EAJNS East African Journal of Neurological Sciences
Official journal of East African Association of Neurological Surgeons

Original Article EAJNS 3(2): 53-60

A Radiological Assessment Of The Morphology And Morphometry Of The Vidian Canal In A Select Kenyan Population

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Received:23-04-2024; Revised: 20-07-2024; Accepted: 20-07-2024
DOI: https://dx.doi.org/10.4314/eajns.v3i2.3

ABSTRACT

Background: The increased use of endoscopic approaches to the skull base has necessitated the identification of landmarks that assist in avoiding injury to structures within the skull base. The vidian canal (VC) is an established landmark for the petrous portion of the internal carotid artery (ICA). Although population differences have been reported in the literature, the area remains relatively unexplored in African populations. **Materials and methods:** Axial and coronal sections of 96 high-resolution computed tomography Head and neck CT from Kenyan patients were analyzed to determine VC morphometry. The VC length was determined using axial sections, and the VC-medial pterygoid plate (MPP) distance was determined using coronal sections. **Results**: The mean VC length studied was 16.50±2.30mm (10.50-22.40mm). No statistically significant differences were noted between sides (p=0.686) or sexes (p= 0.826, 0.593). The mean VC-MPP distance was 9.60±2.70 mm (2.40-21.40mm). No statistically significant differences were noted between sides (p=0.237) or sexes (p=0.886,0.850). The relational configurations of the VC to the SS were noted as follows: Type I (wholly within the cavity of the SS)-21.35%, Type II (VC on the floor of the SS or partially protruding into the SS) -76.57%, Type III (VC within the sphenoid corpus)- 2.08%. No significant correlation was noted between the type of VC configuration described and the side of the skull studied (p= 0.499). However, a significant correlation was noted between the type of VC configuration and sex (p=0.001). **Conclusion**: A greater VC-MPP distance implies a reduced risk of iatrogenic injury to the contents of the vidian canal during trans pterygoid approaches. The relational configurations of the VC to the SS show a correlation with sex in the current study. The increased prevalence of type I VCs among males indicates an increased risk during transsphenoidal surgical approaches.

Keywords: Vidian canal, medial pterygoid plate, endoscopic endonasal approaches.

INTRODUCTION

The vidian canal (VC) connects the foramen lacerum (FL) at the base of the skull to the pterygopalatine fossa (PPF) [1]. It runs through the sphenoid bone, from the FL to the PPF, opening into its posterior wall [2]. It houses the vidian nerve as well as the vidian artery. The vidian nerve is a fusion of the greater petrosal nerve, which innervates the lacrimal gland with parasympathetic fibres, and the deep petrosal nerve, which innervates the nasal mucosa with sympathetic fibers [3]. The vidian artery has been shown to originate from the internal carotid artery (ICA) or the maxillary artery. It has also been shown to be an anastomosis between the two arteries [4].

The increased use of endoscopic approaches to the skull base has necessitated the identification of landmarks that assist in avoiding iatrogenic injury to structures within the skull base. The VC is regarded as an accurate landmark for the petrous ICA. Drilling along its inferior and medial walls allows access to the ICA's anterior genu as it runs over FL without causing damage [5]. Moreover, the landmark reduces the risk of ICA damage during transsphenoidal and trans pterygoid approaches to the PPF. Trans pterygoid approaches to the base of the skull, particularly type III trans pterygoid approaches, may also necessitate the removal of part of the medial pterygoid plate (MPP) [6]. Therefore, understanding the distance between the VC and MPP would be critical in reducing the risk of iatrogenic injury to the contents of the VC during trans pterygoid surgical approaches to the skull base and middle cranial fossa (MCF) [6].

The structure of the VC has been reported in other published studies. In particular, its length, relation to sphenoid sinus (SS), and distance to MPP have recorded the most differences between populations [7]. Although the variant anatomy of the VC has been reported in other populations, it remains relatively unexplored in African populations, especially in Kenyan populations. The dearth of information has been attributed to the VC's depth and difficulty of access [3]. However, the advent of high-resolution computed tomography has simplified the visualization of the VC, which was previously difficult in osteological studies. Computed tomography (CT) has been shown to allow good visualization of the VC [2]. Therefore, this study aimed to describe the morphology and morphometry of the VC in a sample of the Kenyan population.

MATERIALS AND METHODS

Permission to conduct the study was obtained from our local hospital ethical committee, the Department of Radiology and local hospital administration granted permission to conduct the study. Identification serial numbers were used to ensure anonymity.

Our variables were measured on high-resolution CT scans (Head and neck) of adult Kenyan patients who presented to our local hospital between May 2020 and April 2021. The CT scans were taken by Neusoft ™ Neuviz 64-slice machine. 0.5 mm slices were used to examine the images on the bone window. Patients with a history of surgical procedures, trauma, or pathology that could distort the anatomy of the VC were excluded from the study. Axial and coronal sections of 96 Head and neck CT scans from Kenyan patients were analyzed to describe the morphometry of the VC. The axial sections were used to determine the length of the VC *(Fig. 1),* while coronal sections were used to determine the VC -MPP distance and the relational configurations of the VC to the SS *(Fig. 2)*. The relational configurations of the VC to the SS were described using coronal sections. They were classified as Type I (totally protruding into SS), Type II (partially protruding into SS), or Type III (wholly embedded in the sphenoid body). The classification was based on a study by Lee *et* *al*. (2011) [8]. *(Fig. 3)*. An independent t-test was used to compare sex differences in the length of the VC and its distance from the MPP, while the paired t-test was used to compare both sides intra-individually. The data was presented using photographs, tables, and graphs after statistical significance was determined.

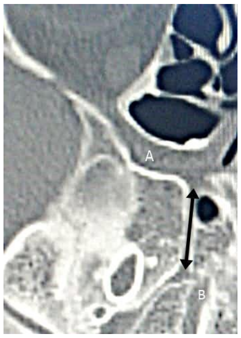

Figure 1: Measurement of the length of the vidian canal on axial sections

LEGEND: A - Pterygopalatine Fossa B- Foramen Lacerum

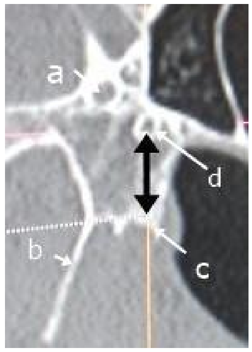

Figure 2: Measurement of the distance of the vidian canal to the base of the medial pterygoid plate

LEGEND: a- Foramen Rotundum b- Lateral pterygoid plate c- medial pterygoid plate d- Vidian canal.

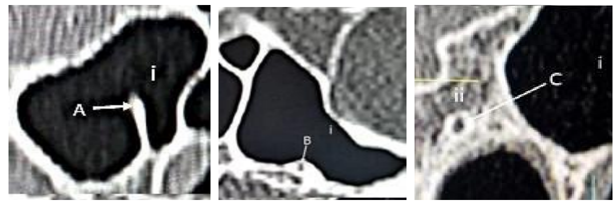

Figure 3: Relational configurations of the vidian canal to the sphenoid sinus

LEGEND: (indicated with blue arrows) A- Type 1 VC B- Type II VC C- Type III VC
i- Sphenoid sinus
ii- Sphenoid body

RESULTS

A total of ninety-six (96) scans were studied of which 48 (50%) were males and 48 (50%) were females. Therefore, a total of 192 VCs (96 on each side) were measured. No statistically significant side differences in VC length were noted (p=0.686). VCs on the right were longer than those on the left. There were no statistically significant sex differences (p= 0.826,0.593). The VC was found to be longer in males than females. *(Table 1).* The mean distance from VC to MPP was found to be 9.60± 2.70 mm (2.40 – 21.40 mm). No statistically significant side differences were noted (p=0.237). Right VC-MPP distances were generally greater than those on the left. No statistically significant sex differences were noted (p= 0.886, 0.850). The VC-MPP distances were found to be greater in males than females *(Table 1).* 147 (76.56%) had a type II configuration, 41 (21.35%) had a type I configuration, and 4 (2.08%) had a type I configuration. No significant correlation was made between the relational configurations of the VC and the side of the skull studied (p= 0.499). A significant correlation was made between the relational configurations of the VC and sex (p= 0.001). Male VCs exhibited all 3 configurations whereas female VCs only exhibited type II and III configurations. (*Fig. 4*)

Table 1: Sex differences in lengths of vidian canal and VC-MPP distances

Parameter (mm)	Side	Male (mean ±SD) N= 48	Female (mean ±SD) N= 48	P
Length of Vidian canal	Right	16.60 ± 2.50	16.50± 2.50	0.826
	Left	16.60± 2.30	16.40± 2.20	0.593
Distance to the base of MPP	Right	9.74 ±2.70	9.66± 3.00	0.886
	Left	9.51± 2.40	9.41± 2.70	0.850

Figure 4: Relational configurations of the Vidian canal to the sphenoid sinus in males and females

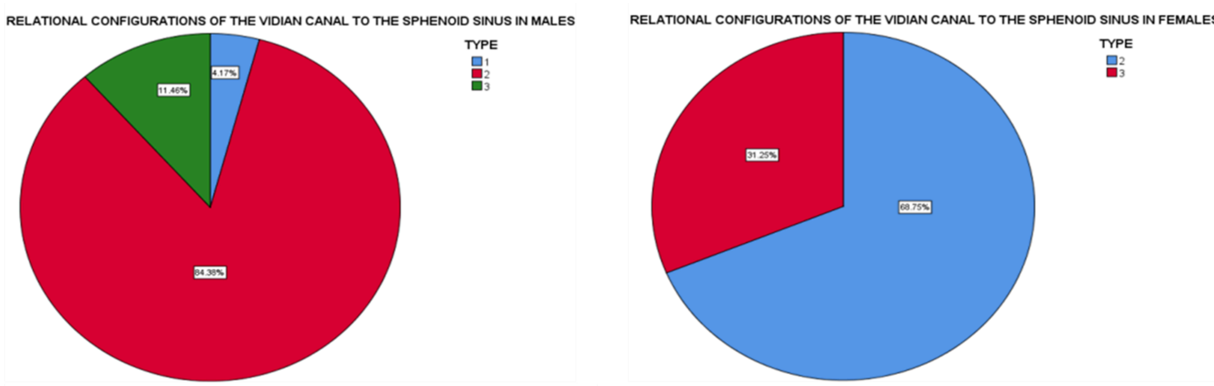

Table 2: A comparison of VC lengths measured in the present study and previous studies

AUTHORS	POPULATION	STUDY TYPE	SAMPLE SIZE	SEX	SIDE	LENGTH (mm)
Vescan *et al.*, 2007	North American	CT	44	-	RIGHT	18±2.6
				-	LEFT	18±2.5
Bidarkotimath et al., (2012)	Indian	CT	200	-	-	17
Chen and Xiao, 2015	Chinese	CT	167	MALE	RIGHT	13.0±2.6
					LEFT	12.9±2.5
				FEMALE	RIGHT	11.9±3.1
					LEFT	12.3±2.0
Mato *et al.*, 2015	Japanese	CT	231	-	RIGHT	14.4
				-	LEFT	14.7
Cheng *et al.*, 2016	Chinese	CT	200	-	RIGHT	14.56
					LEFT	14.86
Bahşi et al., 2019	Turkish	CT		MALE	-	13.29±1.71
				FEMALE	-	12.91±1,26
Açar et al., 2019	Turkish	CT	250	-	-	12.9±1.9
Lakshman et al., 2020	Indian	CT	52	-	RIGHT	16.32±1.68
					LEFT	16±1.97
Ucerler et al., 2020	Turkish	Osteology	183	-	-	16.2 ±2.6
Present study, 2021	Kenyan	CT	96	MALE	RIGHT	16.6±2.5
					LEFT	16.6±2.3
				FEMALE	RIGHT	16.5±2.5
					LEFT	16.4±2.2

Table 3: Comparison of VC-MPP distances measured in the present study and previous studies

AUTHORS	POPULATION	SAMPLE SIZE	SIDE	VC-MPP DISTANCE MEAN (mm)
Vescan *et al.*, 2007[9]	North American	44	RIGHT	9.3 ± 3.4
			LEFT	9.3±3.3
Mato *et al.*, 2015	Japanese	231	RIGHT	8.5
			LEFT	8.9
Present study, 2021	Kenyan	96	RIGHT	9.7±3.0
			LEFT	9.5±3.0

Table 4: Comparison of VC types found in present and previous studies

AUTHORS	POPULATION	SAMPLE SIZE	TYPE I (%)	TYPE II (%)	TYPE III (%)
Yazar *et al.*, 2007	Turkish	150	10	54	36
Lee *et al.*, 2011	Taiwanese	89	28	47	45
Omami *et al.*, 2011	Libyan	300	38.3	39.6	22
Liu *et al.*, 2010	Taiwanese	67	53.4	34.2	12.5
Mohebbi *et al.*, 2017	Iranian	100	28	48	24
Yeğin *et al.*, 2017	Turkish	594	35.1	28.5	36.4
Present study	Kenyan	96	2.08	76.56	21.35

DISCUSSION

A comparison of the current study's VC lengths with those of other studies shows minor differences which could be racial differences and environmental factors that determine skull base dimensions [9] *(Table 2).* No statistically significant differences between sides and sexes were reported in this study. This is similar to previous studies done in North America [10], Turkish [2,3,11], Chinese [12], Indian [13,14] and Japanese populations [7]. The VC is a reliable landmark for endoscopic surgery; therefore, its length is important for surgical planning, particularly in determining the extent of drilling to be done within the sphenoid bone [3].

A comparison of the present study's VC-MPP distances and those obtained from previous studies is summarized (*Table 3*). The VC-MPP distance was greater in the present study than in previous studies done in North American and Japanese populations. The VC-MPP distance is important to consider while planning for trans pterygoid approaches to the skull base [6]. Type II VCs were most commonly encountered in the present study. This is similar to other studies done by Yazar et al. (2007) in a Turkish subpopulation [15], Lee et al. (2011) in a Taiwanese population [8], Omami et al. (2011) in a Libyan population [16] and Mohebbi et al. (2017) in an Iranian population [17]. The present study's results contradict those of Yeğin et. al (2017) [18] who found that Type III was the most common in a Turkish subpopulation and Liu et. al. (2010) [19] who found Type I was the most prevalent in a Taiwanese subpopulation. These racial and ethnic differences could be attributed to the different sample sizes used as well as genetic and environmental factors [9]. (*Table 4*).

A significant correlation was found between sex and the relational configuration of the VC. This finding has been previously overlooked in other studies as observed by Yeğin et al. (2017) [18]. The association could be attributed to genetic and hormonal differences in skull development between sexes [9]. The relational configurations of the VC to SS are important in the surgical planning of transsphenoidal approaches as they determine the amount of drilling required to access the SS. Furthermore, knowledge of these configurations is important to reduce the risk of iatrogenic injury to the contents of the VC as well as the ICA. Type I VC is considered the riskiest due to its location within the SS cavity [12]. Type III VCs usually require a lot of drilling to access them [7]. Furthermore, their visualization is difficult. Type II VCs are considered ideal due to their proximity to the SS cavity [12]. Since type II VCs are the most prevalent in the Kenyan population, it implies relative ease of visualization during transsphenoidal approaches. This reduces the risk of iatrogenic injury to VC contents. Moreover, the increased likelihood of finding type I VCs among male patients raises the need for increased caution while handling male patients.

Intra-observer errors during the measurement of parameters and the limited nature of our study sample were our study limitations. Each variable was measured thrice to reduce the intra-observer area, and the level VI status of our study site made it an ideal area to collect data from individuals from all over the country.

CONCLUSION

This study has offered some insight into the morphometry of the VC in a select Kenyan population. A greater VC-MPP distance implies the reduced risk of iatrogenic injury to the contents of the vidian canal during trans pterygoid approaches. The relational configurations of the VC to the SS show a correlation with sex in the current study. The increased prevalence of type I VCs among males indicates an increased risk during transsphenoidal surgical approaches in male patients. Therefore, precautions, such as the use of imaging techniques pre-operatively, should be taken to reduce the risk of injury to high-risk patients.

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