



## PTERYGOSPINOUS AND PTERYGOALAR BAR IN NORTH INDIAN HUMAN SKULLS: INCIDENCE AND CLINICAL RELEVANCE

### Anatomy

**Dr. Vanita Gupta\*** Professor & Head Department of Anatomy Rama Medical College & Research Centre, Hapur, U.P, India. \*Corresponding Author

**Dr. Archana Sinha** Assistant Professor Department of Anatomy Rama Medical College & Research Centre, Hapur, U.P, India.

### ABSTRACT

The presence of ossified pterygospinous & pterygoalar ligaments at the base of skull has attracted attention of research scholars from time to time. The proximity of these ossified bars with foramen ovale have made them clinically significant. The present study was conducted to know the incidence, morphology, morphometry and clinical relevance of pterygospinous and pterygoalar bar in north Indian human skulls. A total of 48 skulls (96sides), belonging to Rama medical college, Hapur were studied. Completely ossified pterygospinous ligament was observed in 1.04% cases whereas, 18.75% cases showed incompletely ossified ligament. The ossified pterygoalar ligament was observed in 13.54% cases with 3.12% cases of completely ossified ligament and 10.42% cases of partially ossified ligament. The mean length and width of completely ossified pterygospinous bar was 10.40mm and 2.16mm respectively and that of pterygoalar bars was 6.62mm and 2.22mm respectively. Pterygospinous bar in this study created 2 pterygospinous foramens, one related to foramen ovale (F1) and the other related to foramen spinosum (F2). The mean vertical and horizontal diameter of F1 foramen was 5.17 and 4.33mm respectively and that of F2 foramen was 3.85 and 3.03mm respectively. The pterygoalar foramen was found to be 3.22 & 5.42mm in vertical and horizontal diameters respectively. The pterygoalar bar traversed across foramen spinosum and foramen ovale, a finding unique in this study. The pterygoalar bar was lateral to foramen ovale in 2 cases and inferior to it in 1 case. These bony bridges can compress neurovascular structures in infratemporal area, mandibular nerve and its branches and can cause lingual numbness and trigeminal neuralgia. The ossified ligaments may obstruct surgical approach to base of skull for giving mandibular nerve block to relieve pain of neuralgia. It reduces success rate of trigeminal ganglion block through transovale approach. Therefore, knowledge about these ossified ligaments is vital for anesthetists, radiologists, dentists, oral & maxillofacial surgeons, when planning and executing surgical procedures or giving nerve blocks in the infratemporal area.

### KEYWORDS

Pterygospinous bar, Pterygoalar bar, Civinini's foramen, Trigeminal neuralgia

### INTRODUCTION

Sphenoid bone is structurally the most complex bone in the human body. It consists of a central body, paired greater and lesser wings and two pterygoid processes, descending from the junction of body and greater wings. Each pterygoid process has long and narrow medial pterygoid plate and broad, thin and everted lateral pterygoid plate (1). The posterior border of lateral pterygoid plate gives attachment to pterygospinous and pterygoalar ligaments.

The pterygospinous ligament (ligament of Civinini), is formed by pterygoid fascia, which extend from spine of sphenoid to pterygospinous process on the upper part of posterior border of lateral pterygoid plate (2). The complete ossification of pterygospinous ligament forms pterygospinous bar (3,4) and creates a foramen called pterygospinous or Civinini's foramen (5,6).

The pterygoalar ligament (Hyrtl-Calori's ligament) is formed by dense connective tissue extending from the base of lateral pterygoid plate to infratemporal surface of greater wing of sphenoid, its complete ossification results in formation of pterygoalar bar and pterygoalar foramen (Porus crotaphitico-buccinatorius) (4,7).

Ossification of pterygospinous and pterygoalar ligaments is of great clinical importance as these ossified ligaments exist in close vicinity to foramen ovale (8,9), therefore, can obliterate the foramen and may cause compression of neurovascular structures passing through it (3,9,10). These bony bridges have been reported to cause entrapment of mandibular nerve & its branches, that may lead to trigeminal neuralgia (11,12).

The ossified pterygospinous and pterygoalar ligaments may be a concern for clinicians as they can cause trouble in performing thermo-coagulation and in giving anesthesia or mandibular nerve block for the treatment of trigeminal neuralgia (12,13). These may challenge surgeons to approach retropharyngeal and para-pharyngeal spaces through lateral transzygomatic route (10,13,14).

Literature available describes close relation of pterygospinous and pterygoalar bars with foramen ovale, however there is paucity of reports on the relation of pterygospinous bar with foramen spinosum. Also, there are fewer studies available on the incidence and morphometry of pterygoalar bar in Indian population.

Therefore, the present study was undertaken to evaluate, the incidence, morphology, morphometry and clinical relevance of ossified pterygospinous and pterygoalar ligaments in north Indian population.

### MATERIALS & METHODS

The study was conducted on 48 ( 96 sides) north Indian dry human skull of unknown sex and age, belonging to department of anatomy, Rama medical college, hospital and research centre. The base of skulls were studied for the following:

1. Incidences of pterygospinous and pterygoalar bar.
2. Degree of ossification of pterygospinous and pterygoalar ligaments i.e complete and incomplete.
3. Relation of bony bars with foramen ovale and foramen spinosum
4. Length and width of pterygospinous and pterygoalar bar was measured using digital Vernier caliper
5. Size of pterygospinous and pterygoalar foramen was measured using Vernier caliper

All readings were taken three times and an average was taken for better accuracy. Results were tabulated and percentages calculated for each type.

### RESULT

48 (96 sides) dry human skulls used in the present study were examined for the incidence, morphometry and morphological evaluation of pterygospinous and pterygoalar bar and foramen. Out of 48(96 sides) skulls studied, ossified pterygospinous ligament was observed in 19.79% cases (19 sides). Completely ossified pterygospinous ligament was present in 1.04% (1 left side), (Fig.1), whereas, 18.75% (18 sides: 10 right and 8 left) presented partial ossification (Fig.2). 5 skulls (5.21%), showed bilateral incomplete ossification of pterygospinous ligament.

The ossified pterygoalar ligament was present in 13.54% cases (13 sides) of the skulls studied. Completely ossified Pterygoalar ligament was seen in 3.12% cases (3 right sides) (Fig.3 and Fig.4) and partially ossified in 10.42% (10 sides: 6 right & 4 left), (Fig.5). Bilateral ossification of pterygoalar ligament was seen in 3 skulls (3.12%), all had incomplete ossification on both sides (Table.2).

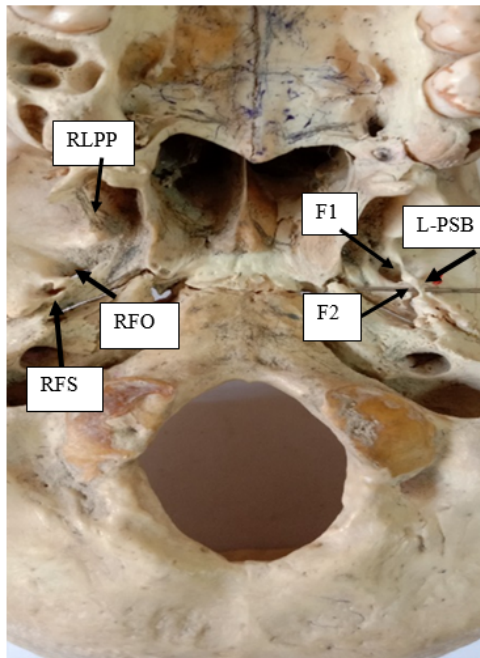
The Pterygospinous bar measured 10.40 mm in length and 2.16 mm in

width. It was inferior to both foramen spinosum and foramen ovale, partially obstructing them. The mean length and width of pterygoalar bars was 6.62 & 2.22mm respectively (Length varied from 10.17mm - 3.75mm). The pterygospinous bar created two pterygospinous foramens separated by a bony spicule, one related to foramen ovale (F1) and other related to foramen spinosum (F2), (Fig.1). The mean vertical & horizontal diameters of the F1 pterygospinous foramen was 5.17 and 4.33mm respectively and that of F2 was 3.85 and 3.03mm respectively.

The mean vertical and horizontal diameter of pterygoalar foramens was 3.22 and 5.42 mm respectively. In 2 skulls, the pterygoalar bar was present lateral to foramen ovale and in one it was passing across the foramen ovale (Fig. 4).

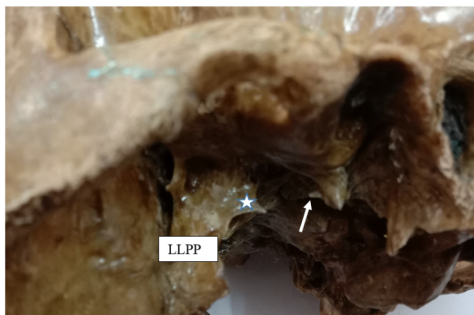
**Table 1: Incidence of complete and incomplete ossified Pterygospinous ligament**

	Right		Left		Bilateral	
	Number-n	%	n	%	n	%
Complete	0	0	1	1.04	0	0
Incomplete	10	10.42	8	8.33	5	5.21
Absent	86	89.58	87	90.63	91	94.79
Total	96	100	96	100	96	100



**Fig.1.** Base of skull showing: a. Left side pterygospinous bar (L-PSB) passing inferior to foramen ovale & foramen spinosum. Presence of 2 pterygospinous foramen F1 & F2 (probe inside)

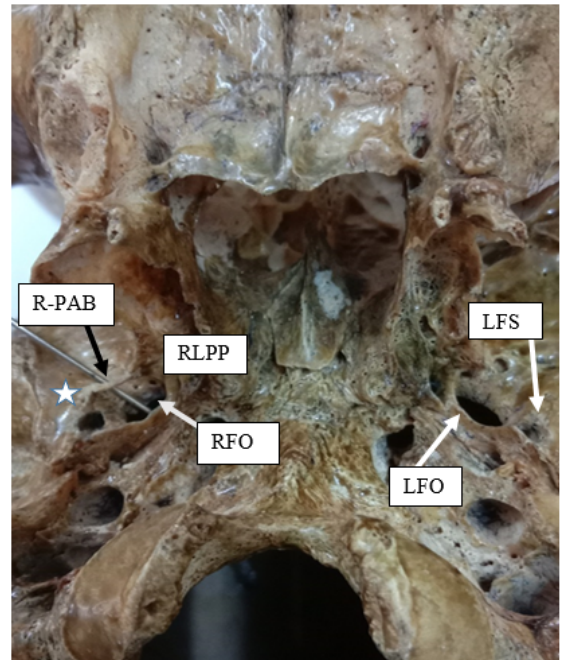
b. Right side, Foramen ovale (R FO) and Foramen spinosum (RFS). Foramen spinosum partly covered by a bony spicule  
RLPP- Lateral pterygoid plate (Right side)



**Fig.2.** Lateral view of the left side of a skull showing: Incomplete ossification of pterygospinous ligament, seen as spinous projection from lateral pterygoid plate (star) and spine of sphenoid (arrow). LLPP-Lateral pterygoid plate (left side)

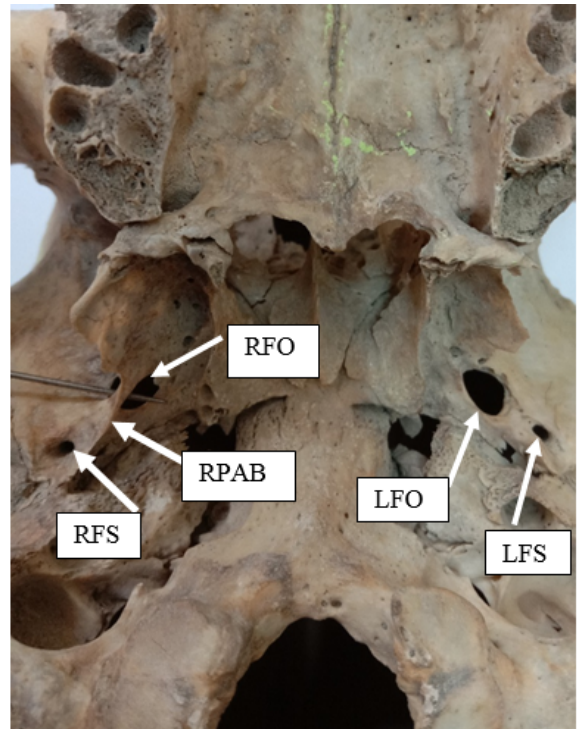
**Table 2: Incidence of complete and incomplete ossified Pterygoalar ligament**

	Right		Left		Bilateral	
	n	%	n	%	n	%
Complete	3	3.12	0	0	0	0
Incomplete	6	6.25	4	4.17	3	3.12
Absent	87	90.63	92	95.83	93	96.88
Total	96	100	96	100	96	100



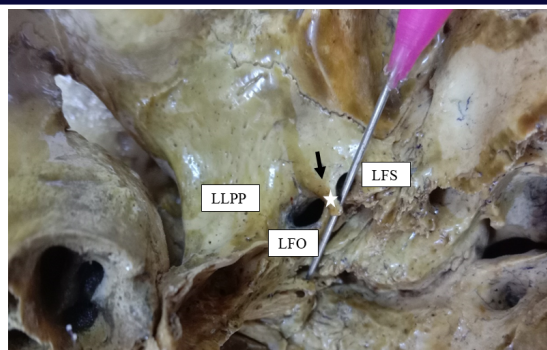
**Fig.3.** Base of skull showing: a. Right side Pterygoalar bar (R-PAB), lateral to foramen ovale (RFO) and extending from greater wing of sphenoid (star) to lateral pterygoid plate (RLPP)

b. Left side, foramen ovale (LFO) and Foramen spinosum (LFS).



**Fig.4.** Base of skull showing: a. Right side pterygoalar bar (RPAB), passing across foramen ovale (RFO). RFS-right foramen spinosum.

b. Left foramen ovale and spinosum-LFO & LFS



**Fig.5.** Lateral view of left side of skull showing: Incomplete ossification of pterygoalar ligament (star), spinous process projecting from greater wing of sphenoid (arrow). LLPP-left lateral pterygoid plate. LFO & LFS (foramen ovale & spinosum)

## DISCUSSION

The infratemporal region presents an osseous projection called pterygoid process with lateral and medial pterygoid plates. The posterior border of lateral pterygoid plate gives attachment to pterygospinous and pterygoalar ligaments which may ossify and form pterygospinous and pterygoalar bars respectively. The Civinini foramen enclosed by pterygospinous bar may transmit neurovascular structures to medial pterygoid muscle (4,6,8). The pterygoalar foramen may transmit branches from anterior division of mandibular nerve and auriculotemporal nerve (10). Occurrence of these bony bars in adults may be due to secondary ossification (8), however their presence in children suggest genetic factors (6,10,15).

The literature available on presence of pterygospinous and pterygoalar bar indicates variations in their incidence and types, in different populations. The present study on 48 skulls showed ossified pterygospinous ligament in 19.79% cases with 1.04% cases of complete & 18.75% cases of incomplete ossification. Same findings reported in a study on 142 Korean skulls where ossified pterygospinous ligament was seen in 18% cases with, 1.4% complete & 16.6% cases of incompletely ossified ligaments (2), whereas 0.98% for completely ossified type observed in a study on 204 south Indian skulls (10), this was less as compared to present work. Study on 54 dried skulls of Indian origin observed 26.66% cases for ossified pterygospinous ligament, with 4 skull (6.66%) showing complete ossification (16). However, a radiographic study on 93 Brazilian skulls, reported higher incidence (8.16%) for completely ossified pterygospinous ligament (9).

Incidence of 10.2% for ossified pterygospinous ligament (4% complete and 6.2% incomplete) was reported in a study on 500 north Indian skulls (11). A study on 67 Indian skull reported total incidence of 9.71% (2.99% complete ossification) only (17). A greater percentage (19.79%) for ossified pterygospinous ligament observed in present work. Incompletely ossified ligament in 2 skulls with no case of completely ossified ligament was observed in another study (18)

Variation in occurrence of pterygospinous bar could be because of sample size or age of the sample, ossification is more in older population. Most studies, including ours reports higher incidence for incomplete type. However a study on 416 dried skulls, reported more cases (5.76%) of completely ossified ligament than incompletely ossified (3.84%) ligament (5).

Incidence for ossified pterygospinous ligament has been reported to be higher in African population (12-13%) as compared to Caucasians (2-7%) (4)

Ossified pterygoalar ligament was observed in 13.54% cases in the present study, with 3.12% complete & 10.42% cases of incomplete ossification. In contrast, a Korean study (2) and a study on 305 Croatian skulls (19) reported lower incidence for both complete (2.8% & 2.4%) and incomplete (5.6% & 4.4%) pterygoalar bars respectively. A Brazilian study reported completely ossified pterygoalar bar in 3.84% and incompletely ossified ligament in 22.43% cases (15). However, a radiographic study observed higher percentage (12.91%) for completely ossified and 49.44% for partially ossified pterygoalar bridges (9).

Most studies showed higher incidence for incompletely ossified pterygoalar ligament as compared to complete ossification, however a Brazilian study on 183 skulls reported 2.18% of complete and 0.54% cases of incomplete ossification of pterygoalar ligament (20). Higher percentage for partially ossified pterygospinous & pterygoalar ligaments observed in present work.

The completely ossified pterygoalar bar were observed on right side in this study, contrary to this left side preference in unilateral occurrence has been reported in a study (12). Completely ossified pterygospinous & pterygoalar bars had unilateral occurrence in our study, which is in sync with other studies on Indian skulls (4,11,21)

The mean length and width of pterygospinous bar in present study was 10.40 and 2.16mm respectively. Similar results for length and width (10X2.5mm) reported in a study on Indian skulls (10). Pterygoalar bar measured 6.62mm in length and 2.22mm in width (length ranged from 3.75-10.17mm) in our study, this was close to 6.3mm and 3.1mm for length and width of pterygoalar bar reported in one study (10). The pterygospinous bar was longer than pterygoalar bar in both the works.

The 2 pterygospinous foramen (F1, F2) in the present study, were in close relation to foramen ovale and foramen spinosum respectively. The vertical and horizontal diameter of the former (F1) was 5.17mm and 4.33mm and that of F2 was 3.85 and 3.03 mm respectively. However, values for vertical and horizontal diameter reported in one study was 7.5 & 7mm respectively (10) and 10 & 12 mm respectively in another study (4). A diameter of 2X 1 mm respectively was reported in a study on 54 human skulls (16). The size of pterygospinous foramen could not be compared with present work as here, foramen was split into 2 parts by a bony spicule.

The mean vertical and horizontal diameter of pterygoalar foramen was found to be 3.22mm and 5.42mm respectively in the present work. Another study reports, vertical & horizontal diameter of pterygoalar foramen as 2.7 and 3.2mm respectively (10).

A smaller vertical diameter of pterygoalar foramen (3.22mm) as compared to pterygospinous foramen (5.17mm) suggests, pterygoalar bar to be in close proximity to base of skull. This will increase chances of nerve entrapment by pterygoalar bar. Complete ossification of pterygoalar ligament occur more often than pterygospinous (2) and is more likely to cause compression of mandibular nerve (3). Present study also reports higher percentage for completely ossified pterygoalar ligament than pterygospinous, though both were obstructing foramen ovale.

The pterygospinous bar, being medial or inferior to foramen ovale has been reported in literature (8,12). It was found inferior to foramen ovale in all cases (1.25%) of one study (4). However, in the present study, pterygospinous bar was inferior to both foramen ovale and foramen spinosum, a finding unique in our study. To the best of our knowledge none of the previous studies on Indian population report, its inferior relation to foramen spinosum.

The pterygoalar bar as, medial, lateral or across the foramen ovale has been reported in literature (10, 22). It was lateral to foramen ovale in 2 cases and inferior to it in 1 case in the present study.

The occurrence of pterygospinous bars in humans is considered as phylogenetic remnants. Herbivores, carnivores and mature monkeys skull show a wide pterygospinous bar, but it is absent in humans and new world monkey (4,14).

Awareness about such ossified ligaments is of immense importance for maxillofacial surgeons, anesthetists, neurologists and radiologists, while performing radiological investigations, surgery or giving anesthesia in the infratemporal fossa. These osseous bars may pose difficulty in locating foramen ovale & hinder the surgical procedures like percutaneous injection of mandibular nerve (4,22), trigeminal rhizotomy, cavernous sinus tumor biopsy(2) and thermocoagulation of trigeminal ganglion (14,23), to relieve pain in patients of cancer or fracture mandible. They obstruct high quality conductive anesthesia through lateral sub-zygomatic route (12,19,23). The bony bars may block the passage of needle into foramen ovale therefore can disable anaesthesia of trigeminal ganglion for pain relief (2, 22), hence reduce success rate for ganglion block through transovale route (15,19). The knowledge about such osseous bars may prompt clinicians to seek a different technique or take inframandibular route (10).

The ossified pterygospinous & pterygoalar bars may be responsible for compression of branches of the mandibular nerve, otic ganglion and middle meningeal vessels (8,14). This knowledge is important in explaining painful conditions that may arise due to nerve compression in this area. The pterygospinous bar may cause lingual nerve entrapment causing numbness on anterior 2/3<sup>rd</sup> of tongue along with speech impairment (8,11,19). The chorda tympani nerve is closely related to pterygospinous bar it may get compressed and result in altered taste sensation on anterior 2/3<sup>rd</sup> of tongue (23). The pterygoalar bar may compress nerve to muscles of mastication, buccal branch and auriculotemporal nerve and cause chewing disorders, pain and numbness in buccal region and altered function of parotid gland (2). The bony bars may reduce space between lateral pterygoid plate and spine of sphenoid, and restrict access to retropharyngeal and parapharyngeal spaces by the surgeons (4,10,14). Therefore prior identification of these osseous bars may increase the success rate of surgical or anesthetic procedures in the infratemporal region. Radiologically these bony bars can be identified best by using Hertz axial technique (9) or mentocoronal and lateral views (4).

The present study is of importance as it reports a rare variant of pterygospinous bar that bridged across foramen ovale and foramen spinosum. The partially obstructed foramen spinosum may become a potential site for compression of structures around it and those passing through it, which can result in vascular and nervous complications.

## CONCLUSION

The incidence and clinical significance of ossified pterygospinous ligament is well documented in literature, however there is paucity of reports on pterygoalar bar and foramina in Indian population. Knowledge about such osseous variations is important as, they may compress, branches of mandibular nerve, chorda tympani nerve and other neurovascular structures with serious complications like trigeminal neuralgia and loss of taste from anterior 2/3<sup>rd</sup> of tongue. They may create a barrier to access foramen ovale for performing trigeminal ganglion block, percutaneous trigeminal rhizotomy and biopsy of cavernous sinus tumors. For successful outcome of such procedures, it is important to identify these osseous anomalies and take an alternative approach. Therefore, the knowledge about ossified pterygospinous and pterygoalar ligaments is not only of interest to anatomists and anthropologists but also important for oral and maxillofacial surgeons, anesthetists, radiologists and dentists to increase success of diagnostic and surgical management.

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