National Journal of Basic Medical Sciences ORIGINAL ARTICLE Volume - III, Issue-2

A STUDY ON OSSIFIED PTERYGOSPINOUS AND PTERYGOALAR LIGAMENTS IN INDIAN SKULLS

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ABSTRACT

Pterygospinous and pterygoalar ligaments are the intrinsic ligaments present in the sphenoid bone, which may get ossified occasionally. The aim of this study is to observe the incidence and detailed anatomy of ossified pterygospinous and pterygoalar ligaments in Indian skulls. A total of 204 skulls from various Medical and Dental Colleges of Puducherry and Chennai were studied. Pterygospinous ligament ossified completely in 2 skulls (0.98%) and incompletely in 22 skulls (10.78%). Pterygoalar ligament ossified completely in 5 skulls (2.45%) and incompletely in 8 skulls (3.92%). The length of complete pterygospinous bar was 9-11 mm and its width measured 2-3 mm. The length of complete pterygoalar bar measured 3-9 mm and its width was 2-5 mm. The mean vertical and horizontal diameter of the pterygospinous foramen was 7.5 x 7.0 mm respectively and that of pterygoalar foramen was 3.2 x 2.7 mm respectively. Pterygospinous bar was observed most commonly medial to foramen ovale and pterygoalar bar was most commonly found to traverse across the foramen ovale. Thereby, the mandibular nerve emerging out through foramen ovale and its branches can be compressed by these bars and lead to trigeminal neuralgia. These bars hinder the surgical approaches to the base of the skull. Their presence reduces the success rate in trigeminal ganglion block by trans-ovale approach. Therefore, knowledge about these bony bridges is essential for physicians, anesthetists, radiologists, dentists, oral and maxillofacial surgeons.

Key words: Pterygospinous bar, pterygoalar bar, ossified ligaments of sphenoid, mandibular nerve entrapment.

INTRODUCTION

The pterygospinous ligament stretches between the spine of sphenoid to the upper part of the posterior border of the lateral pterygoid plate. Sometimes it may be ossified completely or incompletely.[1] Complete ossification of this ligament was named after Fillipo Civinini (1837) as Civinini's bar or pterygospinous bar. The foramen formed by the pterygospinous bar was called as Foramen of Civinini or pterygospinous foramen. [2,3,4]

Most of the standard text books remain silent in describing about another intrinsic ligament called pterygoalar ligament. In 1862, Hyrtl explained that it extends from the root of lateral pterygoid plate to the undersurface of greater wing of sphenoid. This ligament may be ossified completely or incompletely. Complete ossification of pterygoalar ligament leads to formation of a foramen, called porus crotophitico-buccinatorius or pterygoalar foramen. [5,6]

The pterygospinous and pterygoalar bars were considered as the outcome of secondary ossification of intrinsic ligaments of sphenoid.[2] However, the presence of these bony bridges in skulls of children suggested the possibility of genetic factors. [4] The incidence of pterygospinous and pterygoalar bars is more common in Africans and this may be due to racial variations. [7]

Both pterygospinous and pterygoalar bars are closely related to the foramen ovale. Hence the mandibular nerve and its branches can be potentially compressed by these osseous bridges leading to entrapment neuropathy. The presence of pterygospinous and pterygoalar bars may challenge the surgeons to approach retro and para pharyngeal spaces. [3,8] These osseous bridges may act as an obstacle during trigeminal ganglion block through foramen ovale.[3,8,9]

The present study is undertaken to evaluate the incidence, clinical relevance and phylogenic significance of ossified pterygospinous and pterygoalar ligaments in the skulls of Indian population.

MATERIALS AND METHODS

A total of 204 dry human skulls of Indian origin were collected irrespective of age and sex from various

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Medical and Dental Colleges at Puducherry and Chennai. The base of the skull was studied for the following:

- Location of pterygospinous and pterygoalar ligaments (right, left or bilateral)
- The degree of ossification (complete or incomplete)
- Relation of the bar to the foramen ovale (medial, lateral or across)
- Measurements of the osseous bridges (length and width)
- Measurements of pterygospinous / pterygoalar foramina (vertical and horizontal diameter).

The data was tabulated and statistically analyzed by Non-parametric test using SPSS software.

RESULTS

Out of 204 skulls studied, 2 skulls (0.98%) had complete ossification of pterygospinous ligament (Fig 1) and 22 skulls (10.8%) had incomplete ossification of pterygospinous ligament (Fig 2). Complete pterygospinous bar was observed on left side in both skulls; Incomplete ossification of pterygospinous ligament was observed on right side in 9 skulls, left side in 10 skulls and bilateral in 3 skulls (Table 1). The mean length and width of the complete pterygospinous bar was 10 mm and 2.5 mm respectively. The mean vertical and horizontal diameter of the newly formed pterygospinous foramen was 7.5 mm and 7 mm respectively (Table 2). Non-parametric test showed that the difference between the frequencies of occurrence of ossified pterygospinous ligament with respect to the side of the skull was statistically insignificant (P=0.336).

Pterygoalar ligament was found to be ossified completely (Fig 3) in 5 skulls (2.45%) and ossified incompletely (Fig 4) in 8 skulls (3.92%). Complete pterygoalar bar was observed on right side in 2 skulls, left side in 2 skulls and bilateral in 1 skull; Incomplete ossification of pterygoalar ligament was observed on right side in 3 skulls, left side in 1 skull and bilateral in 4 skulls (Table 1). The mean length and width of the pterygoalar bar was 6.3 mm and 3.1 mm respectively. The mean vertical and horizontal diameter of the newly formed pterygoalar foramen was 2.7 mm and 3.2 mm (Table 2). Non-parametric test showed that the difference between the frequencies of occurrence of ossified pterygospinous ligament with respect to the side of the skull was statistically insignificant (P=0.926).

Ossified pterygospinous ligament was observed medial to foramen ovale in 17 skulls, lateral to foramen ovale in 5 skulls and across the foramen ovale in 1 skull. Ossified pterygoalar ligament was traversing across the foramen ovale in 7 skulls, medial to it in 3 skulls and lateral to it in 3 skulls.

Table 1 : Incidence of complete/incomplete ossification of pterygospinous/pterygoalar ligament

	Pterygospinous bar						Pterygoalar bar					
	Left		Right		Bilateral		Left		Right		Bilateral	
	n	%	n	%	n	%	n	%	n	%	n	%
Complete	2	0.98	0	0	0	0	2	0.98	2	0.98	1	0.98
Incomplete	10	4.9	9	4.41	3	1.47	1	0.49	3	0.49	4	1.47
Absent	192	94.12	195	95.59	201	98.53	201	98.53	199	97.55	199	97.55
Total	204	100	204	100	204	100	204	100	204	100	204	100

Table 2 : Measurement of the ossified pterygospinous and pterygoalar bars and their foramen

	Measurement of complete bars				Measurement of the foramen			
	Pterygospinous bar		Pterygoalar bar		Pterygospinous foramen		Pterygoalar foramen	
	Length (mm)	Width (mm)	Length (mm)	Width (mm)	Vertical diameter (mm)	Horizontal diameter (mm)	Vertical diameter (mm)	Horizontal diameter (mm)
Minimum	9	2	3	2	6	5	1	1
Maximum	11	3	9	5	9	9	4	5
Mean	10	2.5	6.3	3.1	7.5	7	2.7	3.2

Table 3 : Incidence of Ossified pterygospinous and pterygoalar ligaments in different population

Population	*No. of skulls*	*Ossification of Pterygospinous ligament*		*Ossification of Pterygoalar ligament*	
		Complete	*Incomplete*	*Complete*	*Incomplete*
Africans[16]	100	12-13%	-	-	-
Anatolian[17]	452	5.5%	12.3%	4.9%	26.8%
Turkish[18]	361	3.8%	11.1%	1.3%	5.7%
Greek[13]	50	2%	14%	2%	2%
Brazilians[14]	312	1.6%	13.14%	3.84%	22.43%
Brazilians[15]	183	-	-	2.18%	0.54%
Indians[10]	516	3.9%	33%	-	-
Indians[3]	50	-	1%	-	-
Indians[11]	416	5.76%	3.84%	-	-
Indians[12]	65	-	3.76%	-	-
Present study (Indians)	**204**	**0.98%**	**10.8%**	**2.5%**	**3.9%**

DISCUSSION

Incidence

Earlier studies on skulls of Indian population were mostly concerned with ossification of pterygospinous ligament.[3,10,11,12] Only one case-report about pterygoalar bar has been reported so far.[6] To the best of our knowledge, the present study is the first to provide a comparative data on the incidence of both pterygospinous and pterygoalar bars amongst Indian population.

The incidence of complete and incomplete ossification of pterygospinous and pterygoalar ligament of the present study was compared with the previous study (Table 3). The results of present study (Indian population) were almost similar to that of Brazilian and Greek population.[13,14,15] The incidence of ossification was found to be more in African population.[16]

Morphometery

In Shoubhagya et al's[11] study, the mean length and width of pterygospinous bar was 6.22 mm and 3.35 mm respectively. In the present study, it was 10 mm and 2.5 mm respectively. The length and width of pterygospinous bar in the present study was longer and thinner when compared to Shoubaghya et al's[11] study.

In Skratz et al's[19] study, the length of pterygoalar bar ranged from 4-8 mm; In the present study, it measured between 3-9 mm. Hence pterygospinous bar was longer and thinner; and pterygoalar bar was shorter and thicker.

As per the findings of Suazo et al[14], the diameter of pterygoalar foramen (3.79-5.2 mm) was relatively smaller than that of pterygospinous foramen (7.36-10.62 mm). In the present study also mean dimension of pterygoalar foramen (2.7x3.2 mm) was smaller than pterygospinous foramen (7x7.5 mm). Lang and Sander stated that pterygoalar bar is in close proximity with the skull base; and pterygospinous bar is at a greater distance from the

Fig 1. Lateral view of the left side of a skull showing complete pterygospinous bar (arrow) extending from lateral pterygoid plate to the spine of sphenoid forming a relatively large pterygospinous foramen.

Fig 2. Lateral view of the right side of a skull showing incomplete ossification of pterygospinous ligament (asterisk) with spinous projection from lateral pterygoid plate and spine of sphenoid.

Fig 3. Lateral view of the right side of a skull showing complete pterygoalar bar (arrow) situated closer to skull base and extending from lateral pterygoid plate to undersurface of greater wing of sphenoid, thus forming a relatively smaller pterygoalar foramen.

skull base. [2] That made pterygoalar foramen to be smaller than pterygospinous foramen.

Relation to foramen ovale

Pterygospinous foramen is medial to foramen ovale and pterygoalar foramen is lateral to it. [2] In the present study, pterygospinous bar was most commonly observed on medial side to foramen ovale.

Fig 4. Lateral view of the right side of a skull showing incomplete ossification of pterygoalar ligament (asterisk) with spinous projection from lateral pterygoid plate and undersurface of greater wing of sphenoid bone.

Previous studies stated that the position of pterygoalar bar with respect to foramen ovale differed from medial, lateral or even across to it. [19,6] In the present study also pterygoalar bar was found medial to foramen ovale in 3 skulls, lateral to it in 3 skulls and most commonly found to traverse across the foramen in 7 skulls. The compression of mandibular nerve branches by pterygoalar bar may be probably more common because of its mid-way position across the foramen ovale and its closeness to the skull base.

Clinical significance

- ENTRAPMENT NEUROPATHY

Pterygospinous foramen being medial to foramen ovale, may transmit nerve to medial pterygoid. [2,4] Pterygospinous bar may lead to lingual nerve entrapment leading to lingual numbness associated with speech impairment[20,21,22,] and chorda tympani nerve compression leading to abnormal taste sensation.[3,4]

Pterygoalar foramen being lateral to foramen ovale, may transmit nerve to lateral pterygoid, deep temporal nerves, masseteric nerve, buccal nerve [4,16,19] and auriculotemporal nerve. [17]

During contraction of pterygoid muscles, the branches of mandibular nerve can be compressed against these bony bars leading to symptoms related to trigeminal neuralgia.[17]

- DIFFICULTY IN SURGICAL APPROACHES

The presence of ossified pterygospinous and pterygoalar bars may obliterate the space between the lateral pterygoid plate and spine of sphenoid (pterygospinous

gate). The narrowness of pterygospinous gate may restrict the access to retropharyngeal and parapharyngeal space by surgeons.[8]

When there is a problem of surgical approach at one side of the skull, it is likely that the same problem can appear on other side [13]. In the present study, bilateral ossification of pterygospinous ligament was found in 3 skulls and that of pterygoalar ligament in 5 skulls. The presence of these ossified bars should be borne in mind when one finds difficulty during surgical approaches in the base of skull.

- DIFFICULTY IN GIVING BLOCK ANESTHESIA

Pterygoalar bony bridge may act as a barrier for the passage of the needle through foramen ovale to approach the trigeminal ganglion for treating trigeminal neuralgia. [8] The presence of pterygospinous bar may make thermo-coagulation of the trigeminal ganglion difficult or even impossible. [3,8]

Therefore these bony bars should be identified by radiological methods prior to the procedure. The best view to visualize these bony bars is mentocoronal view.[6] Moreover, an ossified pterygospinous ligament can present a picture of a divided foramen ovale on the axial projection of the skull.[20,22]

If these bars are identified before the procedure, it is recommended to prefer inframandibular approach of trigeminal ganglion, instead of routine supramandibular or transzygomatic approach to overcome the failure of trigeminal ganglion block.[9]

Phylogenic significance

A wide pterygospinous bar exists in all skulls of herbivores, carnivores and mature monkeys and a small pterygospinous osseous bar is seen in rodents. [8]

In Lemurs, the pterygospinous bar is noted on medial side of the foramen ovale. In the typical pithecoids, the pterygospinous bar passes lateral to the foramen ovale. In man and anthropoids, usually it is not complete osseous bar. [23] Therefore, the presence of osseous pterygospinous bar in man is considered to be a phylogenic remnant.[8]

CONCLUSION

As per the findings of present study (Indian population), the incidence of complete and incomplete ossification of pterygospinous ligament was 0.98% and 10.78% respectively and to that of pterygoalar ligament was 2.45% and 3.92% respectively. While treating trigeminal neuralgia, these ossified bars need to be considered as one of the possible etiology and should be evaluated; thereby the root cause of nerve entrapment can be rectified early by surgical decompression. Moreover, prior to trigeminal ganglion block, if these bars are identified, the alternate inframandibular approach may be preferred for the successful outcome of the procedure.

Therefore, it is concluded that the knowledge about the ossification of pterygospinous and pterygoalar ligaments is not only an interesting factor to anatomists and anthropologists, but also important for physicians, anesthetists, dentists, radiologists, oral and maxillofacial surgeons.

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