Medeniyet Med J. 2019;34:239-43
doi:10.5222/MMJ.2019.20586

Original Study

Morphological Description and Clinical Implication of Sphenopalatine Foramen for Accurate Transnasal Sphenopalatine Ganglion Block: An Anatomical Study

İdeal Transnazal Sfenopalatin Ganglion Bloğu İçin Sfenopalatine Foramenin Morfolojik Ölçümü ve Klinik Uygulaması: Anatomik Bir Çalışma

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Ethics Committee Approval: This study approved by the Health Sciences University, Kecioren Training and Research Hospital, Clinical Studies Ethic Committee, 27 July 2017, 2017/1490
Conflict of interest: The authors declare that they have no conflict of interest.
Funding: None.
Informed Consent: Not Applicable.

Cite as: Sir E, Eksert S. Morphological description and clinical implication of sphenopalatine foramen for accurate transnasal sphenopalatine ganglion block: An anatomical study. Medeniyet Med J. 2019;34:239-43.

ABSTRACT

Objective: *Transnasal sphenopalatine ganglion block is a commonly used approach for treatment of a variety of headache disorders. However, no standard technique has yet been defined for this less invasive approach. In this study, our aim was to investigate morphometric and anatomical features of the sphenopalatine foramen, and to describe a more efficient approach for transnasal sphenopalatine ganglion block.*
Method: *The present study was designed retrospectively. Ten cadaver semi- heads and 18 adult dry skulls (28 samples totally) were included in the study. The distances between the sphenopalatine foramen and palatum durum, and also between the sphenopalatine foramen and the spina nasalis anterior, angle of elevation of the sphenopalatine foramen from palatum durum, and the length and width of the sphenopalatine foramen were measured.*
Results: *The mean width and length of the foramen were 3.79±0.35 and 6.44±0.94 mm, respectively. The mean distance between the palatum durum and the sphenopalatine foramen was 15.58±1.68 mm. The mean angle of elevation of the sphenopalatine foramen from the palatum durum was 26.10±3.97 degrees. The mean distance between the sphenopalatine foramen and the anterior nasal spine was 52.90±2.98 mm.*
Conclusions: *In the transnasal sphenopalatine block, we suggest advancement of nasal applicator through superolateral direction for approximately 5.3 cm, and at an angle of about 26° from the nasal base..*

Keywords: *Sphenopalatine ganglion block, pterygopalatine fossa, cluster headache, migraine*

ÖZ

Amaç: *Transnazal sfenopalatin gangliyon bloku, baş ağrısı hastalıklarının tedavisi için yaygın olarak kullanılan bir tedavi yöntemidir. Ancak bu noninvaziv teknik için henüz standart bir teknik tanımlanmamıştır. Bu çalışmada amacımız, sfenopalatin foramenlerin morfometrik ve anatomik özelliklerini araştırmak ve transnazal sfenopalatin gangliyon bloku için daha etkili bir yaklaşım ortaya koymaktır.*
Yöntem: *Bu çalışma retrospektif olarak dizayn edilmiştir. Çalışmaya 10 adet yarım kadavra kafası ve 18 erişkin kuru kafatası olmak üzere toplam 28 örnek dahil edildi. Sfenopalatin foramen ve palatum durum arasındaki mesafe, sfenopalatin foramen ve spina nasalis anterior arasındaki mesafe, palatin durumundan sfenopalatin foramenlerin yükselme açısı ve sfenopalatin foramenlerin uzunluğu ve genişliği ölçüldü.*
Bulgular: *Foramenlerin ortalama genişliği ve uzunluğu sırasıyla 3,79±0,35 ve 6,44±0,94 mm idi. Palatum durum ve sfenopalatin foramenler arasındaki ortalama mesafe 15,58±1,68, sfenopalatin foramenlerin palatum durumdan yükselme açısı ortalama 26,10°±3,97, sfenopalatin foramenlerin anterior nazal spinadan ortalama uzaklığı 52,90±2,98 mm idi.*
Sonuç: *Transnazal sfenopalatin blok uygulamasında kullanılan nazal aplikatörün süpero-lateral yönde ortalama 5,3 cm, burun tabanından ortalanma 26° açı yapacak şekilde ilerletilerek uygulanmasını tavsiye ediyoruz.*

Anahtar kelimeler: *Sfenopalatin gangliyon bloku, pterigopalatin fossa, küme baş ağrısı, migren*

Received: 16 May 2019
Accepted: 24 July 2019
Online First: 27 September 2019

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INTRODUCTION

The sphenopalatine ganglion (SPG) (according to Nomina Anatomica; ganglion pterygopalatinum) is a predominantly parasympathetic ganglion of the nervous system with extracranial location within the sphenopalatine (pterygopalatine) fossa[1]. Superior salivatory nucleus is the parasympathetic root of the sphenopalatine ganglion in the brainstem. Activation of this nucleus triggers release of acetylcholine, vasoactive peptides, and nitric oxide that results in cerebral vasodilatation and an increase in the flow of cerebral blood and cerebrospinal fluid[2-4]. Symptoms, and signs of rhinorrhea, lacrimation, nasal congestion, conjunctival injection, and periorbital edema are the results of this parasympathetic activity[5]. Primary headache disorders such as migraine, cluster headache, hemicrania continua, and paroxysmal hemicrania may present with these autonomic symptoms. SPG block is a commonly used approach for these headaches and is thought to be effective in the treatment of these disorders by providing parasympathetic inhibition.

Sluder was the first to describe SPG block via a transnasal approach which is the least invasive and easiest technique that targets sphenopalatine foramen (SPF) without need of fluoroscopic or endoscopic guidance[6]. SPF connects the nasal cavity and the sphenopalatine fossa and allows branches of SPG to reach nasal and palatal mucosa[1]. Transnasal SPG block is a topical block formed by the action of the local anesthetic that passes through the thin mucosal layer overlying the SPF[7]. Therefore, blockage should be administered to the most accurate place, that is likely to be the nearest point to the SPF. However, in the literature, to our knowledge, there is no study regarding gold standard application of transnasal SPG block in terms of anatomical features.

In this study, we aimed to identify an ideal SPG block technique by investigating the anatomical and morphometric features of SPF and thus to encourage further use of this less invasive outpatient approach.

MATERIAL and METHOD

This study approved by the Health Sciences University, Kecioren Training and Research Hospital, Clinical Studies Ethic Committee, (27 July 2017, 2017/1490).

Ten formalin- fixed cadaver semi -heads and 18 adult dry skulls (28 samples totally) were included in the study. The cadavers and skulls had belonged to Caucasian adult subjects, and the material was provided by Department of Anatomy, Cadavers had been fixed with formaldehyde; the ages and sexes of the deceased individuals were unknown. Since recognition of the palatum durum and spina nasalis anterior was easy in specimens, those bony landmarks were utilized for the measurements to define the location of the SPF. After nasal cavity dissections under a dissecting microscope (Zeiss OM 1, Germany), the distance of the SPF to the palatum durum and spina nasalis anterior were measured in mid-sagittal sections. The distance between the inferior border of the SPF and the palatum durum was assessed as a vertical distance, whereas the distance between the anterior border of the SPF and the spina nasalis anterior was measured as a longitudinal distance. The shape, length, and width of the SPF were noted. Measurements with high accuracy were obtained by digital photography of the lateral wall of the nasal cavity. The measurements were made on the images using the Image J (image processor program) under the guidance of a scale bar previously placed next to the samples. A digital camera (Canon Ixus 115 HS, Japan) was used for the photography.

Descriptive analyses were made for all variables. Statistical results are given as mean±standard deviation. Comparisons of the measurements between the left and right sides were conducted using Mann-Whitney U test. The SPSS program

(ver. 15.0) was used for statistical analysis of the measurements at a statistical significance set at $p<0.05$.

RESULTS

Examination of the cadavers revealed the SPF in the neighborhood of the posterior edge of the middle nasal turbinate in nine samples. In one of our samples, the SPF extended to the posterior edge of the superior nasal concha. Examination of dry bones revealed most of the SPFs on the transition of the middle and superior nasal turbinates.

Most frequently hourglass-shaped SPF was observed. In four samples, the foramen was irregularly shaped. In the present study, an accessory foramen was found in only one of the investigated samples (Fig. 1).

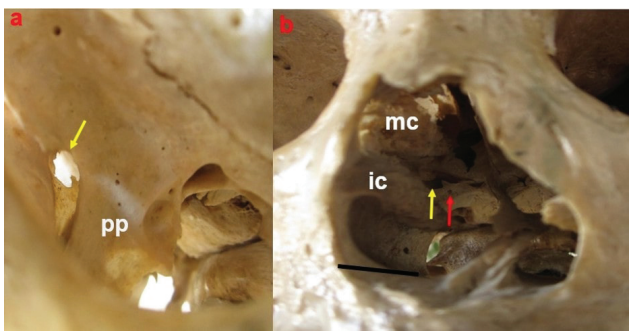

Figure 1. Sphenopalatine foramen.
a. Lateral view of the sphenopalatine foramen through the pterygopalatine fossa. b. View of the sphenopalatine foramen from nasal cavity. pp: proc. pterygoideus, ic: inferior nasal concha, mc: middle nasal concha, Yellow arrows: Sphenopalatine foramen, Red arrow: Accessory sphenopalatine foramen.

The mean width and length of the foramen were 3.79±0.35 mm and 6.44±0.94 mm, respectively. The widest and the longest distances were accepted as the widths and lengths of the foramina due to the irregular shape of the SPF.

The mean distance between the palatum durum and the SPF was 15.58±1.68 mm.

The mean angle of elevation of the SPF from the palatum durum was 26.10±3.97 degrees (Fig. 2).

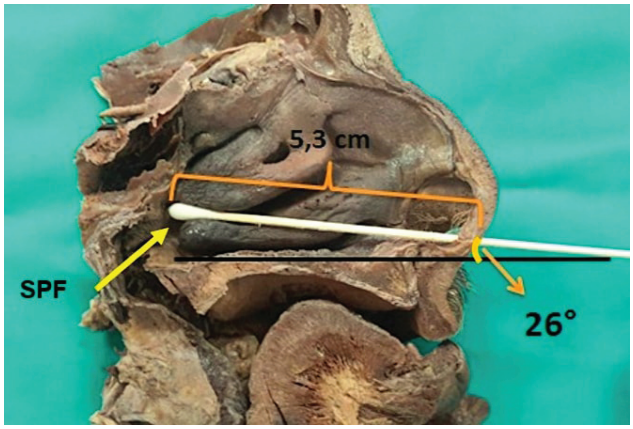

Figure 2. Morphometric measurements of the sphenopalatine foramen.
Mean distance of sphenopalatine foramen from anterior nasal spine (5,3 cm) and mean angle of elevation from palatum durum (26°) is demonstrated with cotton swab. SPF: Sphenopalatine foramen.

The mean distance of the SPF from the anterior nasal spine was calculated as 52.90±2.98 mm. All measurements of the SPFs are summarized in Table 1.

Table 1. Measurements of sphenopalatine foramen (n:28).

Variables	Mean±SD	Range
SNA - SPF	52.90±2.98 mm	49.90-59.10 mm
PD - SPF	15.58±1.68 mm	13.69-18.94 mm
Angle	26.10±3.97°	20.6-32.4°
Width	3.79±0.35 mm	3.21-4.31 mm
Length	6.44±0.94 mm	5.48-8.67 mm

SNA: Spina Nasalis Anterior, SPF: Sphenopalatine Foramen, PD: Palatum Durum

No statistically significant difference was found between the distances of the right and the left sides ($p>0.05$). Similarly, no statistically significant difference was found between the angles of the elevation of the SPF from the palatum durum of the right and left sides ($p>0.05$).

DISCUSSION

We investigated the appropriate approach for transnasal SPG block via using the morphometric features of the SPF, the angles and the distances of the SPF relative to the nasal anatomical land-

marks. In this study, according to the results of anatomical and morphometric measurements we described a standardized approach for the transnasal SPG block.

Prades et al.[8] observed that most of the SPFs in their samples were located superior to the horizontal lamina of the middle concha. Scanavine et al.[9] found that most of the SPFs were located at the neighborhood of the superior nasal meatus, whereas Wareing et al.[10] reported that SPFs extended below the ethmoidal crest in more than half of their samples. Our study showed that the SPF is mostly located in the posterior aspect of the middle nasal turbinate and less frequently in the posterior aspect of the superior nasal turbinate and this data supports the data of previous literatures.

The distance between the SPF and the spina nasalis anterior was almost 53 mm that was in the reported range of the literature (49.1-68.9 mm) [9,11-15].

The dimensions of the SPF (3.79-6.44 mm) were smaller than those reported in the literature (4.62-6.8 and 7.5-9.35 mm)[16,17]. Also, the vertical distance between the SPF and palatum durum (or nasal floor) was reported as 15.58 mm that is less than those reported in the literature ranging from 18.27 to 26.6 mm[8,18]. Hadoura reported an angle of elevation of the SPF from the nasal floor of 22.5° in his computed tomography guided surgical navigation study[13]. As far as we know, this is the first anatomical study to investigate the angle of elevation of SPF from the nasal floor, and we observed a relatively higher angle of elevation of 26.1°. We suggest that the reason of these differences may be related with demographic and racial variations among the sample groups.

The use of a local anesthetic absorbed cotton swab may improve the positioning of the applicator since it is a rigid material and can be directed precisely with the required angle of elevation and lateral deviation. However, this may cause a relative increase in the complications related to trauma, such as epistaxis. Complications may be fewer in experienced hands while using a standardized technique for transnasal SPG blocks[6].

Conventional transnasal and intranasal approaches have given rise to a wide range of pain relief rates, as reported in literature. For example, Robbins et al.[7] reported a 53% pain relief following intranasal spraying, whereas Barre et al.[19] reported a 65% success rate in their study with transnasal cotton swabs. In a study an 80% reduction in headaches was achieved using cotton swabs, while Costa et al. reported a 100% success rate with cotton swabs applied under direct visualization of SPF with rhinoscopy[6,21]. These findings suggest that pain relief rates increase depending on proximity of the administration site to the SPF. However, rhinoscopy is an endoscopic procedure that requires educated staff, advanced equipment, and has low patient tolerability; however a transnasal SPG block with a local anesthetic absorbed cotton swab is a minimally invasive application that can be easily performed in the outpatient clinic without need of any additional equipment and operating room facilities[6].

Although influenced by some individual anatomical characteristics of the patients, we suggest that an optimal transnasal SPG block can be administered via paying attention to features of the technique while advancing the transnasal applicator. The rigidity of the material used for SPG block ensures accurate guidance and estimation of the tip of the device as it moves through the targeted location. According to average results obtained from the study, the distance between the tip of the applicator and the spina nasalis anterior should be around 5.3 cm. The advance angle of the device should be 26 degrees so that it can give a priori information whether the correct spot is reached and the success of the block. Since the SPF is on the lateral wall of the nasal cavity, the tip of the transnasal applicator must be advanced to the lat-

eral wall of the middle meatus with a lateral deviation maneuver and a continuous contact should be maintained during the blockage procedure.

There are limitations to this study. Although, adult skulls were used in the study, ages, sexes of the deceased were unknown. These demographic differences may have led a change in outcomes. Since this was a relatively small study conducted in a single center, there is a need to conduct studies with larger sample groups to determine reliability of the results. Furthermore, since this study conducted with reference to the anatomical landmarks in cadavers, prospective clinical trials are needed to demonstrate the efficiency of the technique described in the study.

CONCLUSION

In the light of our first and preliminary reports, we suggest that an optimal transnasal SPG block can be performed by advancing the transnasal applicator for a distance of a 5.3 cm from the spina nasalis anterior to the SPF through superolateral direction, and continuously maintaining the contact with the lateral wall with an elevation angle of 26° from the palatum durum. Using a rigid applicator such as cotton swab may improve the efficiency of the block. Future anatomical studies with larger samples and clinical trials with follow up results of patients are needed to evaluate the efficacy of the technique we described for transnasal SPGB.

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