

Vidian canal: radiological anatomy and functional correlations

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Abstract

The Vidian or pterygoid canal is the osseous tunnel for both the Vidian artery and nerve. The aim of the current study is to delineate the Vidian canal in CT scans of head and to establish the landmarks for swift and easy localization of the canal. It is also intended to focus on the functional correlations of the structures present in the canal with its anatomy. The Vidian canal is studied in 200 adult CT scans and its measurements including its internal diameter, distances of the canal from the vomerine crest, from superior & inferior sphenoid sinus wall and from the foramen rotundum are noted. It is observed that canal starts from the medial end of petrous part of internal carotid or up to 8 mm from its medial end, mean distance being 6 mm and runs medial to lateral from foramen lacerum in 1/3rd of cases. Canal with suspended by bony stalk into sphenoid sinus noted in 22%, canal embedded in the body of sphenoid noted in 11% and rest had canals in normal expected position. In 5 instances the canal was found to be divided into two identifiable canals. It was concluded that the course of the Vidian canal vary widely interpersonally and also within the subject and thorough evaluation of the canal morphology by imaging techniques is essential in understanding the physiological and pathological events associated with the structures passing through this canal.

Keywords: Vidian canal, Vidian nerve, sphenoid sinus, foramen lacerum, foramen rotundum.

1 Introduction

Word pterygoid means winglike or resembling wing. Pterygoid canal is a passage in the skull leading from just anterior to foramen lacerum in the middle cranial fossa to the pterygopalatine fossa. It's an anteroposterior canal in the base of each medial pterygoid plate of the sphenoid bone that gives passage to the Vidian artery and the Vidian nerve. These structures are named after Guido Guidi (*L. Viduus* or *Vidianus* or *vidius vidus*). He was a professor of Medicine at college of France in middle of sixteenth century and he was also physician to Francis I. He carried out important anatomical investigations in Pisa after 1548 and recorded his findings in *Anatome, corporis hymani*, which was published posthumously (USTAN, 2003). The anatomical structures bearing his name as eponyms are Vidian nerve, Vidian artery and Vidian canal.

Pterygoid (Vidian) nerve is formed by the union of the greater petrosal branch of facial nerve and deep petrosal nerve from carotid plexus. Greater petrosal nerve (contains mainly taste fibers from palatal mucosa and also preganglionic parasympathetic fibers travelling to the pterygopalatine ganglion) receives a ramus from tympanic plexus, traverses the hiatus on the anterior surface of the petrous temporal bone and enters a groove on it, passing underneath the trigeminal ganglion reaches the medial end of foramen lacerum where the petrous part of internal carotid artery located. Here it is joined by the deep petrosal nerve from the internal carotid sympathetic plexus to become the Vidian nerve or nerve of pterygoid canal which traverses the pterygoid canal to end in the pterygopalatine ganglion. Fibers exiting from the

pterygopalatine ganglion join the nasal, nasopalatine and palatine nerves to convey secretomotor impulses to nose and palatine areas (RHOTON, 2002). The glands in these areas receive the cholinergic fibers passing through the greater petrosal nerve and the blood vessels receive essentially adrenergic innervations through the deep petrosal nerve. Greater petrosal or chorda tympani nerves are considered as pretrematic nerve derived from facial nerve (JONES, 1995). Vidian artery is an inconsistent branch of petrous part of internal carotid artery in foramen lacerum, runs along Vidian nerve in the canal to reach pterygopalatine fossa. A branch of distal maxillary artery travelling posteriorly from the pterygopalatine fossa to foramen lacerum is also reported (OSBORN, 1980). Vidian artery is a "remnant" of the first aortic arch. Pterygoid bone corresponds to the inner plate of the pterygoid process of the human skull. In all vertebrates below mammals, it is not connected with the posterior nares, but serves to connect the palatine bones with the point of suspension of the lower jaw.

Vidian canal anatomy is of technical importance for Vidian neurectomy done for treating resistant cases of allergic and vasomotor rhinitis. The primary purpose of the present study is to show that Vidian canal is appreciated by common imaging technique, CT scan of paranasal air sinuses. Secondary goal of the study is to establish landmarks for swift and easy localization of Vidian canal. This study aims at establishment of position and configuration of Vidian canal. It is also intended to focus on the functional correlations of the structures present in the canal with its anatomy. Vidian

canal also acts as primary landmark for the localization of petrous part of internal carotid artery (KASSAM, VESCAN, CARRAU et al., 2008). Transantral approach to Vidian canal also serves as route for ligation of maxillary artery, for resection of maxillary nerve or resection of pterygopalatine ganglion. This study may serve valuable for the surgeons working in the pterygopalatine area for various reasons. In this study the variation of the Vidian canal wall in anteroposterior direction is noted which is unreported so far which is of particular value in identifying the petrous part of internal carotid artery and also in resection of bone at the mouth (anterior end) of Vidian canal.

2 Materials and method

Paranasal CT scans of 200 (72 males and 128 females) patients who underwent the investigation for various suspected paranasal diseases but found completely normal are selected for the study. Patients with proven paranasal pathology and those who had prior surgery in paranasal areas and in pituitary fossa are excluded. Using G.E. hi speed FX CT (2001), 3 mm contiguous slices were taken and reconstructed in bone algorithm and evaluated. Axial images were taken parallel to cribriform plate of ethmoid and coronal images taken perpendicular to the hard palate. Measurements were made with the 'measure' tool provided with the software of the machine, which has a least count of 0.01 mm.

In each of the images the Vidian canal is demonstrated and its localization with respect to known radiological landmarks (Figure 1). Its length, internal diameter, distance from foramen lacerum, foramen rotundum and palatovaginal canal are measured. Its relation to sphenoid sinus, including whether it is in the inferior wall, embedded in the body of sphenoid or protruded into the sinus cavity was noted. Their relations to medial plate of pterygoid, greater wing of sphenoid are studied. Importance is given to its internal diameter of the Vidian canal in the anterior and posterior end, and to the completeness of the canal in its superior aspect especially anteriorly. Absence of any noticeable bony structures are considered as bony dehiscence and made note off. Canal's internal divisions are given importance. Pterygoid canal relation to the petrous part of internal carotid artery is noted. Also, the relationship to ala of sphenoid bone, to the medial lamina of pterygoid process and to vomerine crest is investigated. Variation in the canal's wall thickness in anteroposterior direction is noted.

3 Results and discussion

Pterygoid canal is identified in all the 200 scans studied on both sides. It can be fairly be pointed to the wedge shaped area formed by the intersection of vertical line drawn up from the medial pterygoid plates and horizontal line joining the two greater wing of sphenoid. Most common variety of sphenoid sinus pneumatization encountered in the study is sellar (90%). Rest of the siuses being presellar. In all the cases the canal starts at the anterior genu of the petrous carotid artery. Canal may start from the medial end of petrous part of internal carotid or up to 8 mm from its medial end, mean distance being 6 mm. In third of the cases pterygoid canal runs medial to lateral from foramen lacerum,

in rest two thirds of cases it runs lateral to medial. Frequently it is closely apposed to the lateral wall of the sphenoid sinus assuming its shape. In most of the patients canal is seen at the lower wall of the sphenoid sinus embedded in its wall or the superior part of canal slightly protruded from it. In 22% of the patients it was found to be suspended from the sphenoid wall by a bony stalk. In these cases the canal almost freely floats in the cavity of sphenoid sinus.

In 11% of patients the canal is embedded in the body of sphenoid, buried almost 2-6 mm deep from the inferior wall of it (Figure 3). Canal is found to be floating in the sphenoid sinus on right side in 2% of the cases studied (4 of the scans) and measured the smallest in the study, has 12.5 mm length. Usually canal internal diameter is smallest near the foramen lacerum and it widens as it approaches the pterygoid fossa and frequently its superior wall is deficient (Figure 1 and 2). Anterior end of the canal is found to be dehiscence superiorly

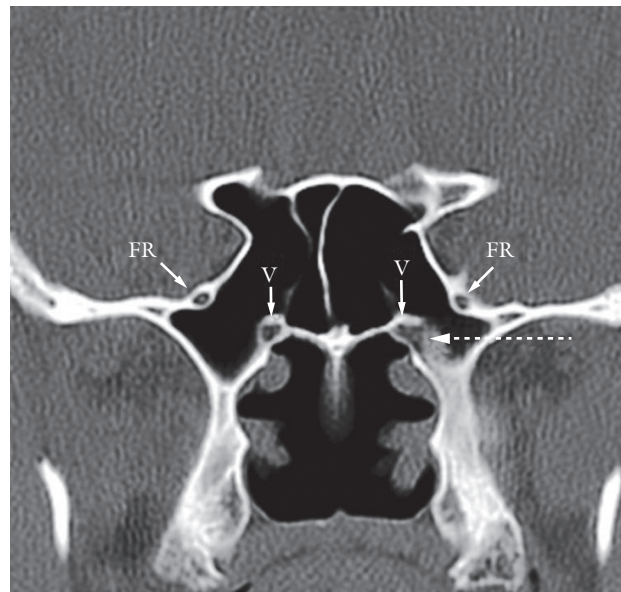


Figure 1. Shows normal position of Vidian canal (V) and foramen rotundum (FR). Dotted arrows shows the deficient anterior end of the Vidian canal.

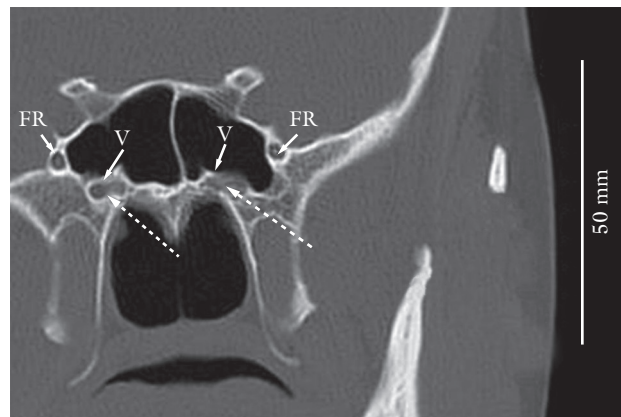


Figure 2. Shows normal position of Vidian canal (V) and foramen rotundum (FR). Dotted arrow shows the deficient anterior end of the Vidian canal.

in 3% of cases studied (6 patients). In 5% instances the canal is found to be divided into two identifiable canals. In one instance the canal is divided by a vertical bony lamina. In this case the palatovaginal and vomerovaginal canal were identified on the same side and it is confirmed that it is not the adjacent canal touching the pterygoid canal, and indeed it is divided into two compartments by the bony lamina, probably each for its contents. In other case the division is horizontal, by soft tissue. The distances of the Vidian canal from notable radiological landmarks are tabulated in Table 1. Internal diameter of the canal varied on both sides; being 0.9 to 2.7 mm. Canal is circular in cut section in third of the cases, vertically oval in other third and horizontally oval in rest. Foramen rotundum and pterygoid canal are very close, less than a millimeter distance in 1% of cases, and in one case the bony lamina of each of these canals are in contact. In one instance the pterygoid canal is touching the palatovaginal canal.

Though it is said that the canal is in line with the medial pterygoid plate projected upwards, in 24% of the cases the canal is situated either medial (16%) or lateral (8%) to it. In both the cases the canal is fairly identified within a millimeter to 3 mm (max distance) from the plane of medial pterygoid plate. The pterygoid canal is inferior to greater wing of sphenoid in 22% of cases and superior to greater wing of sphenoid in 3% of the cases, and it is at the same level as the greater wing of sphenoid in 75% cases.

Endoscopic skull base surgeries demands thorough understanding of complex neurovascular anatomy of the region and its relation to known anatomical and radiological landmarks. In this regard swift and easy localization of Vidian

canal in the CT scans of paranasal sinuses is of significance in understanding its relation to sphenoid sinus and to internal carotid artery. The Vidian nerve exits the cranium through the pterygoid canal, which is identifiable between the foramen lacerum posteromedially and the pterygopalatine fossa anterolaterally at the caudal portion of lateral vertical compartment (GRANEY and BAKER, 1993). This nerve is an important landmark leading to foramen lacerum, mandibular nerve, foramen ovale, pterygopalatine fossa and to eustacian tube (ALFIERI and JHO, 2001). Anterior end of the Vidian canal widens to a funnel-like mouth similar in size to the foramen rotundum. The mouth of Vidian canal lies 8-9 mm below and medial to the foramen rotundum. It is also recessed on a posterior plane and between these two foramina there is often a distinct vertical bony ridge (GOLDING-WOOD and PHILIP, 1983). Ordinarily the Vidian canal runs along the inferolateral aspect of sphenoid sinus. The sphenopalatine or pterygopalatine ganglion lies directly in front of the mouth of the Vidian canal (CURTIN, SOM, BRAUN et al., 1996). Vertically below the Vidian canal's anterior mouth but slightly anterior is the pterygopalatine canal between palatine bone and maxilla. The foramen lacerum is located medially and superiorly to the Vidian canal. The lacerum segment of the internal carotid artery is boedred by the Vidian canal inferolaterally and origin of the mandibular nerve superolaterally (ALFIERI and JHO, 2001).

The structures which can be readily delineated in the CT scan of skull base like foramen lacerum, sphenoid sinus lateral wall, pterygopalatine fossa (in axial view) and foramen rotundum, vomerine crest (in coronal view) are used in the study for ease of measurement and consistency of identification, and are used to define the relative position of the Vidian canal (BARAKOS, DILLON and CHEW, 1991). In the current study it is found that Vidian canal can be fairly localized to the wedge shaped area formed by the intersection of the floor of the sphenoid sinus with the medial pterygoid plate, which leads to the pterygoid wedge. This is in accordance with the cadaveric study done by Amin B. Kassam (KASSAM, VESCAN, CARRAU et al., 2008) and radiological study by Chang (CHANG, FAN, LAU et al., 2000). The relation to the superior and inferior wall of the sphenoid sinus is also noted as there can be Vidian canals which are freely suspended in the sinus cavity or attached to the lateral (at times inferior wall) of the sphenoid sinus by a thin bony lamina or it can also be embedded in the body of the sphenoid bone. The intrasinus Vidian canal has been reported by Pandolfo (7.5-13% CT study) (PANDOLFO,

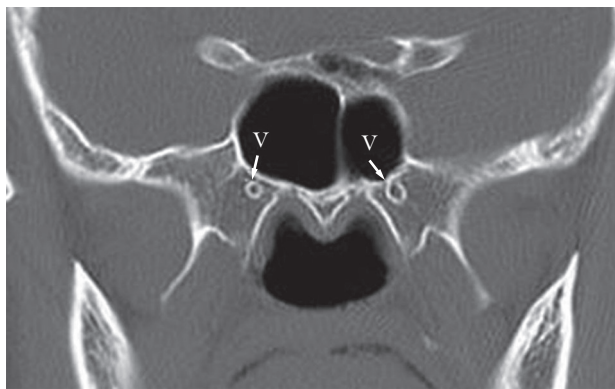


Figure 3. Shows the Vidian canal (V) burried in the body of sphenoid.

Table 1. Tabulation of pterygoid canal measurements.

Parameter	Measurements (mm)		
	Minimum	Maximum	Mean
Length of pterygoid canal	12.4	21	17
Internal diameter of pterygoid canal	0.9	2.7	2.3
Distance from the foramen rotundum	0	10.6	5.4
Distance from medial wall of foramen lacerum	0	8	6
Distance from the palatovaginal canal	0	9.8	5.2
Distance from superior wall of sphenoid sinus	11	27.6	21
Distance from inferior wall of sphenoid sinus	0	10.8	2
Distance from vomerine crest	11.5	18.8	16

GAETA, BLANDINO et al., 1987) by Tan (upto 50% cadaveric study) (TAN and ONG, 2007) and by Kazkayasi (KAZKAYASI, KARADENIZ and ARIKAN, 2005). Zoran Rumboldt reported 15% endosinus Vidian canals, a slightly higher incidence than previous workers (RUMBOLDT, CASTILLO and SMITH, 2002). Nearly one fourth of the canals in the current study are intrasinus (Figure 4). This is the highest incidence in all the reported work. The knowledge of variations of Vidian canal is important in both understanding the normal functions of the contents of it and also in pathological conditions affecting the sinus cavity to which it is freely communicated. Osborn has reported 4.5-5% of canal's superior wall is deficient (OSBORN, 1980), which in current accounted to about 9%. Nerve fibers in such intrasinus suspended canals with bony dehiscence are at risk of exposure to changes in temperature and humidity and also to direct effect of sphenoid sinus pathology. This kind of variations accounts to the rare cases of perineural invasion of inflammatory and neoplastic conditions of sphenoid sinus (CALDEMEYER, MATHEWS, RIGHI et al., 1998) (PARKER and HARNBERGER, 1991) (PANDOLFO, GAETA and BLANDINO, 1989) (CHONG and FAN, 1997) (GINSBERG, DEMONTE and GILLENWATER, 1996).

Direction of canal, in axial CTs, is medial to lateral in 80% (KIM, KIM and CHUNG, 1996) (KAZKAYASI, KARADENIZ and ARIKAN, 2005) to almost 98% (KASSAM, VESCAN, CARRAU et al., 2008) and current study showed such direction in just 70%, rest being directed lateral to medial when seen from foramen lacerum. Though, according to Amin B Kassam, most (98%) of the Vidian canals are found in the wedged area between the floor of the sphenoid sinus and medial pterygoid plate, present study showed the canal's anterior end present, lateral to pterygoid plate in 8%, medial to it in 16%, inferior to floor of sphenoid sinus in 22% and superior to it in 3%. In 2 occasions it was noted that the Vidian canal is in contact with foramen rotundum, separated only by a thin bony lamina.

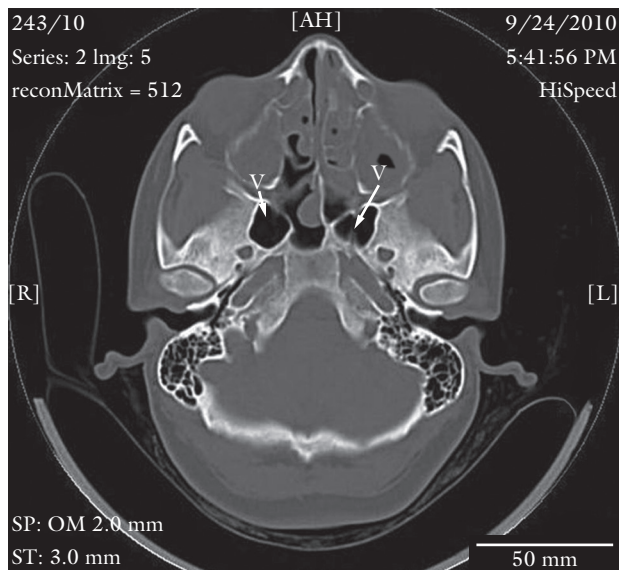


Figure 4. Shows the intrasinus Vidian canal (V).

4 Conclusion

The course of the Vidian canal may vary interpersonally and also from one side to another. Vidian canal can be effectively and easily delineated in all the paranasal CT scans. Vidian canal localization in coronal paranasal CT scans may vary significantly below or above and medial or lateral to the established landmark of wedged area between greater wing of sphenoid and medial pterygoid plate. Intrasinus Vidian canals are subjected to the direct effects of changes of the sphenoid air sinus functional anatomy and to its pathology. Significant proportion of patients has deficient anterior ends of canals which makes exposure of mouth of the canal easy during transantral approach to Vidian neurectomy. CT evaluation of each patient is of paramount importance in understanding and correlating the functional and pathological events occurring at neurovascular structures with the adjacent sphenoid sinus.

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