are based on cadaveric dissections, further clinical research and imaging validation are necessary to confirm its applicability in live tissues. This technique may also facilitate the management of PPS pathologies and deep neck abscesses, providing a promising alternative to traditional methods that require more invasive procedures.

Author contributions Pelin Samaraz Olgun: Conceptualization, Data curation, Methodology, Software, Investigation, Writing- Original draft preparation Aybegüm Balcı: Data curation, Writing- Original draft preparation. Ayhan Cömert: Visualization, Supervision. Validation and Editing. Halil İbrahim Açar: Supervision. Software, Validation and Editing.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Conflicts of Interest The authors declare no competing interests.

Ethical Approval This study was approved by the University of Ankara Ethical Committee (Approval number 19–615-21).

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