Section: Anatomy

Original Research Article

INCIDENCE AND MORPHOLOGY OF ACCESSORY TRANSVERSE FORAMINA IN THE CERVICAL SPINE

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Abstract

Background: The cervical skeleton serves as a bony support for the vertebral arteries when they traverse from the aortic arch to the cranial fossa. Accessory foramen transversarium is a common variation, and this type of variation can potentially influence the trajectory of the vertebral artery. Accessory foramen reduces the diameter and may cause compression on the vertebral artery; which may result in headache, migraine & fainting attack. **Materials and Methods:** For the present study total 1673 cervical vertebrae (239 set of human cervical vertebrae) were collected and studied. All the cervical vertebrae, typical i.e.C3-C6 and atypical i.e. C1, C2, &C7 were observed on both sides macroscopically for variation in foramen transversarium. The accessory foramina were noted. Presence of unilateral or bilateral accessory foramen transversarium was observed. Direct measurements were taken with vernier callipers which are sensitive to 0.01 mm. Number, type, and diameter of AFTs were assessed, recorded and analyzed. **Results:** Out of 1673 cervical vertebrae only 155 (9.25%) cervical vertebrae showed the accessory foramina transversarium. Among them 53 (3.16%) vertebrae had AFT bilateral and 102 (6.09%) vertebrae had unilateral foramina. Most of the AFT was observed in the lower cervical vertebrae. C4, C5 and C6 showed AFT present as 0.71%, 2.39%, and 3.88%. AFT were 62 on right side and 40 on left side.**Conclusion:** Anatomical knowledge of this variation is helpful for spine surgeon and Radiologist. For Surgeon, This information is very helpful in pre-operative planning and for preventing injury of vertebral vessels along with sympathetic nerves during transpedicular screw fixation of cervical spine. For radiologist, these variations are important for interpretation of CT Scan and for MRI images.

INTRODUCTION

The characteristic features of cervical vertebrae are the presence of Foramen Transversarium in the transverse process. Cervical vertebrae can be easily differentiated from other vertebrae by the presence of foramen transversarium. This foramen usually transmits the vertebral artery (except, in the seventh cervical vertebrae), vertebral vein and sympathetic fiber from the inferior cervical ganglion. The C7 vertebra usually has only a vertebral vein; sometimes this foramen is either absent or very small.

The cervical skeleton serves as a bony support for the vertebral arteries when they traverse from the aortic arch to the cranial fossa. As a result of the large number of tasks performed by this part of the skeleton, any disorder affecting it may lead to a significant lowering of the quality of life. Accessory foramen transversarium is a common variation, and this type of variation can potentially influence the trajectory of the vertebral artery. Accessory foramen reduces the diameter and may cause compression on the vertebral artery; which may result in headache, migraine & fainting attacks.[1]

Clinically this type of variation is important for the radiologist while doing computed tomographic scans and magnetic resonant imaging scan.[2] This variation of foramina transversaria is also important for surgeon during posterior cervical surgery.[3] to safeguard the vertebral artery during pedicle fixation of a screw. There are various studies on the origin and course of vertebral artery but there is a paucity of studies regarding the morphology of accessory

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foramen transversarium in the cervical vertebrae and its incidence. Objective of our study was to study the morphology of double FT and to calculate its incidence. The foramina were macroscopically analyzed and the incidence of double FT was calculated. The aim of present study is to know the incidence of double foramen transversarium in the dried cervical vertebrae and its morphological importance. These foramina are known to exhibit variations in size, shape and may be multiple in number or absent, to find out unilateral and bilateral prevalence of double foramen transversarium and its variations in size. The objective of this study is to know the incidence of accessory foramina transversarium in cervical vertebrae and to analyze them morphologically with emphasis on their embryological and surgical importance.

MATERIALS AND METHODS

For the present study total 1673 cervical vertebrae (239 set of human cervical vertebrae) were collected and studied. These cervical vertebrae were collected from various medical colleges of Gujarat. All the cervical vertebrae, typical i.e.C3-C6 and atypical i.e. C1, C2, &C7 were observed on both sides macroscopically for variation in foramen transversarium. The accessory foramina were noted. Presence of unilateral or bilateral accessory foramen transversarium was observed.

Outcome Measure

- Macroscopically both sides of vertebrae were observed for foramen transversarium and accessory foramen transversarium and the accessory foramina were noted.
- Direct measurements were taken with vernier calipers, which are sensitive to 0.01 mm. Number, type, and diameter of AFTs were assessed, recorded and analyzed.

After collection of data by simple mathematical calculation, percentage of AFT and the presence of unilateral and bilateral AFT are found. By vernier caliper the diameter of AFT is measured and maximum, minimum and mean diameter is calculated.

Figure 1: Showing How to Measure Diameter of Accessory Foramina Transversari Um

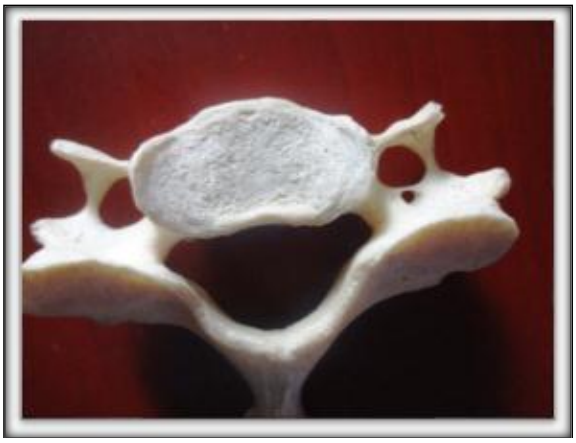

Figure 2: Typical Cervical Vertebra Showing Accessory Foramina Transversarium on Right Side

RESULTS

Out of 1673 cervical vertebrae only 155 (9.25%) cervical vertebrae showed the accessory foramina transversarium. Among them 53 (3.16%) vertebrae had AFT bilateral and 102 (6.09%) vertebrae had unilateral foramina. Among unilateral 62 were present on right side and 40 were present on left side. No any cervical vertebrae showed the absence of foramen transversarium. Most of the AFT was observed in the lower cervical vertebrae. C4, C5 and C6 showed AFT present as 0.71%, 2.39%, and 3.88%. AFT were 62 on right side and 40 on left side. The mean diameter on right side is 1.40 mm and on left side 1.45 mm. The incidence of AFT in different cervical vertebrae is shown in table – 1.

Table 1: Incidence of AFT in different cervical vertebrae

Types of vertebrae	No. of vertebrae observed	Vertebrae with unilateral AFT	Vertebrae with bilateral AFT	Total AFT
C1	239	0	0	0
C2	239	0	0	0
C3	239	0	0	0
C4	239	07	06	13
C5	239	26	14	40
C6	239	39	26	65
C7	239	30	7	37
Total	1673	102	53	155

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There was no any AFT observed in upper cervical vertebrae C1, C2, C3. The AFT was observed only in the lower cervical vertebrae C4, C5, C6, and C7.The incidence of AFT in typical cervical vertebrae (C3-C6) & atypical (C7) cervical vertebrae shown in table – 2.

Table 2: Incidence of AFT in typical (C3-C6) & atypical (C7) cervical vertebrae

Type	No. of vertebrae examined	Vertebrae with Unilateral accessory FT	Vertebrae with bilateral Accessory FT	Total AFT	Incidence in %
C3-C6	956	71	46	117	12.23
C7	239	30	7	37	15.43

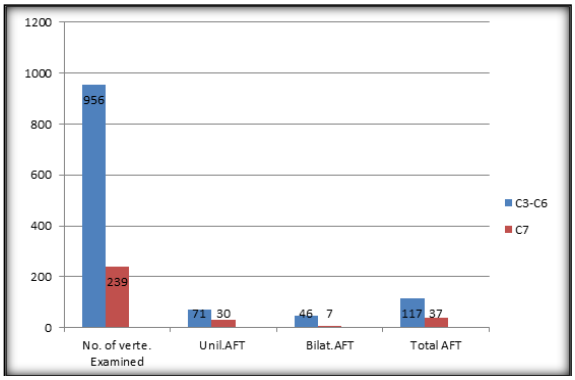

Figure 1: Incidence of double FT in lower typical vertebrae &C7 vertebrae

DISCUSSION

It seems that many factors are involved in causing morphological variations of foramen transversarium, including developmental factor, mechanical stress, size and number of anatomical structure passing through the foramen transversarium. The vertebral vessels are major factor in the formation of foramen transversarium. So variation in the vessel can be manifested as changes in foramen transversarium. Accessory foramen transversarium may be correlated to the duplication or fenestration of the vertebral artery. As the vertebral vessels are the important in the formation of the foramen transversarium, it is clear that variation in the presence and course of the vertebral vessels will result in variation in foramen Transversarium. Vertebral artery that ascends parallel to spines through the transverse foramina of the upper six cervical vertebra. It was reported that this artery enters foramen transversarium of vertebra at C6 in 88% of cases, and C7 and C5 only 5% and 7% cases (Murlimanju B.V. et.al.[1]

Mehta G.et.al.[4] observed that out of 500 cervical vertebrae accessory FT was found in 66 (13.2%) vertebrae. Among these 17 (3.4%) showed accessory FT bilaterally and 49 (9.8%) showed accessory FT on one side only. Pretty Ratnakar.et.al.[2] (2013) reported the incidence of accessory foramen transversarium as a total of 5.7% (unilateral 3.6% and bilateral 1.42%) out of 140 vertebrae. Patil N.P.et.al.[5] Reported out of 175 cervical vertebrae double foramen transversarium was found in only 10 vertebrae. The incidence was calculated as 5.71%. In 6 vertebrae (3.42%) among these, unilateral duplication was found and in 4 vertebrae (2.28%) among these, bilateral duplication was found. So unilateral double foramen transversarium was more found than the bilateral one.

In present study, total 155 (9.26%) out of 1673 cervical vertebrae are observed with accessory foramen transversarium, either unilateral or bilateral. Bilateral accessory foramina transversarium is observed on 53 vertebrae (3.16%). Unilateral accessory foramina transversarium observed on 102 vertebrae (6.09%). It shows that unilateral accessory foramina transversarium is more common than bilateral accessory foramina transversarium. The incidence of accessory foramina transversarium is seen most common on lower cervical vertebrae i.e. on C4, C5, C6 &C7 vertebrae. Among them C6 vertebrae have greater incidence of accessory foramina Transversarium. On C6 vertebrae, accessory foramina transversarium was observed on 65 vertebrae (3.88%); on C5 vertebrae' accessory foramina transversarium was observed on 40 vertebrae (2.39%); on C7 vertebrae accessory foramina transversarium was observed on 37 vertebrae (2.21%) and on C4 vertebrae, accessory foramina transversarium was observed on 13 vertebrae(0.77%). On upper cervical vertebrae i.e. on C1, C2 and C3 accessory foramina transversarium was not present.

Table 3: Comparison of incidence of AFT with previous study

Author	Year	Number of cervical vertebrae studied	Incidence of AFT	Unilateral AFT	Bilateral AFT
Mehta G. et.al	2014	500	13.2%	9.8%	3.4%
Ratnakar p. et.al	2013	140	5.7%	3.65%	1.42%
Patil N.P. et.al	2014	175	5.7%	2.28%	3.42%
present study	2014	1673	9.26	6.09	3.16

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CONCLUSION

The present study observed the accessory foramen Transversarium in 9.26% of cases. The unilateral presence was more common than bilateral. In the case where foramen Transversarium was double, one was main Foramen Transversarium and other was accessory foramen Transversarium. The variation in Foramen Transversarium and vertebral artery are interrelated. Anatomical knowledge of this variation is helpful for spine surgeon and Radiologist. For Surgeon, This information is very helpful in pre operative planning and for preventing injury of vertebral vessels along with sympathetic nerves during transpedicular screw fixation of cervical spine. For radiologist, these variations are important for interpretation of CT Scan and for MRI images.

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