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Investigation of accessory transverse foramen in dry cervical vertebrae: incidence, variations, types, locations, and diagnostic implications

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Abstract

Background This research aimed to determine the incidence, variations, types, and potential locations of the accessory transverse foramen (ATF) in dry cervical vertebrae. A total of 250 Turkish dry cervical vertebrae were examined, with 500 transverse foramina investigated. The cervical vertebrae were categorized into five groups (C_3–C_7), and each cervical vertebra was assessed bilaterally to determine the location, incidence, and side of the ATF.

Results ATF was observed in 21 vertebrae (8.4%) and was distributed posteriorly (76.2%), posterolaterally (19.04%), and posteromedially (4.8%) in relation to the location of the TF. The incidence of ATF was 4.8% in C_3, 28.6% in C_4, 9.5% in C_5, 23.8% in C_6, and 33.3% in C_7. Furthermore, a statistically significant difference was observed in the unilateral or bilateral occurrence of the ATF ($F = 3.079$; $p = 0.047$, $p < 0.05$).

Conclusions In this study, we have presented an investigative approach and discussed the potential implications of identifying the ATF in dry cervical vertebrae. The presence of ATF can be crucial in the diagnosis of variations in the vertebral artery (VA) and underlying disorders, potentially aiding in the determination of the cause of death or ancestry. Additionally, the posterior location of the ATF and its asymmetric distribution should be taken into account when evaluating dry cervical vertebrae, which may offer valuable information for the identification of variations.

Keywords Transverse foramen, Accessory transverse foramen, Cervical vertebra, Vertebra, Spine, Bone

Background

The transverse process of the cervical vertebra contains the transverse foramen (TF), which are distinctive bony characteristics of the cervical vertebra. They have bony passageways for the sympathetic plexus and vertebral vessels. They display differences in size and form, and they may even be non-existent or duplicated (Aziz and Morgan 2018). The vertebral artery (VA) often enters via the TF of C_6, and it can also pass through C_{3-5} or C_7. The size and shape of the TF have been shown to have a direct impact on the development of the VA (Travan et al. 2015).

Detailed knowledge of the ATF can help in identifying variations in the arteries and related nerves. The size and shape of the ATF may vary between individuals, and this variation can be used to study medical conditions related to the spine and nervous system (Singh et al. 2019). The aim of the study is to investigate the variations of the ATF of the cervical vertebra and contribute to the understanding of these bony characteristics and their importance in identification processes and diagnostic implications.

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Methods

The current study was approved by the ethics committee of the university (approval date: 26 August 2020, number: 598). Five hundred transverse foramina were investigated out of 250 contemporary Turkish dry cervical vertebrae which were obtained from the osteological collection of the Anatomy Department of Akdeniz University in 2018–2021. The cervical vertebrae used in this study were not obtained through post-mortem or body donation programs, and information regarding the time of birth and death, age, sex, and medical history of the individuals was unknown. Each vertebra was evaluated bilaterally to determine the presence, location, and side of the ATF. Twenty-five cervical vertebrae which were incomplete, morphologically unsuitable, had pathology or fractures, or had undergone surgery were not included in the study. The ATF was classified according to the type, incidence, and location as previously described in the literature (Taitz et al. 1978). The observations were performed by one observer to prevent intra-observer measurement errors. The technical error measurements, relative error measurements, and coefficient of reliability were detected in order to attain intraobserver precision (*R*) (Regoli et al. 2016, Akdag et al. 2020, Ogut et al. 2021, Ogut and Yildirim 2021, Sekerci et al. 2021, Ögüt et al. 2022, Ogut et al. 2022, Guzelad et al. 2023, Ogut and Yildirim 2023).

Statistical analyses

All statistical analyses were performed using SPSS 25.0 (IBM SPSS Software, USA). The following descriptive statistics were provided for continuous variables: mean, median, standard deviation (SD), standard error of the mean (SE), minimum, maximum, frequency, and incidence. The Shapiro-Wilk test was used for normality. Normally distributed variables were compared between two independent groups using the unpaired *t*-test. Nonnormally distributed variables were compared using the Wilcoxon test. $p < 0.05$ was taken to signify statistical significance for all comparisons.

Results

The coefficient of reliability (*R*) value was close to 1, indicating that causes other than measurement error were responsible for most of the variance in the sample's variables. These findings imply that the measurements were performed adequately with intra-observer accuracy.

Types

Five types (types 1–5) were identified according to the shape and location of the ATF. Type 1 round, type 2 elliptical (anteroposterior), type 3 elliptical (transverse), type 4 elliptical (oblique, from right to left), and type 5 elliptical (oblique, from left to right) were detected. In addition, a unilateral irregular type was detected (Fig. 1).

Incidence, side, and location

ATF was seen in 21 (8.4%) cervical vertebrae (C_{3-7}). An ATF was detected on the posterior (76.2%), posterolateral (19.04%), and posteromedial (4.8%) sides of the TF (Table 1). An ATF was recorded unilaterally in 4 dry cervical vertebrae (19%) on the left side and in 6 dry cervical vertebrae (28.6%) on the right side and recorded bilaterally in 11 dry cervical vertebrae (52.4%). Bilateral dominance of ATF was more frequently observed compared to unilateral ones, and they were frequently detected in vertebrae C_{4-7}. The locations of unilateral ATF were found in C_{3-4}, C_7 on the left, and C_4 and C_{6-7} on the right side. The incidences of unilateral ATF were observed more frequently in vertebra C_7 (23.8%) and less frequently in C_3 and C_6 (4.7%). The total presence of ATF varied among different cervical vertebrae, with the highest incidence observed in C_7 (33.3%) followed by C_4 (28.6%), C_6 (23.8%), C_5 (9.5%), and C_3 (4.8%). Homogeneity of variances was confirmed with $p > 0.066$, indicating equal variances between the groups. Statistical analysis revealed a significant difference in the presence of unilateral or bilateral ATF ($p = 0.047$, $p < 0.05$) but not in their location ($p = 0.961$, $p > 0.05$) (see Table 1).

Discussion

The present study identified five types and one irregular type of ATF based on their shape and location. The ATF was predominantly located in the lower cervical vertebrae, with a higher incidence observed in C_6 (23.8%) and in C_7 (33.3%).

Types

It has been reported that type 1 (rounded) was predominant in 54.1% of Egyptians, type 2 (oval) less prominent in 29.6%, type 3 (irregular) in 10.4%, and type 4 (quadrangular) in 5.8% (Aziz and Morgan 2018). Five types were recorded in Kenyans. The following types and incidences were as follows: type 1 was recorded with 9.8% (right) and 11.8% (left), type 2 (elliptical) was found with 29.4% (right) and 39.2% (left), type 3 (elliptical with transverse diameter) was found with 4.9% (right) and 2% (left), type 4 (right to the left oblique diameter) was found with 40.2% (right) and 7.8% (left), and type 5 (left to right oblique diameter) was found with 15.7% (right) and 39.2% (left) (Odula and Bundi 2013).

Population affinity

There is limited information available on the contribution of ATF to population affinity, as it is a rare anatomical variation that is not frequently studied.

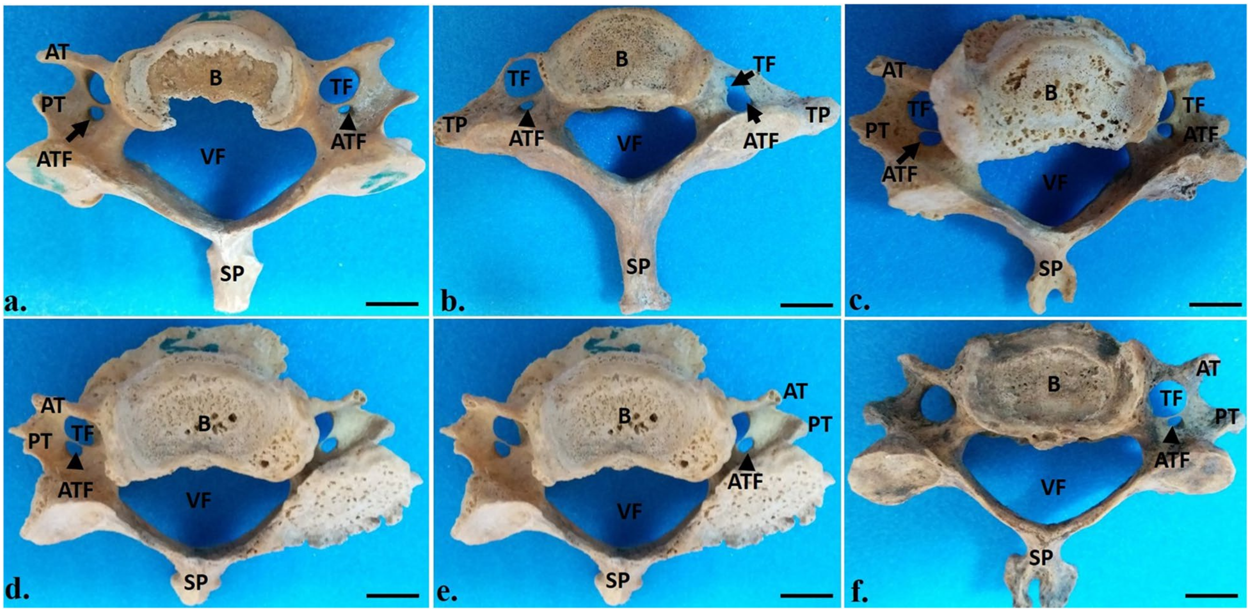

Fig. 1 Classification of ATF types based on morphological features. **a** Type 1 (rounded posterior ATF, on the left side, C4). **b** Type 2 (elliptical posterior ATF, on the left side, C7). **c** Type 3 (elliptical posteromedial ATF with transverse diameter, on the left side, C6). **d** Type 4 (oblique posterolateral ATF from right to left side, C6). **e** Type 5 (oblique posterolateral ATF from left to right side, C6). **f** Unilateral irregular posterior ATF, on the right side, C5. ATF of the cervical vertebra was located bilaterally except for **f**. AT, anterior tubercle of transverse process; ATF, accessory transverse foramen; B, body of cervical vertebra; PT, posterior tubercle of transverse process; SP, spinous process, TF, transverse foramen; TP, transverse process; VF, vertebral foramen

Table 1 The location, side, and incidence of ATF

		n/%	*p*
Location	Posterior	16 (76.2)	0.961
	Posterolateral	4 (19.04)	
	Posteromedial	1 (4.8)	
	Total	21(100)	
Side	Left	4 (19)	0.047*
	Right	6 (28.6)	
	Bilateral	11 (52.4)	
	Total	21(100)	
Incidence	C_3	1 (4.8)	0.022*
	C_4	6 (28.6)	
	C_5	2 (9.5)	
	C_6	5 (23.8)	
	C_7	7 (33.3)	
	Total	21 (100)	

Multiple *t* test (*$p < 0.05$)

n number

Various structural alterations, absences, fragmentations (Kaya et al. 2011, Travan et al. 2015), or taphonomical injury of skeletal elements may have precluded the observation of ATF, and therefore, the frequencies of these anomalies were not clear within or between the populations (Barnes 2012). Numerous studies have examined human skeletal variation and the population-specific prevalence of certain cranial (Öğüt et al. 2020, Blau et al. 2023) and post-cranial skeletal traits (Blau et al. 2023). However, some studies have reported on the occurrence of ATF in different populations. Double TF was recorded in 8.6% of Romans by Nagar et al. (1999), in 1.5% of Indians by Das et al. (2005), in 22.7% of Jewish by Kaya et al. (2011), in 3.9% of Kenyans by Odula and Bundi (2013), and in 17.7% of Egyptians by Aziz and Morgan (2018). Molinet et al. reported ATF in 17.35% of the Chilean population (Molinet et al. 2017). Singh et al. reported TF variations in 63 out of 240 cervical vertebrae, and they also reported complete double TF in 48 vertebrae (20%), unilateral double TF in 29 vertebrae (12%), and bilateral double TF in 19 vertebrae (8%) (Singh et al. 2019). However, in the present study, ATF was recorded unilaterally in 4 dry cervical vertebrae (19%) on the left side, in 6 dry cervical vertebrae (28.6%) on the right side, and bilaterally in 11 cervical vertebrae (52.4%). The identification of different types of ATF can be used in population studies, as the frequency of each type may vary between different populations. This information can be useful in human identification processes, as the presence of a certain type of ATF can help to identify the ancestry.

Incidence, location, and side

The incidence, location, and sides of ATF in this study were compared with studies in the literature (Table 2). The ATF may indicate a duplication or fenestration in the VA (24%) (Sangari et al. 2015). The presence of an ATF was reported in 42 of 161 cervical vertebrae (26.09%), with 32 on the right and 27 on the left (Gupta and Agarwal 2019). Chaudhari et al. reported 23.15% double TF (Chaudhari et al. 2013), Murlimanju et al. reported 1.6% ATF, 5 (1.4%) double TF, and 1 (0.3%) triple TF (Murlimanju et al. 2011). Akhtar et al. reported that of 25 (14.36%) ATF, 16 (9.19%) were found in the typical cervical vertebra, and 9 (5.17%) were found in the atypical cervical vertebra (Akhtar et al. 2015). In a previous study conducted by Travan et al. 2015, double TF was observed with greater frequency in the lower cervical vertebrae, specifically in C_6 and C_5, with 35.7% and 44.4%, respectively, demonstrating right/left-sided dominance (Travan et al. 2015). In contrast, the current study found bilateral double TF in vertebrae C_{4-7}, with unilateral double TF found on the left in C_{3-4} and C_7 and on the right in C_4 and C_{6-7}. Unilateral double TF was more frequently detected (23.8%) in vertebra C_7, whereas it was less frequently in dry vertebra C_3 and C_6 (4.7%). These findings are consistent with those in the literature (Chaudhari et al. 2013). It has been suggested that the presence of double or triple TF should be classified as basic anatomical variations, as their existence does not indicate any clinical concerns (Travan et al. 2015).

It has been reported in many studies that the ATF is located posterior to the TF and is smaller than the TF (Kumar et al. 2016, Gupta and Agarwal 2019). Akhtar et al. observed a greater incidence of the ATF on the right side of both typical and atypical dried cervical vertebrae (Akhtar et al. 2015). Incomplete TF occurs due to the absence of an anterior bony element and deficient ossification of the posterior root, as reported by Travan et al. in 2015. In the current study, the ATF was predominantly positioned posterior to the TF, which could be attributed to developmental abnormalities such as bony element fusion, neural arch clefting, bending deformities, TF bridging, or impediments in the neural canal (Saunders et al. 2008; Barnes 2012). The incidence and location of ATF can help to identify developmental defects in the cervical vertebrae, which can aid in the understanding of spinal and neurological conditions.

Clinical implications

ATF may have clinical implications, as it has the potential to compress adjacent nerves and blood vessels resulting in various symptoms including pain. Hence, understanding the prevalence and anatomy of ATF can aid in clinical diagnosis and appropriate management. Changes in the diameter of the ATF can be suggestive of hypoplasia or variations in the VA, as these two anatomical features have been found to be positively correlated. Additionally, the presence of a curved VA, an uncommon vascular abnormality, can potentially result in nerve compression and subsequent symptoms such as numbness and muscle weakness (Urut 2018). Hence, identifying the etiology of abnormalities in the atlanto-occipital region, such as vascular variations, size differences, and atypical ATF, can assist surgeons and radiologists in making an accurate diagnosis of cervicogenic symptoms (Odula and Bundi 2013).

The absence of TF, double or triple TF, and non-closure or the presence of grooves are described in the literature (Table 2). These differences can also be explained by several disorders including transient ischemic strokes due to thrombus or embolization (Sangari et al. 2015, Gupta and Agarwal 2019). These pathological conditions can affect the bony architecture of the cervical vertebra (Odula and Bundi 2013). The entrapment of the vessels and osteophytes due to TF variations can cause vascular instability and vertebrobasilar impairments (Aziz and Morgan 2018). In addition, aberrant pathways of the VA can compress related nerve roots and lead to occipital neuralgia, characterized by sudden pain in the upper cervical, occipital, or retroauricular regions. These conditions can result from joint instability, bony anomalies at the craniovertebral junction, or compression, which can cause neurological symptoms such as headache, vertigo, vegetative manifestations, auditory disruption, loss of postural muscle tone, or cerebral ischemia (Odula and Bundi 2013, Travan et al. 2015, Aziz and Morgan 2018). Studies have shown that subjects with ATF have a higher risk of developing acute headache, dizziness, and vomiting than those without it. While a double VA may supply collateral arterial circulation to the basilar artery and protect against ischemic lesions of the cerebrum, it is also linked to an increased risk of transient ischemic strokes, cervical radiculopathy, and thoracic outlet syndrome (Sangari et al. 2015, Sanchis-Gimeno et al. 2017, Gupta and Agarwal 2019). Therefore, understanding the clinical implications of ATF can help healthcare professionals better treat and manage patients with related conditions and provide important information for the proper diagnosis of related conditions.

Future directions

Further research can focus on exploring the clinical significance of ATF in living individuals, especially in relation to vascular and neurological disorders. This can involve imaging studies to evaluate the prevalence of ATF in the cervical vertebrae of patients with cerebrovascular diseases or other disorders affecting

Table 2 A comparative review of previously conducted studies over time

Author	*ATF*	*Year*	*Study design*	*Total number*	*Prevalence (%)*	*Place*	*Location*	*Symmetry/ asymmetry*	*Significant outcomes and related disorders*
Nagar	Narrowing TF Double TF Disoriented TF	1999	Dry cervical vertebra	1388	61 (8.6%)	Israel Roman-Byzantine	C_1–C_7	Bilateral and unilateral	-Osteophytes (degrees 2–4) 39 (5.5%), arthritic lesions 70 (9.9%), Schmorl's nodes, spondylolysis, erosion of articular process, arthritis of the atlanto-axial joint, calcification of the apical ligament, failure of fusion of the spinous process.
Das	Double	2005	Dry cervical vertebra	132	2 (1.5%)	India	C_1–C_6	Bilateral and unilateral	-The course of the VA may be distorted due to ATF. -It may be developmental or related to the variations in the course of the VA. -It can be useful for clinicians and radiologists to interpret X-rays and CT.
Murlimanju	Single Double Triple	2011	Dry cervical vertebra	363	6 (1.6%)	India	C_1–C_7	Bilateral and unilateral	-Compression or spasm of the VA. -The osseous deformity and variations of the cervical spine. -The surgical anatomy of these variations is essential for neurosurgeons and radiologists to interpret CT and MRI.

Table 2 (continued)

Author	*ATF*	*Year*	*Study design*	*Total number*	*Prevalence (%)*	*Place*	*Location*	*Symmetry/asymmetry*	*Significant outcomes and related disorders*
Odula	Single Double Triple (types 1–5)	2013	Dry cervical vertebra	102	4 (3.9%)	Kenya	C_1	Bilateral and unilateral	-Tortuosity of the VA may cause bony erosion or impede the formation of the TF. -Incomplete TF on the right side is related to erosion by the VA due to the presence of atlas bridges. -Embryologically: a fusion of costal elements of the atlas may explain the formation of multiple TF.
Choudhari	Single Double	2013	Dry cervical vertebra	133	22 (23.15%)	India	C_1–C_7	Unilateral: 14 (14.73%) Bilateral: 8 (8.42%)	-Compression or other pathology of such aberrant artery. -Neurological symptoms, hearing disturbances. -Double TF were observed only in the lower cervical vertebrae. -Each vertebra had at least one ATF on either side.
Gujar	Bilateral complete Bilateral incomplete Unilateral complete Unilateral incomplete	2015	Dry cervical vertebra	150	41 (27.33%)	India	C_1–C_7	Unilateral: 27 (18%) Bilateral: 14 (9.33%)	-Unilateral ATF was more frequent than bilateral. -Variation in the course of the VA may lead to compression and neurological symptoms. -The ATF is essential for neurosurgeons during the posterior surgical approach.

Table 2 (continued)

Author	*ATF*	*Year*	*Study design*	*Total number*	*Prevalence (%)*	*Place*	*Location*	*Symmetry/ asymmetry*	*Significant outcomes and related disorders*
Travan	Absence of TF Double TF Triple TF Unclosed TF Retrotransverse canal groove Arcuate foramen Supertransverse foramen	2015	Dry cervical vertebra	923 136 (14.7%) C1, 143 (15.5%) C2, 128 (13.9%) C3, 178 (19.3%) C4, 126 (13.6%) C5, 112 (12.1%) C6, 100 (10.8%) C7	C1 (1.1%), C3 (2.6%), C4 (9.5; 8.5%), C5 (23.6; 23.9%), C6 (35.7%, 44.4%), C7 (20%, 10%)	(Friuli Venezia Giulia) North-eastern Italy	C_1–C_7	Unilateral Bilateral	-The VA may be compressed within the arcuate foramen since the mean area of the arcuate foramen was lower than the mean area of the ipsilateral TF. -The signs and symptoms may include headache, vertigo, vegetative manifestations, auditory disruption, loss of postural muscle tone, cerebral ischemia, arterial dissection, and rotating vertebral artery blockage (bow-hunter stroke).
Kumar	Unilateral duplication Bilateral duplication	2016	Dry cervical vertebra	240	20 (8.4%)	India (Gurgaon. Haryana)	C_3–C_6	Unilateral: 16 (6.66%) Bilateral 4 (1.66%)	-The lower cervical vertebrae appear more affected by the TF variants. -Spinal surgeons and radiologists can better evaluate patients with the assistance of their understanding of these variations. -A double VA may be associated with a double TF.
Molinet	Shape 1, 41.32%; shape 2, 4.13%; shape 3, 18.8%; shape 4, 14.04%; shape 5, 12.39%	2017	Dry cervical vertebra	121	(17.35%)	Chile	C1–C7	66.6% unilateral, 57.14% (right), 42.85% (left)	-These variations are useful for spine surgeons in preoperative planning and preventing vertebral vessels and sympathetic nerve injuries during surgical approaches.

Table 2 (continued)

Author	*ATF*	*Year*	*Study design*	*Total number*	*Prevalence (%)*	*Place*	*Location*	*Symmetry/ asymmetry*	*Significant outcomes and related disorders*
Akhtar	16 (9.19%): typical 9 (5.17%): atypical	2015	Dry cervical vertebra	174	25 (14.36%)	India	C1, C3–C7	Unilateral: 20 (11.49%) Bilateral: 5 (14.36%)	-It may affect the course of VA and nerves, which causes various symptoms in patients. -It is also helpful for spine surgeons to plan surgery around the cervical vertebra and avoid postoperative complications. -These variations are also significant and helpful for anatomists, anthropologists, and radiologists. -ATF is more frequent on the right side in both typical and atypical cervical vertebrae.
Tellioglu	Complete double Incomplete double Agenesis: 37 (3.74%) Hypoplasia: 26 (2.63%)	2018	MCT	141 (90 males, 51 females) 987 vertebra	88 (8.91%)	Turkey	C_2–C_6	Bilateral	-The determination of foraminal variations could be an essential guide for neurosurgeons and radiologists in the diagnosis and treatment of diseases. -The most frequent entry level for VA through TF was C6, and the least was C4, C5, and C7.
Zibis	Hypoplastic 0.28% Double 1.71% Triple 0.57% Absence 2.28% Complete 1.71%	2018	CTa	50 (32 males, 18 females) 350 (66.4 ± 10.78 years)	17 (4.85%)	Indo-European	C_1–C_7	12 (24%) asymmetry	-The preoperative evaluation of variations by CTa is functional.

Table 2 (continued)

Author	*ATF*	*Year*	*Study design*	*Total number*	*Prevalence (%)*	*Place*	*Location*	*Symmetry/ asymmetry*	*Significant outcomes and related disorders*
Gupta	Double TF -Unilateral -Bilateral -Absence	2019	Dry cervical vertebra	319 TF of 161 dry cervical vertebrae	42 (26.09%)	India	C_1–C_7	Unilateral: 25 (15.53%) Bilateral: 17 (10.56%)	-All accessory TF was located posterior to the main TF except in one C4. -It would be helpful for neurosurgeons to improve surgical outcomes. -It would also help radiologists for better understanding.
Murugan	15 typical cervical vertebrae, 12 (80%) had double right, one (6.6%) left, two (13.3%) bilaterally	2014	Dry cervical vertebra	150	19 (12.6%)	India	C_3–C_6: 15 C_1, C_2, C_7: 4	Unilateral/bilateral	-Radiologists must understand these variances to interpret CT and MRI.
Singh	Complete double 48 (20%) Unilateral double 29 (12%) Bilateral double 19 (8%) Incomplete double 15 (6%) Unilateral incomplete 8 (4%) Bilateral incomplete 5 (2%)	2019	Dry cervical vertebra	240	63 (26.25%)	India	C_5–C_7	Unilateral: 38 (15.75%) Bilateral: 25 (9.5%) (asymetry)	-Compression of the neurovascular bundle may occur if compartmentalization is present. -There may be spicules of inadequate septation that might penetrate the neurovascular systems, causing vascular insufficiency and persistent discomfort. -The results may guide spinal surgeons when preparing for surgery.

Table 2 (continued)

Author	*ATF*	*Year*	*Study design*	*Total number*	*Prevalence (%)*	*Place*	*Location*	*Symmetry/ asymmetry*	*Significant outcomes and related disorders*
Present	Single Double (five types: types 1–5)	2021	Dry cervical vertebra	250 (500 sides)	21 (8.4%)	Turkey	C_3–C_7	Unilateral: 4 (19%) left, 6 (28.6%) right Bilateral: 11 (52.4%)	-The identification of ATF plays a crucial role in the diagnosis of variations of VA and underlying disorders. -It may provide a new strategy for identifying the possible cause of death. -The posterior location of ATF and asymmetrical distribution should be considered in the evaluation of dry cervical vertebra. -It may also give a clue for the determination of geographically based variations and population affinity.

the vertebral artery. Additionally, future studies can investigate the genetic and environmental factors that contribute to the development of ATF in different populations.

Limitations

Due to limitations in the study design, the assessment of potential differences between sexes and age groups was not feasible. Although the present study provides some evidence suggesting that the ATF may have a role in determining population affinity, further investigation utilizing imaging modalities is required to validate these findings. Future research should also explore the association between the presence of ATF and populations on a large scale.

Conclusions

The present article proposes an approach for the diagnosis and several potential implications of the ATF. The identification of ATF is crucial for diagnosing variations of the VA and related disorders. Additionally, the posterior location and asymmetrical distribution of an ATF should be considered when evaluating dry cervical vertebrae, as this knowledge can provide clues for determining variations and ancestry.

Abbreviations

ATF	Accessory transverse foramen
C	Cervical
CT	Computed tomography
CTa	Computed tomography angiographies
MRI	Magnetic resonance imaging
MCT	Multidetector computed tomography
R	Coefficient of reliability
SD	Standard deviation
SE	Standard error of the mean
SPSS	Statistical Package for the Social Sciences
TF	Transverse foramen
VA	Vertebral artery

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Authors' contributions

Research idea: EO, OG, and FBY. Design of the study: EO, OG, and FBY. Acquisition of data for the study: EO and OG. Analysis of data for the study: EO. Interpretation of the data for the study: EO. Drafting and writing of the manuscript: EO. Critical revision for important intellectual content: EO. Final approval of the version to be published: EO, OG, and FBY.

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Availability of data and materials

The dataset used and analyzed during the current study is available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Akdeniz University, School of Medicine under the ethical standards in the 1964 Declaration of Helsinki on August 26, 2020, with protocol number 598. All procedures were executed strictly following the tenets of the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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