Surgical Implication for the Endoscopic Anatomy of the Sphenopalatine Foramen Region

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SUMMARY

Introduction: The failure rate of the sphenopalatine artery ligation has been described varying from 2 to 10%, and it may occur because of anatomical variations found in these region.

Objective: To describe the anatomy of the sphenopalatine foramen region and observe possible surgical implications during the ligation of the sphenopalatine artery.

Method: The sphenopalatine forame region of 122 cadavers nasal fossae were endoscopic dissected. Presence of the ethmoidal crest, location of sphenopalatine and accessory foramens, and number of arterial branches emerging through foramens, were observed. Data were analyzed in relation to gender, racial group and symmetry of the cadaver.

Results: Ethmoidal crest was present in 100% of cadavers,. The most frequent sphenopalatine forame location was the transition of the middle and superior meatus (86.9%). Accessory foramen was present in 9.8% of cases. A single arterial stem emerged through the sphenopalatine forame in 67.2% of times, and 100% through accessory foramens. The prevalence analyses showed no diferences statistically significant (p>0,05) between gender and racial group. The symmetry analyses showed a strong conformity (p0,05) association with the presence of the accessory foramen.

Conclusion: The mucoperiosteal flap should be done large enough until the anterior wall of the sphenoid sinus to improve the successful of the sphenopalatine artery ligature.

Key words: anatomy, artery, foramen, sphenopalatine, Epistaxis, surgery.

Introduction

Although the success rate of sphenopalatine artery ligation surgery is higher than 95% (1,2), some authors (3) have reported some difficulties in isolating such arteries during the procedure under endoscopic visualization. The therapeutic failure of the ligation surgery or of sphenopalatine artery cauterization has been described and may vary from 2% up to 10% (2, 4-7). Some anatomic variations on the nose lateral wall have been reported, referring to the localization of the sphenopalatine foramen (8-15), to the presence of an accessory foramen (10,13,15-18), to the artery ramification (12,14,16,19,20) and to the dimension and morphology of sphenopalatine foramen (8,18,21).

The anatomic variation of such region, as well as the lack of endoscopic studies which show repairing points to join the sphenopalatine artery and its branches, may justify the surgical failure in some cases as well as the technical difficulty found by some authors. Therefore, the aim of the present study is to describe the anatomy of the sphenopalatine foramen region on the nose lateral wall and its possible anatomic variations, during the endoscopic dissection in corpses, and to observe the probable differences between the anatomic findings, gender, racial group and symmetry between nasal fossa, as well as to observe its implications in the sphenopalatine artery (and its branches) ligation surgery.

Method

Material

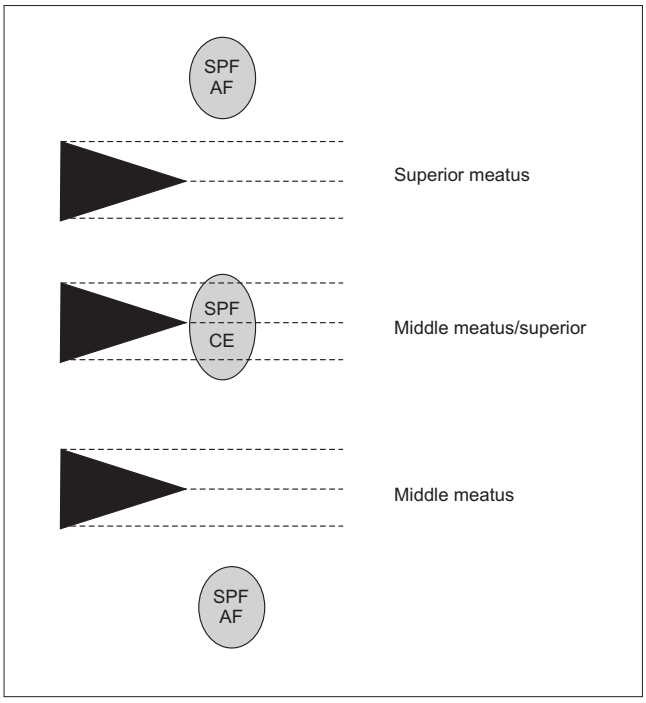
Prospective study developed in the Death Verification Service of *São Paulo* at *Universidade de São Paulo*, after approval by Ethics Committee for Research Projects of the *Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo* (# 812/06) between September 2006 and January 2007.

The corpses which have been excluded from this study were the ones which presented previous history of nasal trauma, background of nasal-sinus surgery or affections which would harm the anatomical dissection such as tumors or nasal-sinus polyposis. All individuals with 18 years of age or more have been included in this study.

Methods

All dissections have been performed bilaterally, rigorously according to the surgical steps which follow: After the proper installation of video-endoscopy system, the corpse nasal fossae were visualized with rigid endoscopy at 0º. After the careful displacement of the middle turbinate, one vertical incision was done on the lateral nasal wall mucosa by using a Cottle knife, at around 1 cm behind the posterior portion of the middle turbinate, reaching the superior portion of the inferior turbinate. Afterwards, a mucoperiosteal flap was raised in posterior direction of the nose until the sphenopalatine foramen was identified, and a careful dissection of the region of the sphenopalatine foramen until exposition of all the vessels that emerged from it was performed. The dissection was extended posteriorly up to the anterior wall of the sphenoidal sinus to certify the identification of other possible arterial branches. The photo-documentation of all cases has been performed. Fragments of the vessels gotten during the dissection have been analyzed histologically to certify the artery origin. The following structures and anatomical measures have been investigated:

1. Presence of ethmoidal crest (EC) of the perpendicular blade of the palatal bone.
2. Localization of sphenopalatine foramen and presence and localization of the accessory foramen.



Picture 1. Localization of sphenopalatine and accessory foramen - EC: ethmoidal crest of the perpendicular blade of palatal bone SPF: sphenopalatine foramen AF: accessory foramen.

The localization of the sphenopalatine foramen and the accessory foramen were defined in relation to the line of insertion of the middle nasal turbinate in the lateral wall of the nose (which is the ethmoidal crest of the perpendicular blade of the palatal bone) (Picture 1); that is:

a) in the superior meatus (SM): when the crest becomes tangent to the inferior edge of the SPF and, therefore,

the foramen is presented above the line of insertion of the middle turbinate;

b) in the transition of the middle meatus and superior meatus (MM/SM): when the crest points to the foramen and, therefore, the inferior edge of the foramen is extended through the ethmoidal crest of the palatal bone;

c) in the middle meatus (MM): when the crest becomes tangent to the superior edge of the foramen, being present below the line of insertion of the middle turbinate.

3. Distance of sphenopalatine foramen and the accessory foramen up to anterior nasal spine.

The distances have been measured with a millimetered ruler in which point "zero" was determined by the inferior portion of the sphenopalatine foramen and/or of the accessory foramen and "the final" point was the most anterior portion of anterior nasal spine.

4. Amount of emergent arterial branches by sphenopalatine foramen and by the accessory foramen.
5. Analysis of prevalence and symmetry.

The presence of the EC, the presence and localization of the accessory foramen, the distance of the SPF and the accessory foramen up to anterior nasal spine and the number of branches present in the SPF and accessory foramen have been analyzed in relation to gender and racial and ethnic group. These measures have been compared between nasal fossae of the same corpse.

6. Prediction of the presence of the accessory foramen with number of emergent arterial branches through the spf, of the localization and distance of the spf to anterior nasal spine.

Statistical Analysis

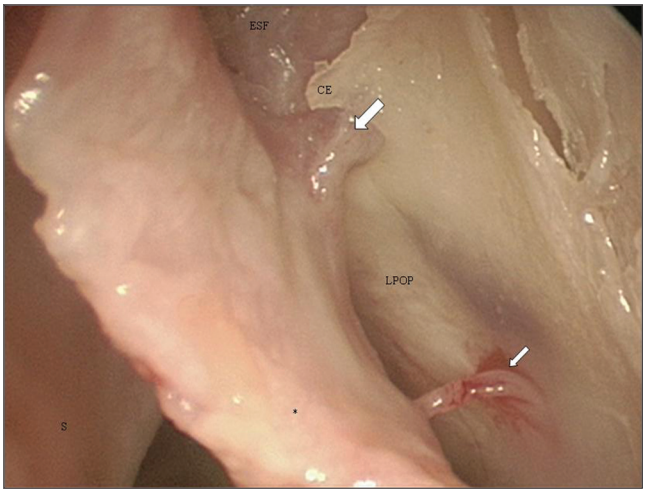
The statistical analysis was performed through SPSS program (Statistical Package for Social Sciences), in its version 13.0, in order to get the results. The relation between the presence of the EC, the localization of the SPF and the accessory foramen in relation to the sort and racial ethnic group was analyzed through the tests of Fischer and qui^2. The distance of the SPF to the anterior nasal spine and the number of arterial branches found in the SPF has been analyzed in relation to gender by the Mann-Whitney test, and the ethnic-racial group through the Kruskal-Wallis test. The Kappa Coefficient has been applied for the verification of the symmetry between nasal fossae of the presence of the EC, the localization of the SPF and accessory foramen as well as of the distances of the SPF to the anterior nasal spine and the number of emergent arterial branches from the SPF. The Wilcoxon Test has been applied to verify the possible symmetry in relation to the distances of the SPF to the anterior nasal spine. The Mann-Whitney test has also been applied to predict the presence of the accessory foramen. The level of significance of 5% has been adopted (0.05), for the application of the statistical tests.

Results

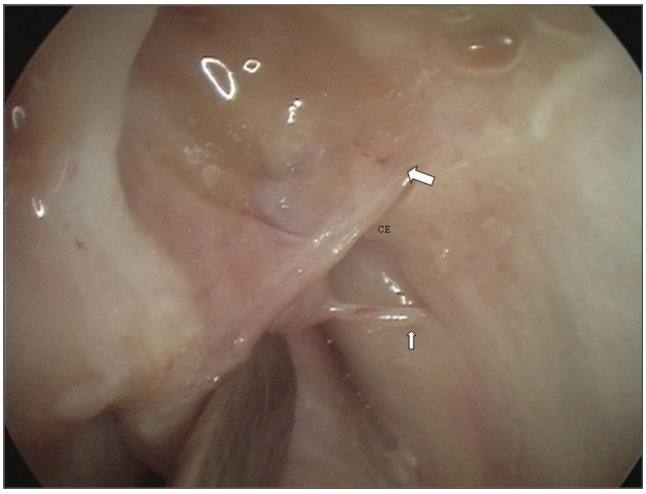
61 corpses (122 nasal fossae) have been studied, being the majority (75%) male patients. The corpses of medium brown color (31) have prevailed , followed by black (22) and white (8).

1. Presence of ethmoidal crest of the perpendicular blade of the palatal bone

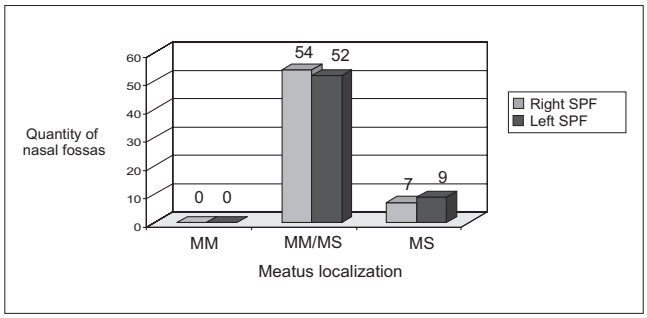
The ethmoidal crest of the perpendicular blade of the palatal bone has been observed in the 100% of the cases, being predominant anterior localization to the sphenopalatine foramen (Pictures 2 and 3).



Picture 2. Endoscopy of left nasal fossa. EC: ethmoidal crest of the perpendicular blade of the palatal bone. PBPB: Perpendicular blade of the palatal bone. * Mucoperiosteal flap. S: nasal septum. AWSS: anterior wall of the sphenoidal sinus. Bigger arrow points to the sphenopalatine foramen which presents an only emergent arterial branch. Smaller arrow points to the accessory foramen, located in the middle meatus.



Picture 3. Endoscopy of left nasal fossa. It is noticed ethmoidal crest (EC) anterior to the sphenopalatine foramen (bigger arrow), which presents only one arterial branch. The accessory foramen joins in the middle meatus (smaller arrow).



Picture 4. Meatus localization of sphenopalatine foramen - MM: middle meatus MM/SM: superior meatus SM: superior meatus.

2a. Localization of sphenopalatine foramen

The most frequent localization of the sphenopalatine foramen, either of the right or left side, was the transition region of the middle meatus and superior meatus (86.9%) followed by the region of superior meatus (13.1%) (Pictures 4 and 5).

2b. Presence and localization of the accessory foramen

The accessory foramen was present in 12 cases (9.83%), having prevalence in the right side. In 91.7% of the times, it was located in the middle meatus. In only one case the foramen was present bilaterally (Pictures 3 and 6).

3a. Distance of sphenopalatine foramenn up to the anterior nasal spine

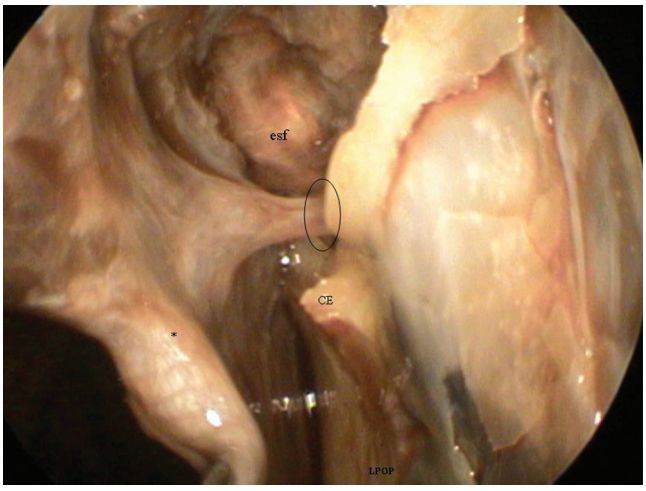
The average distance of the sphenopalatine foramen up to the anterior nasal spine was of 66mm (standard deviation of 53mm), being the minimum distance of 50mm and the maximum of 81mm (Picture 7).

3b. Distance of the accessory foramen up to the anterior nasal spine

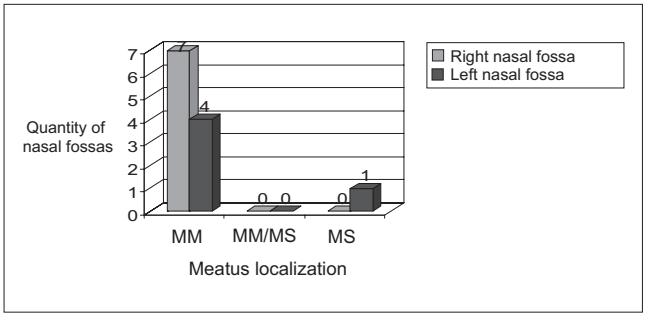
The average distance of the accessory foramen to the anterior nasal spine was of 67mm (standard deviation of 47mm), being the minimum distance of 58mm and in the maximum distance of 72mm (Picture 7).

4a. Amount of emergent arterial branches by the SPF

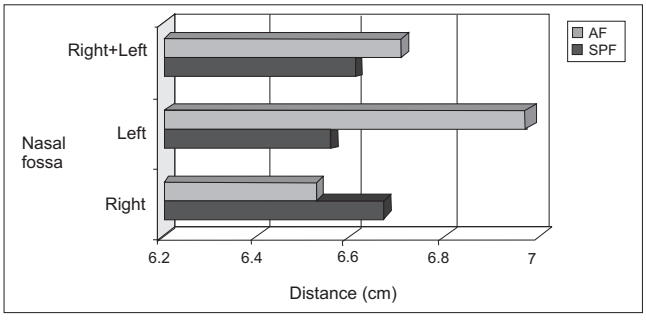
Most of nasal fossae presented only one trunk (67.21%) (Picture 3) emerging for the SPF, followed by two (21.31%) (Picture 8) and three (11.47%) branches.



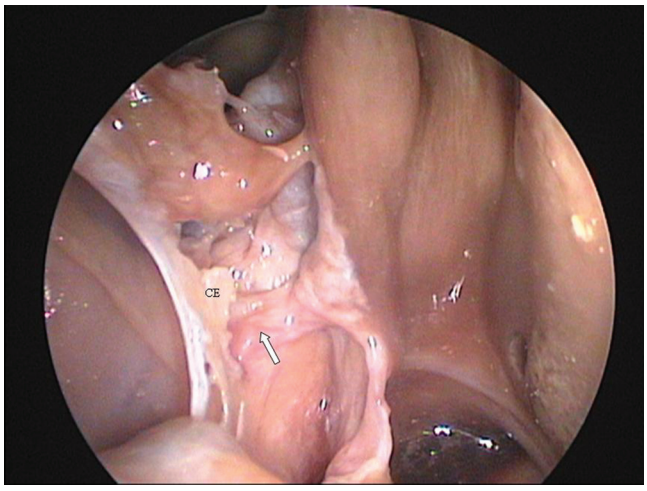
Picture 5. Endoscopy of left nasal fossa. Sphenopalatine foramen (circle) located superiorly to the ethmoidal crest (EC), in the region of the superior meatus. * Mucoperiosteal flap. AWSS: anterior wall of the sphenoidal sinus. PBPB: perpendicular blade of the palatal bone.



Picture 6. Meatus prevalence and localization of foramen accessory - MM: middle meatus MM/SM: superior meatus SM: superior meatus.



Picture 7. Average distance (centimeters) between the sphenopalatine foramen (SPF) and accessory foramen (AF) up to anterior nasal spine - cm: centimeters SPF: sphenopalatine foramen AF: accessory foramen.



Picture 8. Endoscopy of right arterial fossa. Two arterial branches are observed emerging from the sphenopalatine foramen (arrow).

4b. Amount of emergent branches by the accessory foramen

The accessory foramen presented in 100% of the cases only 1 (one) branch.

5. Analysis of prevalence and symmetry

The analysis of the prevalence did not show to statistically significant difference (p>0.05) among gender and ethnic/racial group in relation to all the anatomical parameters studied. The analysis of the symmetry (Table 1) showed that the agreement between the sides in relation to the localization of the SPF was good to excellent, with Kappa index of 0.71 (IC95% 0.58 – 0.85, p<0.001). In relation to the number of emergent arterial branches through the SPF, the agreement was significant, however poor - Kappa of 0.22 (IC95% 0.11 – 0.33, p=0.03). There was no significant agreement between the sides in terms of the presence of accessory foramen. Out of the 12 observed foramens, only one corpse presented it bilaterally.

The average difference between the distances of the right side in relation to the left side was of 1.1 mm (standard deviation of 4.2, minimum -8 and maximum +12), not having presented statistical significance (p = 0.09).

6. Prediction of the presence of the accessory foramen with number of emergent arterial branches through the spf, of the localization and distance of the spf to anterior the nasal spine

In 11 cases there was only one arterial trunk emerging from the SPF in association with the presence of the accessory foramen. In one case, there were two branches emerging from the SPF in association to the accessory foramen. After statistics analysis, it has been observed that none of the interest variable presents some statistically significant association (p>0.05) with the presence of the accessory foramen.

Discussion

The ethmoidal crest of the perpendicular blade of the palatal bone is a bone salience which is formed by the joining of the perpendicular blade of the palatal bone with the most posterior, inferior and lateral portion of middle turbinate (9,11,13,15,20,22,23,24). It represents an important anatomical repair (3,10) for the meeting of the sphenopalatine foramen, being found in 100% of studied cases (10,22,23), being anterior to the SPF most of times (22,23). Bolger et al. (22) have described the EC in another localization, in agreement with the findings of the present study.

The SPF can be located in superior meatus (8,10-13,15), in the transition of the middle meatus and superior meatus (8,10,15,25), in the region of the middle meatus (8,15) or superior to the superior meatus (12). According to the present study, others authors (9,10,25) have already described the transition of the middle and superior meatus as the most frequent localization.

Table 1. Analysis of agreement between the left and right sides in relation to the anatomical parameters which have been studied.

	Simple Agreement	Kappa Index(IC95%)	p
Presence of ethmoidal crest*	100.0 %	-[a]	-
Localization of SPF	93.4 %	0.71 (0.58 - 0.85)	< 0.001
Number of Arterial Branches in the SPF	59.0 %	0.22 (0.11 - 0.33)	0.03
Presence of Accessory Foramen	83.6 %	0.08 (-0.08 - 0.23)	0.53

Subtitle: SPF: Sphenopalatine foramen

[a]: it was impossible to calculate once the presence of ethmoidal crest was constant.

* Ethmoidal crest of the perpendicular blade of the palatine bone.

The average distance between the SPF and the anterior nasal spine found in the present study has been higher than the one found by Lee et al (12) and Scanavini (15). The difference between the studies can suggest differences of ratio between the several races. The study by Lee et al (12) was performed only in Korean individuals, characterized as of yellow color, exactly the color which was not present in the present study. The distance from the accessory foramen up to the anterior nasal spine was not found in the literature.

The presence of an accessory foramen has already been described by some authors (13,15-18). It can be found in 2.6% to 42% (10,15,16,18,20). In the present study, it has been observed that 9.83% of nasal fossae which have been dissected presented only one accessory foramen, similar to findings by Wareing and Padgham (10) and Scanavini (15) who have found 12% and 13% of accessory foramens respectively. Despite the present study having located only accessory foramens, other authors have found double (13,15,18), triples (13,18) or multiples (18) accessory foramens. Generally it is observed inferior (10,15,17) and anterior (17) to SPF, in agreement with the findings of the present study, in which 91.7% of the accessory foramens have been situated in the middle meatus. There may be, however, anatomical variations (14,4), as evidenced in only one case.

The number of emergent arterial branches by the SPF is not well established (16), and can vary from one to ten branches (12,14,16,17,19,20). The findings of the present study are in agreement with the findings by Pearson et al (19) and Ram et al17. Schwartzbauer et al (16) report only one trunk in 42% of there cases. In contraposition to the present study, some authors report that in most of the times there are two branches that emerge from the SPF (12,14,16). Simmens et al (20) have studied 77 sides of corpse head and have observed that 97% of the cases presented two or more emergent branches from the SPF, and 49 (64%) of the cases presented between three and ten branches. Perhaps their findings are justified by having been a dissection in sagital cuts, under microscopic visualization, differing from other studies in literature that had found up to five arterial branches (12,14,16,17,19). In relation to the number of emergent branches through the accessory foramen, in 100% of the cases only 1 (one) branch has been observed, in agreement with Ram et al (17).

Although other authors (20,21) report anatomical variations among corpses and among nasal fossae of the same corpse, the variations have not been submitted to the statistics analysis. In the present study, there has been good to excellent agreement ($p<0.001$) in relation the localization of the SPF. Unfortunately, to the best of our knowledge, there are no other studies in literature which have investigated the symmetry of nasal fossae.

Trying to foresee when an accessory foramen could be present could be of great value to minimize the therapeutical imperfection. Some authors have tried to correlate the presence of the accessory foramen and the number of arterial branches that emerge from the SPF. Schwartzbauer et al (16) report that in 42% of there cases, there was only one trunk emerging from the SPF in association with an accessory foramen. Ram et al (17) report that the accessory foramen was found in a case with only one arterial trunk emerging from the SPF. The same observation has been found in the present work. Unfortunately, the prediction of the presence of the accessory foramen was not statistically significant in relation the variables studied. The correlation of the presence of the accessory foramen and the measure of the diameter of the vessels which are found in the SPF, in a future study, can contribute to establish this relation and perhaps to guide surgeons.

We are aware of the fact that: 1. The accessory foramen can be present in 2.6-42% of the cases, being situated, in most of the times, in the middle meatus, the extension of the mucoperiosteal flap up to the superior region of the inferior turbinate is important for its joining; 2. The SPF can be situated in the superior meatus, transition of the middle and superior meatus or middle meatus, the superior extension of the mucoperiosteal flap (initiating superior insertion of posterior third of the middle turbinate) is important for the correct localization of the SPF; 3. In the present study, the agreement between the nasal fossae in relation to the number of arterial branches was significant, however poor. In order to detect other possible arterial branches, it is important to extend the mucoperiosteal flap up to the anterior wall of the sphenoidal sinus, in the search of possible ramifications.

Conclusion

The anatomy of the sphenopalatine foramen region is complex and can present anatomical variations that must be taken in consideration during the surgical procedure for the surgical treatment of posterior epistaxe. The mucoperiosteal flap, performed during the ligation of the arteries must be ample and extend up to the anterior wall of the sphenoidal sinus in order to reduce the surgical therapeutical imperfection.

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