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# The anatomical and radiological evaluation of the Vidian canal on cone-beam computed tomography images

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## Abstract

**Introduction** The aim of this study is to explore the anatomy of the Vidian nerve to elucidate the appropriate surgical approach based on preoperative cone-beam computed tomography (CBCT) images.

**Materials and methods** The Vidian canal and its surrounding structures were morphometrically evaluated retrospectively in CBCT images of 400 cases by the Planmeca Romexis program. The types of the Vidian canal were determined and seven parameters were measured from the images.

**Results** Three types of the Vidian canal according to the relationship with the sphenoid bone were found as follows: the Vidian canal totally protruded into the sphenoid sinus (19.75%), partially protruded into sphenoid sinus (44.37%) and embedded inside bony tissue of the body of sphenoid bone (35.87%). The position of the Vidian canal was medial (34.62%), on the same line (55.12%) and lateral (10.25%) to the medial plate of the pterygoid process. The distance between the Vidian canal and the vomerine crest, the mid-sagittal plane, the round foramen, the palatovaginal canal, and the superior wall of the sphenoid sinus, the length of the Vidian canal and the angle between the Vidian canal and the sagittal plane was found to be $16.69 \pm 2.14$, $13.80 \pm 2.00$, $8.88 \pm 1.60$, $5.83 \pm 1.37$, $23.98 \pm 2.68$, $13.29 \pm 1.71$ mm and $25.78° \pm 3.68°$ in males, $14.62 \pm 1.66$, $11.43 \pm 1.28$, $8.51 \pm 1.63$, $5.78 \pm 0.57$, $22.37 \pm 2.07$, $12.91 \pm 1.26$ mm and $23.43° \pm 3.07°$ in females, respectively.

**Conclusions** Our results may assist with proper treatment for surgical procedures around the Vidian canal with a high success rate and minimal complications. Therefore, the results obtained in this study contribute to the literature.

**Keywords** Pterygoid canal · Vidian canal · Vidian neurectomy

## Introduction

The Vidian canal (pterygoid canal) and nerve were described by the Italian anatomist and surgeon, Guido Guidi (Latinized name Vidus Vidius) [1]. The Vidian canal can be seen at the base of the skull at the anterior margin of the foramen lacerum and, above and between the pterygoid plates of the sphenoid bone. It leads into the pterygopalatine fossa and transmits the Vidian nerve, artery and vein. The Vidian nerve is formed by the union of postganglionic sympathetic fibers from the deep petrosal nerve from the carotid plexus and preganglionic parasympathetic fibers from the greater (superficial) petrosal nerve from the facial nerve. After leaving the Vidian canal in the pterygopalatine fossa, the Vidian nerve enters the posterior aspect of the pterygopalatine ganglion. The sympathetic fibers supply the vascular constriction in the nasal cavity and the parasympathetic fibers control the mucosal secretions in the oral cavity, the nasal cavity, and the pharynx [2, 3].

The use of endoscopic sinus surgery has gradually increased owing to being a minimally invasive procedure and having a lower rate of complications compared to open surgeries. Developments in endoscopic sinus surgery have necessitated knowing the variations of paranasal sinuses and nasal formations [4]. The Vidian canal may project into the

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sphenoid sinus. It may also be at risk during surgery and it can be affected by sinus diseases [5]. Moreover, Vidian neurectomy can be carried out in the case of drug-resistant vasomotor rhinitis, allergic rhinitis and nasal polyposis [6, 7]. Localization of the Vidian canal and its relationship to the surrounding structures should be understood for both preventing any damage to the structures inside the Vidian canal during endoscopic sinus surgery and for performing a successful Vidian neurectomy.

As clinical assessment of the pathologies of the base of the skull is difficult and complex, it is very important to perform imaging of this area before surgical treatment. Computed tomography (CT) imaging is ideal for delineating the morphometric and morphological anatomy of the cranial bones [8]. Cone-beam computed tomography (CBCT) imaging is an effective volumetric diagnostic imaging technology that produces accurate, submillimeter resolution images of diagnostic quality in formats enabling volumetric visualization of the osseous structures of the maxillofacial region. CBCT is capable of providing accurate, submillimeter resolution images at shorter scan times, lower dose, and lower costs compared with MDCT [9–11].

Identifying the location of the Vidian canal preoperatively would not only decrease potential complications but also increase the success of surgical interventions. Therefore, the aim of this study is to explore the anatomy of the Vidian canal to elucidate the appropriate surgical approach based on preoperative CBCT images.

## Materials and methods

Coronal and axial CBCT images of 400 individuals (200 males, 200 females, aged between 18 and 65) who had no facial surgery, facial trauma or sinonasal tumors were randomly selected. The images of individuals who were admitted to the Faculty of Dentistry at Gaziantep University for any reason were evaluated retrospectively. All the CBCT images were obtained by Planmeca Promax 3D (with Romexis software version 3.2.0) scanner on multiplanar sections (axial, coronal and sagittal) in standard resolution mode, voxel size: 0.4 $mm^3$ and 16 × 9, 16 × 16 cm FOV. The Vidian canal was evaluated using UltraSharp LED TFT 24 inch monitor (Dell, Dell Inc. Round Rock, TX, ABD). The course of the Vidian canal was followed posterior to anterior on the sections on which it could be identified. This study was approved by the ethics committee of Gaziantep University (Approval date and number: 26 September 2018; 2018/256).

On the coronal plane, the morphology of the Vidian canal was classified into three types according to the localization on the sphenoid bone (Fig. 1).

Type 1: The Vidian canal on the localization where the pterygoid process and body of the sphenoid bone fused.
Type 2: The Vidian canal partially protruded into the sphenoid sinus.
Type 3: The Vidian canal totally protruded into the sphenoid sinus.

On the coronal plane, the morphology of the Vidian canal was classified into three types according to the relationship to the medial plate of the pterygoid process (Fig. 2).

Type A: The Vidian canal located medial to the medial plate of the pterygoid process.
Type B: The Vidian canal located on the same line to the medial plate of the pterygoid process.
Type C: The Vidian canal located lateral to the medial plate of the pterygoid process.

The parameters were measured on the coronal plane (Fig. 3).

1. The distance between the Vidian canal and the vomerine crest.

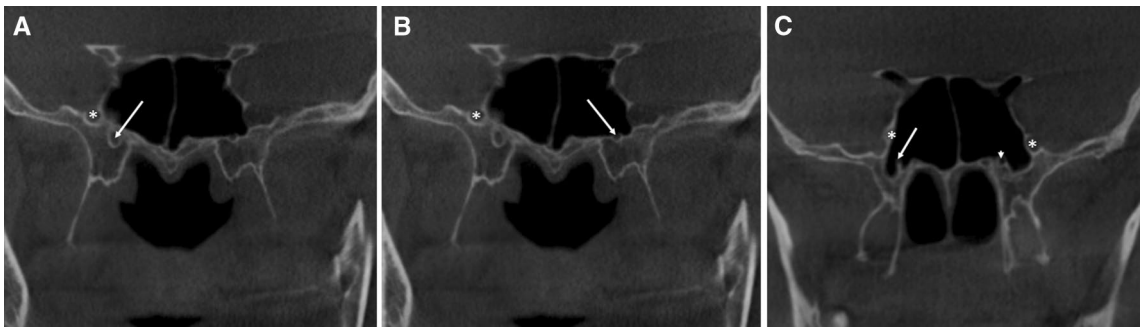


**Fig. 1** Showing the Vidian canal types according to the localization on the sphenoid bone, **A** Type 1, **B** Type 2, **C** Type 3 (Asterisk: Round foramen, White arrow: Vidian canal, Arrowhead: Palatovaginal canal)

2. The distance between the Vidian canal and the mid-sagittal plane.
3. The distance between the Vidian canal and the round foramen.
4. The distance between the Vidian canal and the palatovaginal canal.
5. The distance between the Vidian canal and the superior wall of the sphenoid sinus.

The parameters were measured on the axial plane (Fig. 4).

1. The length of the Vidian canal.
2. The angle between the Vidian canal and the sagittal plane.

## Statistical analysis

The data were evaluated statistically. The suitability of numerical data for normal distribution was tested using the Shapiro–Wilk test. The Student *t* test was used in the comparison of the variables suitable for the normal distribution in two groups; ANOVA test was used in the comparison

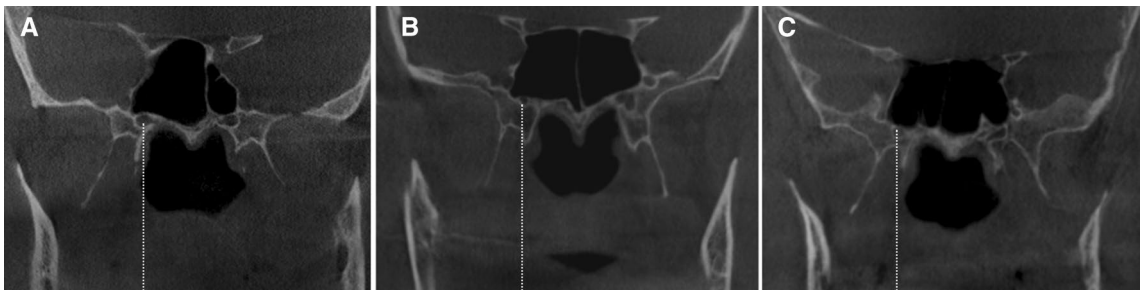


**Fig. 2** Showing the Vidian canal types according to the relationship to the medial plate of the pterygoid process, **A** Type A, **B** Type B, **C** Type C

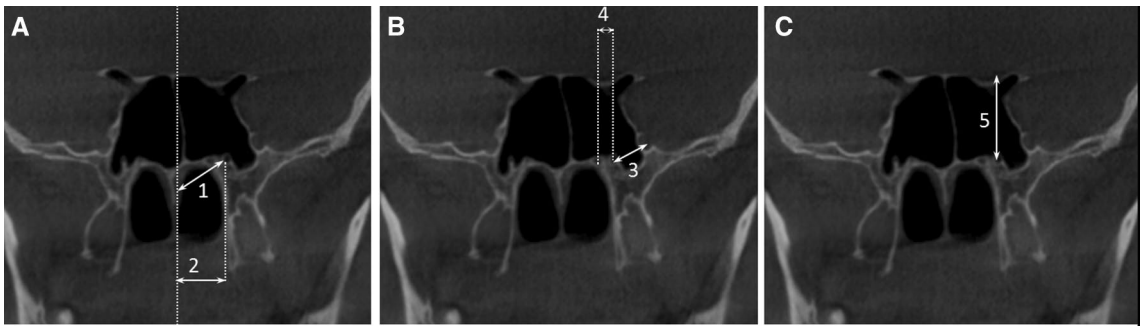


**Fig. 3** Showing the measurements on the coronal plane, **A** Vidian canal-vomerine crest (1), Vidian canal-midsagittal plane (2), **B** Vidian canal-round foramen (3), Vidian canal-palatovaginal canal (4), **C** Vidian canal-superior wall of the sphenoid sinus (5)

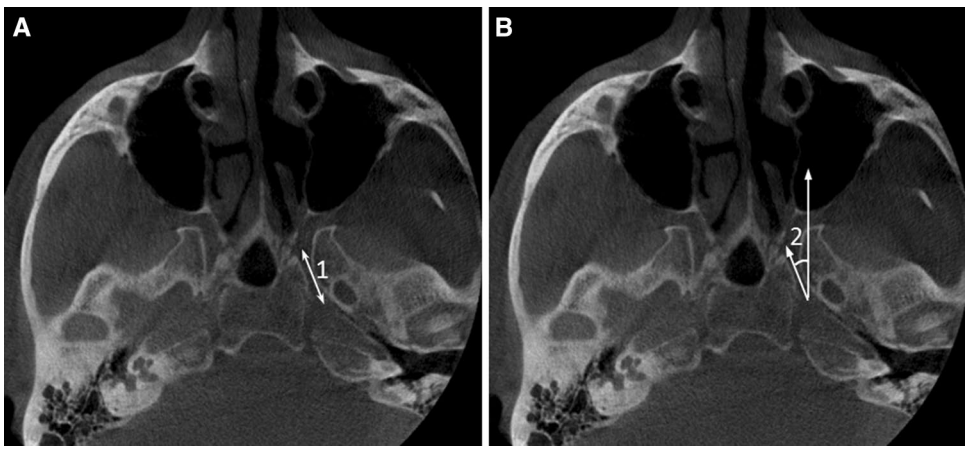


**Fig. 4** Showing the measurements on the axial plane, **A** The length of the Vidian canal (1), **B** The angle between the Vidian canal and the sagittal plane (2)

of the variable in three or more groups. The SPSS 22.0 software package was used in the analyses. $p < 0.05$ was accepted as statistically significant.

## Results

The Vidian canal was examined in detail on the CBCT images of 200 females (mean age: 48.58 ± 12.56) and 200 males (mean age 46.15 ± 12.24) between the ages of 18 and 65. No significant mean age difference existed between the genders ($p > 0.05$). Eight hundred Vidian canals were examined and each of them was evaluated separately.

On the coronal plane, three types of the Vidian canal according to the localization on the sphenoid bone were found as follows: Type 1 (35.87%), Type 2 (44.37%) and Type 3 (19.75%). No significant difference existed between gender and the sides ($p > 0.05$).

On the coronal plane, the results of the morphology of the Vidian canal, classified according to the relationship to the medial plate of the pterygoid process, are given in Table 1. No statistically significant difference was found between the three types in terms of gender and the side ($p = 0.869$, $p = 0.362$, retrospectively).

The measurements of the Vidian canal and its position in relation to anatomical landmarks are summarized in Table 2. There was a significant difference between the two genders in the parameters of the angle between the Vidian canal and sagittal plane, and the distances between the Vidian canal and the vomerine crest, as well as the distances between the Vidian canal and superior wall of the sphenoid sinus (Table 2). The palatovaginal canal was observed in a total of 67 (8.38%) cases, (i.e., 5.63% males and 2.75% females).

**Table 1** Definition of the Vidian canal types according to the relationship to the medial plate of the pterygoid process on the coronal plane

| | Female ($N = 200$) | Male ($N = 200$) | Total ($N = 400$) |
|---|---|---|---|
| Type A | | | |
| R | 79 (39.5%) | 65 (32.5%) | 144 (36%) |
| L | 63 (31.5%) | 70 (35%) | 133 (33.25%) |
| Type B | | | |
| R | 99 (49.5%) | 112 (56%) | 211 (52.75%) |
| L | 119 (59.5%) | 111 (55.5%) | 230 (57.5%) |
| Type C | | | |
| R | 22 (11%) | 23 (11.5%) | 45 (11.25%) |
| L | 18 (9%) | 19 (9.5%) | 37 (9.25%) |

*R* right, *L* left

## Discussion

Vidian neurectomy can be performed in the case of vasomotor rhinitis, allergic rhinitis and nasal polyposis [7]. Vasomotor rhinitis is the most common form of chronic nonallergic rhinitis. Vasomotor rhinitis presents with a clinical picture such as nasal obstruction, postnasal drip, itching, redness, clear rhinorrhea, and watery eyes [12, 13]. It has been thought to result from an imbalance caused by increased parasympathetic stimulation without adequate sympathetic stimulation [6]. Pharmacological approaches are primarily used for treatment purposes [13]. Nasal corticosteroids and antihistamines are two classes of drugs that have been FDA approved for the treatment of nonallergic rhinitis. Other agents such as oral antihistamines, intranasal anticholinergics, oral anticholinergics, oral decongestants, topical decongestants that may be clinically effective are currently used to target specific symptoms [14]. Vidian neurectomy can also be performed in the case of drug-resistant intractable vasomotor rhinitis [6].

In the 1960s, Golding-Wood reported for the first time that Vidian neurectomy could be performed for the treatment of vasomotor and allergic rhinitis [15]. Lee et al. [16] mentioned that many surgeons stopped using this method, because of reasons such as difficulties with the surgical technique, unsatisfactory long-term outcomes and risk of

**Table 2** The measurements of the Vidian canal and its surrounding structures on the coronal and axial planes

| Plane | Parameters | M | F | *p* |
|---|---|---|---|---|
| Coronal | The distance between the Vidian canal and the vomerine crest (mm) | 16.69 ± 2.14 | 14.62 ± 1.66 | $p = 0.001$* |
| | The distance between the Vidian canal and the mid-sagittal plane (mm) | 13.80 ± 2.00 | 11.43 ± 1.28 | $p = 0.001$* |
| | The distance between the Vidian canal and the round foramen (mm) | 8.88 ± 1.60 | 8.51 ± 1.63 | $p > 0.05$ |
| | The distance between the Vidian canal and the palatovaginal canal (mm) | 5.83 ± 1.37 | 5.78 ± 0.57 | $p > 0.05$ |
| | The distance between the Vidian canal and superior wall of the sphenoid sinus (mm) | 23.98 ± 2.68 | 22.37 ± 2.07 | $p = 0.001$* |
| Axial | The length of the Vidian canal (mm) | 13.29 ± 1.71 | 12.91 ± 1.26 | $p > 0.05$ |
| | The angle between the Vidian canal and sagittal plane (°) | 25.78 ± 3.68 | 23.43 ± 3.07 | $p = 0.001$* |

*M* male, *F* female

*Significant difference

complications. In later years, studies using Vidian neurectomy with transseptal [17, 18], transpalatal [19, 20], transantral [21–24], transnasal approach through the middle meatus [25], the microscopic transnasal approach [26, 27], and the endoscopic transnasal approach [7, 28–30] were reported. Although many different methods were reported, Liu et al. [13] stated that these operations did not gain great popularity. They attributed this situation to the difficulty of localizing the Vidian nerve. Morever, Yeh and Wu [31] stated that Vidian neurectomy could not frequently be performed due to the difficulty of the correct identification of the Vidian nerve and potential postoperative complications. Robinson and Wormald [7] explained the failure of Vidian neurectomy in the previous studies due to the fact that the Vidian nerve was never visualized accurately in its canal and was sectioned under direct vision. Liu et al. [13] stated that CT imaging should be performed prior to the surgical approach. In recent years, Robinson and Wormald [7] and Fernandes [32] explained that they achieved favorable results in Vidian neurectomy and no major complications occurred. In a study performing bilateral transnasal Vidian neurectomy in 276 patients, Fernandes [32] reported a satisfactory result in 85–90% was obtained and no major complications occurred; however, minor complications such as dry eyes, temporary headaches and, transient numbness of the palate and teeth were possible. Robinson and Wormald [7] stated that the endoscopic Vidian neurectomy technique was successful in improving rhinorrhea and nasal obstruction symptoms in patients with vasomotor rhinitis in their study. They stated that the most common minor adverse effects were dry eyes (35.7%) and nasal crusting (28.6%) [7]. The cause of such symptoms was the interruption of parasympathetic fibers to the lacrimal gland.

Identification of the Vidian canal on CT images is important in endoscopic sphenoid sinus surgery, transnasal endoscopic approach of the internal carotid artery, transnasal endoscopic skull base surgery, or tumors arising from the Vidian nerve [4, 31]. The Vidian canal can be dissected and followed during endoscopic endonasal surgery to improve orientation and localization of important anatomy [33, 34]. In the endoscopic transpterygoid approach, drilling the sphenoid sinus floor preserving the Vidian canal is thought as an important landmark accessing the anterior genu of the petrous carotid, anteromedial part of the cavernous sinus, and petrous apex [35, 36]. In the endoscopic endonasal transpterygoid nasopharyngectomy, drilling of the Vidian canal must proceed along its inferior hemicircumference, as this better avoids inadvertent injury to the internal carotid artery [37]. Specifically, the Vidian canals Type 1 and Type 2 are reasonably practicable types during these processes. Bolger [38] reported that endoscopic transpterygoid approach makes possible a direct approach to the lateral sphenoid recess that is not possible with previous approaches. In selected cases, such as middle fossa meningoencephalocele with cerebrospinal fluid leak and skull base defect, symptomatic epidermoid cyst and possible invasive fungal sinusitis, Bolger [38] suggested that this approach enables the surgeons to meet modern demands to treat conditions in the lateral sphenoid with the use of endoscopic techniques. In addition, it was mentioned that to be aware of the anatomic variations of the Vidian canal is important and reported that care was taken to preserve the Vidian nerve during the surgery [38]. It is particularly important to know the Vidian canal which both Type 3 and Type C of variation due to the possibility of further damage in this approach.

Liu et al. [13] explained that the Vidian canal could differ between individuals and on both sides of each individual. Therefore, surgeons dealing with this region should keep these differences in mind. There are many studies that evaluate morphometric and morphological features of the Vidian canal [4, 8, 13, 31, 35, 39–54]. Three different types were detected in publications which examined the location of the Vidian canal in the sphenoid bone [4, 8, 13, 31, 39–42, 48–50, 53–55]. However, there are differences in naming of these types. In this study, Type 1 which was the form defined as the Vidian canal on the localization where the pterygoid process and body of the sphenoid bone fused was named as Type 3 by Lee et al. [48], Alam-Eldeen et al. [40], Mohebbi et al. [49], Ozturan et al. [53] and Yeğin et al. [4], while Açar et al. [39], Yeh and Wu [31], Vuksanovic-Bozaric et al. [54] and Liu et al. [13] named it as Type 1. Chen and Xiao [42] classified the same types as Type A, Type B and Type C. Bidarkotimath et al. [41], Omami et al. [50] and Yazar et al. [8] described morphological localization but did not denominate. In comparisons in the literature, standardization was ensured to eliminate complexities using type numbers specified in this study instead of type numbers in previous studies (Table 3).

Liu et al. [13] reported that patients with Vidian canal Type 1, underwent successful Vidian neurectomy using the transnasal approach. They stated that the transsphenoidal approach could be used, though not always, in patients with Vidian canal Type 2 and 3. Therefore, preoperative CT assessments might contribute to determining the surgical method by determining the types of Vidian canal.

Knowing the localization of the Vidian canal in the sphenoid bone, the distances of the Vidian canal to the midsagittal plane as well as to the vomerine crest, increases the rate of success in surgical interventions [13].

Fortes et al. [36] stated that awareness of the anatomical relationships of the Vidian nerve and maxillary nerve are critical for the identification and control of the internal carotid artery and the middle cranial fossa. In addition, Al-Sheibani et al. [37] reported that removing the bone that separates the Vidian canal and round foramen is needed for reaching the petrous internal carotid artery, the Gasserian

**Table 3** Types of the Vidian canal according to the sphenoid bone and comparison with the literature

| Study | *n* | Type 1 | Type 2 | Type 3 |
|---|---|---|---|---|
| Açar et al. [39] | 250 | 278 (55.6%) | 174 (34.8%) | 48 (9.6%) |
| Alam-Eldeen et al. [40][a] | 164 | 102 (31.1%) | 202 (61.6%) | 24 (7.3%) |
| Bidarkotimath et al. [41][b] | 200 | 11% | 67% | 22% |
| Chen and Xiao [42][c] | 167 | 256 (%76.64) | 43 (%12.87) | 35 (%10.47) |
| Lee et al. [48][a] | 89 | 45 (25%) | 83 (47%) | 50 (28%) |
| Liu et al. [13] | 341 | 364 (53.4%) | 233 (34.2%) | 85 (12.5%) |
| Mohebbi et al. [49][a] | 100 | 24% | 48% | 28% |
| Omami et al. [50][b] | 300 | 230 (38.3%) | 238 (39.6%) | 132 (22%) |
| Ozturan et al. [53][a] | 999 | 521 (26%) | 1329 (66.5%) | 148 (7.4%) |
| Vuksanovic-Bozaric et al. [54] | 100 | 60% | 33.5% | 6.5% |
| Yazar et al. [8][b] | 150 | 36% | 54% | 10% |
| Yeh and Wu [31] | 265 | 269 (50.8%) | 211 (39.8%) | 50 (9.4%) |
| Yeğin et al. [4][a] | 594 | 432 (36.4%) | 339 (28.5%) | 417 (35.1%) |
| Present study | 400 | 287 (35.87%) | 355 (44.37%) | 158 (19.75%) |

[a]Standardization was ensured using type numbers specified in our study instead of type numbers in these studies

[b]They described morphological localization but did not denominate

[c]They classified the same types as Type A, Type B and Type C

ganglion, and paraclival internal carotid artery. Kassam et al. [56] stated that care should be taken during bone removal, because the space between the maxillary nerve and the Vidian canal diminishes in a cone-like fashion down to a relatively narrow space separating the two in the depth of the cranial fossa. Mato et al. [55] stated that the distance between the Vidian canal and round foramen is relevant for endonasal approaches to the quadrangular space, which is limited by the horizontal portion of the petrous part of internal carotid artery inferiorly, the maxillary nerve laterally, the paraclival carotid medially, and the abducens nerve superiorly. Therefore, it is important to know the distances between the Vidian canal and round foramen.

The round foramen and the palatovaginal canal can be mistaken for the Vidian canal [13]. Therefore, adjacency of both formations to the Vidian canal should be identified. Although many publications [8, 13, 31, 39, 41, 44–47, 49, 52, 54] examined the distance between the Vidian canal and the round foramen, the distance between the Vidian canal and the palatovaginal canal has been studied less [8, 31, 41]. The reason is the fact that the palatovaginal canal is not always visible on CT images. Rumboldt et al. [57] stated that 38% of bilateral palatovaginal canals and 20.7% of unilateral palatovaginal canals were seen on CT images. Yeh and Wu [31] and Yazar et al. [8] stated that the canal was visible in 47.2% and 16% of cases, respectively. In our study, this rate was detected to be lower than that in the other studies with 8.37%. As for the measurement of the distance between the Vidian canal and the palatovaginal canal, this distance was reported within the range of 3.9–5.2 mm in the previous studies [8, 31, 41]. In our study, we measured this distance as $5.83 \pm 1.37$ mm in males, and $5.78 \pm 0.57$ mm in females (Table 4). The palatovaginal canal transmits the pharyngeal branch of the pterygopalatine ganglion to the pharyngeal orifice of the Eustachian tube. Karligkiotis et al. [58] stated that knowing the macroscopic and radiologic anatomy of the palatovaginal canal is important in the preoperative assessment of the patients, to avoid considering the palatovaginal canal, erroneously as duplication of the Vidian canal. However, during the identification of the Vidian canal, the palatovaginal canal can be confused by surgeons as to be the Vidian canal in the beginning of their experience. Moreover, knowing the anatomy of the palatovaginal canal is of high importance in endoscopic transpterygoid and nasopharyngeal procedures, to determine the Vidian canal, evaluate nasopharyngeal cancer spread in the pterygopalatine fossa, reduce bleeding during surgery of the nasopharynx and harvest adequately the pedicle of the nasoseptal flap [58]. Liu et al. [13] also stated that, if the palatovaginal canal were transected instead of Vidian neurectomy, although no complication had occurred, surgical intervention could be required again as the current complaints of the patient would continue. Particularly, the Vidian canal in which both Type 1 and Type A exist has at high risk of confusion with the palatovaginal canal. Therefore, the presence of the palatovaginal canal should be kept in mind even though it is not always seen on CT images.

Mato et al. [55] stated that length of the Vidian canal is an important distance, because the amount of bone we need to drill during the approach will be related to the length of the Vidian canal. In the literature, the mean measured length of the Vidian canal ranges between

**Table 4** Measurements of the Vidian canal and related landmarks and comparison with the literature

| Study | *n* | Length of pterygoid canal (mm) | | Vidian canal–round foramen (mm) | | Vidian canal–palatovaginal canal (mm) | | Vidian canal–superior wall of the sphenoid sinus (mm) | | Vidian canal–vomerine crest (mm) | | Vidian canal–mid-sagittal plane (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R | L | R | L | R | L | R | L | R | L | R | L |
| Açar et al. [39] | M:143, F: 107 | 12.9 ± 1.9 | | 8.1 ± 2.3 | | | | | | 13.6 ± 1.7 | | | |
| Adın et al. [59] | M: 77, F: 94 | M: 16.6 ± 1.7, F: 15.4 ± 2.0 | | | | | | | | | | | |
| Bidarkotimath et al. [41] | M: 72, F: 128 | 17 (12.4–21) | | 5.4 (0–10.6) | | 5.2 (0–9.8) | | 21 (11–27.6) | | 16 (11.5–18.8) | | | |
| Chen and Xiao [42] | M: 83 | 13.0 ± 2.6 | 12.9 ± 2.5 | | | | | | | | | | |
| | F: 84 | 11.9 ± 3.1 | 12.3 ± 2.0 | | | | | | | | | | |
| Cheng et al. [43] | 200 | 14.56 ± 1.23 | 14.86 ± 1.05 | | | | | | | | | 13.64 ± 0.53 | 13.36 ± 0.34 |
| Fu et al. [44] | M: 64, F: 73 | 13.7 ± 2.3 | 13.3 ± 2.1 | 4.7 ± 2.8 | 5.9 ± 3.6 | | | | | | | | |
| Inal et al. [45] | M: 158 | | | 6.06 ± 2.25 | 6.69 ± 2.38 | | | | | | | | |
| | F: 162 | | | 5.50 ± 2.00 | 6.43 ± 2.12 | | | | | | | | |
| Karci et al. [46] | | 17.90 ± 1.59 | | 9.45 ± 0.60 | | | | | | | | | |
| Kim et al. [47] | M: 51, F: 39 | | | 5.5 (2.4–12.1) | 6.3 (3.4–17.2) | | | | | | | | |
| Liu et al. [13] | M: 54, F: 13 | | | 6.8 ± 0.3 | | | | 14.9 ± 0.5 | | 11.6 ± 0.2 | | | |
| Mato et al. [55] | 116 | 14.4 (7.9–20.3) | 14.7 (8–20.8) | | | | | | | | | | |
| Mohebbi et al. [49] | M: 50, F: 50 | | | 5.06 ± 2.03 | 5.49 ± 2.13 | | | | | | | | |
| Osawa et al. [51] | 20[a] | 13.7 (9.8–19.2) | | | | | | | | | | | |
| | 20[b] | | | | | | | | | | | 10.8 (9.0–13.5) | |
| Tsutsumi et al. [35] | M: 44, F: 47 | 19.8 (15.4–24.9) | 19.3 (14–25.3) | | | | | | | | | | |

**Table 4** (continued)

| Study | *n* | Length of pterygoid canal (mm) | | Vidian canal–round foramen (mm) | | Vidian canal–palatovaginal canal (mm) | | Vidian canal–superior wall of the sphenoid sinus (mm) | | Vidian canal–vomerine crest (mm) | | Vidian canal–mid-sagittal plane (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R | L | R | L | R | L | R | L | R | L | R | L |
| Vescan et al. [52] | 44 | 18 ± 2.6 | 18 ± 2.5 | 5 ± 2.4 | 6 ± 2.5 | | | | | | | | |
| Vuksanovic-Bozaric et al. [54] | M: 56, F: 44 | M: 11.9 ± 0.9, F: 11.1 ± 1 | M: 12 ± 1, F: 10.7 ± 0.8 | M: 5.1 ± 0.8, F: 5 ± 0.9 | M: 5.1 ± 0.9, F: 5.2 ± 1.1 | | | | | | | M: 13.8 ± 1.4, F: 13.4 ± 1.4 | M: 13.7 ± 1.6, F: 13.1 ± 1.7 |
| Yazar et al. [8] | M: 72, F: 78 | | | 7.2 (1–12) | | 4.5 (2–10) | | 19 (12–28) | | 10.5 (8–14) | | | |
| Yeh and Wu [31] | M: 144, F: 121 | | | 6.74 ± 3.65 | | 3.91 ± 1.35 | | | | 11.97 ± 1.63 | | | |
| Present study | M: 200 | 13.40 ± 1.97 | 13.18 ± 1.38 | 8.92 ± 1.68 | 8.84 ± 1.53 | 5.73 ± 0.71 | 6.50 ± 0.51 | 24.16 ± 2.68 | 23.80 ± 2.69 | 16.65 ± 2.28 | 16.73 ± 2.02 | 13.51 ± 2.16 | 14.09 ± 1.81 |
| | F: 200 | 13.08 ± 1.37 | 12.82 ± 1.13 | 8.61 ± 1.59 | 8.42 ± 1.67 | 5.86 ± 0.28 | 5.51 ± 1.60 | 22.65 ± 2.06 | 22.08 ± 2.06 | 14.73 ± 1.68 | 14.51 ± 1.65 | 11.53 ± 1.15 | 11.33 ± 1.41 |

*M* male, *F* female, *R* right, *L* left

[a]Cadaveric specimens

[b]Dry skulls, CT images were used in other studies

11 and 19 mm [35, 39, 41–44, 46, 51, 52, 54, 55, 59]. Osawa et al. [51] detected the distance between the Vidian canal and the mid-sagittal plane in a dry skull as 10.8 (9.0–13.5) mm. Cheng et al. [43] found this distance to be 13.64 ± 0.53 mm on the right side and 13.36 ± 0.34 mm on the left side in CT images. Vuksanovic-Bozaric et al. [54] found this distance to be 13.8 ± 1.4 mm on the right side and 13.7 ± 1.6 mm on the left side in males, 13.4 ± 1.4 mm on the right side and 13.1 ± 1.7 mm on the left side in females in CT images. In our study, we measured these distances similar with the previous studies (Table 4).

In previous studies, the distance between the Vidian canal and the vomerine crest was reported as having a range of 10.5–16 mm [8, 13, 31, 39, 41] and the distance between the Vidian canal and the superior wall of the sphenoid sinus was reported as having a range of 14.9–21 mm [8, 13, 41] (Table 4).

Yeh and Wu [31] reported that the Vidian canal was on the medial or on the same line in 520 (98.1%) cases and on the lateral in 10 (1.9%) cases according to the medial plate of the pterygoid process. Mato et al. [55] identified 90.9% of the cases as medial, 8.7% of cases as being on the same line and 0.4% of the cases as being lateral of the medial plate of the pterygoid process on the right side and 86.1% of the cases as medial, 12.1% of cases as being on the same line and 1.7% of the cases as being lateral of the medial plate of the pterygoid process on the left side. Yazar et al. [8] reported 31% of the cases to be medial, 63% of cases to be on the same line and 6% of the cases to be lateral of the medial plate of the pterygoid process. In this study, the results were found to be similar to those in the study by Yazar et al. [8]. All studies show very low localization of the Vidian canal on the lateral of the medial plate of the pterygoid process.

The angle between the Vidian canal and the sagittal plane was found to be 24.61° ± 3.53° in this study. Cheng et al. [43] detected this angle to be 10.44° ± 2.22° on the right side and 9.49° ± 2.01° on the left side. Liu and Su [60] stated that the angle between the Vidian canal and the sagittal plane was 30.2° ± 4.9° and 33.8° ± 4.8° in the group of patients with (73.58%) and without (26.42%) successful endoscopic Vidian neurectomies, respectively ($p < 0.05$). This result suggests that the rate of failure increases as the angle widens. And as this angle widens, appropriate partial removal of the pterygoid process and a larger area of mucosal destruction are required during the procedure. In such a case, the risk of bleeding of the sphenopalatine artery or branches increases [60]. Therefore, it would be useful to measure this angle via CT imaging prior to the surgical procedure to prevent postoperative complications.

## Conclusion

We believe that these measurements can be used as reference values to determine the localization of the Vidian canal and its position in relation to certain landmarks. Preoperative CT evaluation is important in determining the method of Vidian neurectomy and reducing complications in diseases like allergic rhinitis, vasomotor rhinitis and nasal polyposis. Our results may assist with proper treatment for surgical procedures around the Vidian canal with a high success rate and minimal complications. Therefore, the results obtained in this study will contribute to the literature.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This study was approved by the ethics committee of Gaziantep University (approval date and number: 26 September 2018; 2018/256). We declare that this human study has been approved by the ethics committee of Gaziantep University and has, therefore, been performed in accordance with the ethical standards laid down in the Declaration of Helsinki and its later amendments.

**Informed consent** A formal informed consent procedure was waived due to the retrospective nature of this study.

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