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Prevalence and clinical significance of retro- transverse foramina in Indian population

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ABSTRACT

Introduction: Lumbar vertebrae can be distinguished by presence of mammilary process and accessory process from other vertebrae. Mammilaro-accessory ligament connect these processes. Medial branch of dorsal rami passes underneath this ligament. The ligament may be ossified partially/completly resulting in various morphological forms like complete foramen, 3/4th circle and ½ circle. There is scanty literature describing these forms and their clinical significance. Thus the study was conducted. Aim of the study is to decipher different forms culminated from ossification of mammilo-accessory ligament and to elucidate clinical implications.

Methods: Study was carried out in Department of Anatomy AIIMS Rishikesh. Total of 140 lumbar vertebrae (28 sets) were scanned for the possible presence of various morphological forms resulting from ossification of mammilo-accessory ligament. Our results were compared with those of previous investigators and associated clinical significance was brought out. The age and sex of these vertebrae were not known.

Results: The ossification of mammilo-accessory ligaments in varying degree was observed only in L5 vertebrae. Complete foramen was detected in 3of 28 sets constituting 10.7 incidence, > ½ circle in 21/28 (75%) and ¾ circle in 12/28 (42.8%) sets.

Conclusion: Various percutaneous techniques are used to stimulate, anesthetize and damage the medial branch of dorsal rami. These methods will be difficult to carry out if the mammilo-accessory ligament is ossified. Ossified ligament may also cause entrapment of medial branch leading to back ache. Thus in-depth knowledge of this entity will be useful to neurosurgeons to carry out surgery in the lumbar region.

Keywords: Mammilary process, Accessory process, Lumbar vertebra, ossification

INTRODUCTION

Lumbar vertebrae are characterised by presence of accessory and mammilary processes. The mamillary processes (MP) project backward from the superior articular process and are short and round for the attachment of multifidus and medial intertransverse muscles. The accessory processes (AP) project from the posterior and inferior surfaces of the bases of the transverse processes. They give attachment to medial intertransverse muscles.

A wide groove of variable length is formed between MP and AP of the lumbar vertebra. The fibrous band which passes from the MP to the AP in these vertebrae bridges this groove forming 6 mm long tunnel. This groove in all lumbar vertebrae is converted into a foramen by a band of fibrous tissue. This fibrous band was named as the mamillo accessory ligament (MAL) first by Bogduk [1] describing its clinical significance. The medial branches originated from dorsal rami in turn formed of T12 to L4 spinal nerves and vessels irrigating

paraspinal muscles course along these grooves/foramina. The ascending and descending branches of medial branch of the dorsal rami supplies sensory branches to the zygapophyseal joint capsule and subsequently enters the multifidus muscle [2]. According to Bogduk the ligament encloses the medial branch of the dorsal ramus in an osseofibrous tunnel. The ligament morphologically represents remnant of transverso-spinal elements [1].

The MAL found to be ossified in varied degrees so it has been grouped into three categories; 1. >1/2 circle, 2. ¾ circle, and 3. Complete Mammilary Accessory Foramen (MAF). Varied patterns and degree of ossification of MAL was first observed in China [3] in 1978 followed by Bogduk [1] in 1981 and later by Maigne et al., in 1991 [4]. The importance of MAL to clinicians, its ossification and its relation to medial branch in light of management of low back pain has been elucidated by few authors [5, 6, 7]. Manners-Smith [8] in 1908 observed these bony canals in skeletons and named them as a "retro- transverse foramina."

There is scanty literature describing the ossification of the ligament along with immense clinical significance associated with it, the study was conducted. The aim of the study is to elucidate the prevalence of different morphological forms resulting due to ossification of this ligament in Indian population, compare the results with available literature and to bring out its clinical implications.

Material and methods:

During osteology demonstration classes of 1st year MBBS (Bachelor of medicine and surgery) students, we came across a 5th lumbar vertebra exhibiting complete ossification of MAL forming MAF. This prompted the authors to scan all 28 sets of lumbar vertebra (L1-L5) amounting to a total of n= 140 vertebrae available in osteology lab in the Department of Anatomy AIIMS Rishikesh for prevalence of various morphological forms of MAFs formed by partial/full ossification of MAL. These morphological anomalies of MAFs were analysed and grouped as catagorised by Maigne et al [4]. This classification is appended below.

Category I: The MAFs having ossification > ½ circle (Fig.1),

Category II: The MAFs having ossification ¾ circle (Fig.2) and

Category III: The complete ossification of MAL forming MAFs (Fig.3)

The Statistical analysis in form of percentage has also been carried out to facilitate clinical implication of MAFs besides bringing out its clinical significance. All lumbar vertebrae were completely ossified and belong to adult population. All lumbar vertebrae from L1-L5 were examined for morphological variants of MAFs. The age and sex of these dry vertebrae were not known. Sets of lumbar vertebrae having any gross structural defects were not considered.

Results:

Having scanned 140 lumbar vertebrae (56 sides), none of the morphological anomalies were observed in L1 through L4 vertebrae in all the 28 sets. The ossification of MALs in varying degree was observed only in L5 vertebrae bilaterally or unilaterally. The MALs of 26 L5 vertebrae out of 28 were observed partially/fully ossified presenting an incidence of 92.9 % (26/28). Side wise incidences of various categories of MAF are depicted in Table 1.The category (I, II and III) wise percentage incidences in total 28 vertebrae were detected 75% (21/28) of category I > ½ circle, 42.8% (12/28) of category II ¾ circle and 10.7% (3/28) of category III MAFs whereas the incidences of these categories among anomalous vertebrae were observed as 80.8% (21/26) in category I, 46.2% (12/26) in category II and 11.5% (3/26) in category III out of total 26 anomalous vertebrae. Five 5th lumbar vertebrae were observed having bilateral >1/2 circle in category I of MAF while 6 such circles were found on right and 10 on left sides. The category II of MAF formation describing ¾ circle was observed in two 5th lumbar vertebrae bilaterally having same anomalies on both sides of vertebrae including five MAFs of this category were found each on left and right sides. No complete bilaterally MAF in category III was found. One MAF was observed on right side of a vertebra whereas two MAFs were detected on left sides of two vertebrae.

The incidences of MAFs were analysed category wise for different MAF categories present on two different sides of the vertebrae. Thus besides

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presence of bilaterally similar 2 MAFs of category II on both sides of 2 vertebrae, 5 single sided MAFs of Category II were observed in left sides and on right side of these 5 vertebrae, 4 single sided MAFs of category I and one single sided MAF of category III were observed. Other 5 single sided MAFs of category II were also detected on right sides while on left of these vertebrae 5 single sided MAFs of category I were observed. Thus a total of 10 vertebrae have dissimilarly bilateral MAFs. No single MAF of this category on single side of any vertebrae was observed.

So a total of 17 vertebrae found to possess bilateral anomalies constituting an incident of 60.7% (17/28) out of 28 vertebrae. 9 cases of single anomaly on single side of a vertebra were noticed forming 32.1% (9/28) out of 28 vertebrae. The incidence of bilateral anomaly out of 26 anomalous vertebrae was 65.4% (17/26) and incidence of 9 single anomalies on single side of vertebrae was 34.6% (9/26).

Discussion:

An unusual gross variation nurtures interest of anatomists and causes concern for clinicians when it mimics pathology. MAF is such an unusual variation and is one of the causes of lower back pain whereas the back pain is also caused by numerous other reasons. Therefore, clinician has to diagnose this by filtering all other reasons through CT scan/MRI. This causes concern to clinicians.

First study, elucidating the ossification of MAL forming MAF, was conducted in China [3] in 1978 and then the presence of MAFs was confirmed in 1981 by Bogduk [1]. The incidence of MAF was found 10% by Bogduk [1]. Later, Maigne et al. in 1991 [4] studied 203 lumbosacral skeletal elements having various morphological forms formed by ossification of MAL classified. As per his opinion, the incidence was almost zero at L1 and very rare at L3 and L4 but frequency of MAF was regularly increasing caudally from L1 to L5. Maigne et al [4]. reported the incidence of MAF 26% on the left side and in 13.5% on the right which is higher than Bogduk [1]. The opinion of Maigne et al [4]. regarding incidences of MAFs in L1 to L5 was in congruence to our study as we did not find any MAF from L1 to L4 and an overall incidence of 10.7% was observed in L5 vertebrae and side wise incidence was found 3.6% on right and 7.1% in left. This is similar to Bogduk [1] but lower than Maigne et al [4]. As far as sides are concerned, overall incidence was 5.4% coupled with an incidence of 1.8% in right and 3.6% in left side of these vertebrae having MAFs. Incomplete MAF describing ¾ circle was observed symmetrically bilateral in 2 L5 vertebrae out of total 28 and 26 in vertebrae having anomalous presence was detected in 7.1% and 7.7% respectively whereas side wise 5 vertebrae in this category were found each in left and right side occurring (5/56) 8.9% in each left and right sides out of 56 sides and (5/52) 9.6% in each left and right sides out of 52 sides of anomalous vertebrae. All the other 10 vertebrae, which have asymmetric bilateral presence of MAF of category II, constitute 35.7% (10/28) incidence. Another incomplete circle (>1/2) in category I, incidence of asymmetric bilateral MAFs was detected as 32.1% (9/28) together with 17.8% (5/28) incidence of symmetric bilateral MAF was observed. All these incidences in our study were lower than that observed by earlier authors. Discrepancy observed in prevalence of various morphological forms may be attributed to difference in sample size and ethnic factors.

Previous investigators are of view that MAF is a manifestation of osteoarthritic changes and these may irritate or compress the dorsal ramus along its passage [4]. But recent opinion is that MAF related dorsal rami entrapment neuropathies arise not merely due to osteoarthritic ossification of the MAL but could also be related to facet dimensions or degree of MP-facet fusions that abut close to the mamillo-accessory junctions [9]. Some investigators expressed the view that since both the MP and AP are derived developmentally from transverse element, the ossification of MAL could be congenital [10].

Clinical significance:

Low back pain is very common disease among common populations in general and elderly aged in particular. MAF is calcified 'Retro- transverse foramen' in L5 formed by the ossification of fibres of ligament bridging the tips of MP and AP. The vertical foramen in transverse process of L5 as observed in CT is depicted in Figure-4 should be differentiated from MAF. This calcification of MAL is partial/full producing complete/incomplete MAF. The medial branch and vessels irrigating paraspinal muscles course through this foramen. MAF is hard

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bony structure and many times have bony spurs [11] directed inside the foramen impinging upon medial branch and vessels passing through it. So these structures are likely to be injured by bony MAF and the injury is more severe if bony spurs are present in MAF. The ossification of these ligamentous fibres takes place in varying degree that is partially or fully as categorized.

However, MAF, a complete bony ring defined as Category III is most dangerous than partial bony rings. The MAFs, if present bilaterally, are more harmful. The bilateral MAFs may compress bilateral neurovascular structures passing through it. If the bony ring possess bony spurs projected inward are more dangerous to damage the structure not by mere compression rather it may impinge upon these structures and damage them severely. The incomplete rings, defined as category II ¾ circle and >1/2 circle as category I, may also compress but slightly less than complete rings. The presence of these unilateral partial/full bony rings is less harmful than their presence bilaterally. The structures will be distorted/damaged by the presence of bony ring causing lower back pain and other clinical complication like ischemia to the irrigating structures. Though the sample domain is small yet very useful statistics have been computed and presented in this study which will be very useful to the clinicians. The importance of this foramen is enhanced when and where its prevalence is high.

As such ascending branches, from medial branches emanated from dorsal ramus, supply lumbar facet joints which constitute a common source of pain, accounting for 15-45% of low back pain. But these joints produce pain and difficult to be diagnosed so improperly treated [12]. Therefore, any irritation, compression or injury/degeneration due to medial branch entrapment in partial or full MAF, may invoke low back pain [5]. Lumbar joint pain may be referred to the legs. Consequently attempts are sometimes made to interfere with the nerves that supply the zygapophyseal joints of lumbar vertebra to alleviate sciatica and back pain. Various percutaneous techniques to stimulate, anesthetize or destroy the medial branch are used. Ossification of MAL may create difficulties during some percutaneous denervation techniques. Facet osteoarthritis is highly prevalent in facet disease [13].

Conclusion:

Incidence of various morphological forms of MAF was observed in 26 cases amounting to 92.9% which is remarkably high in Indian Population. Bilateral MAF may be more problematic than unilateral and incidence of bilateral MAF is also high (60.7%). MAF is an important cause of back pain and sciatica and so these morphological forms should not be overlooked. MAF is worth studying not only in different populations and geographical regions to successfully deal with ailments related to MAF but also for the comparison of data in these populations with those of the world.

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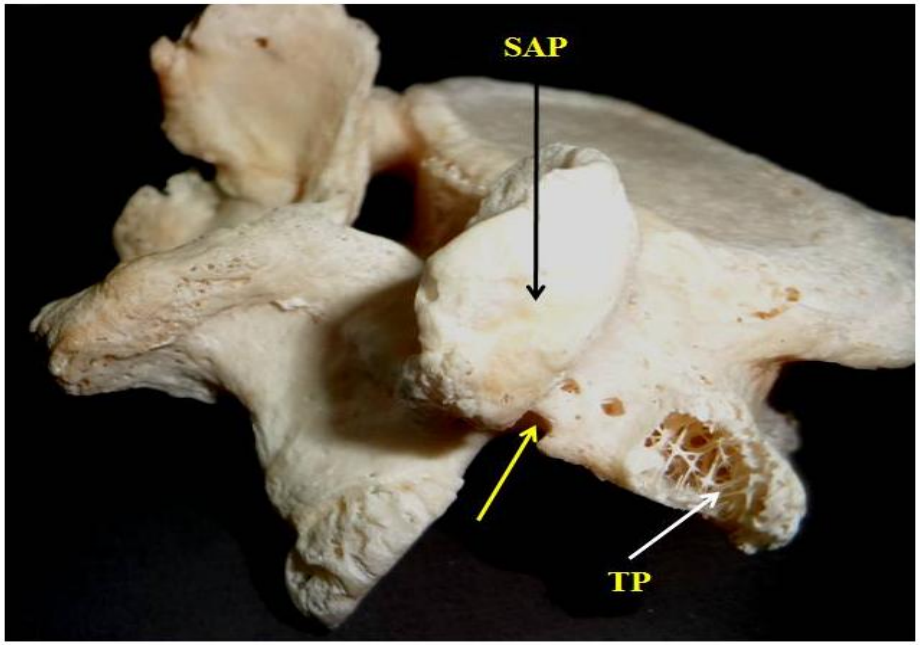

Figure-1 fifth lumbar vertebra showing mammilo-accessory foramen category I, >1/2 circle.

MAF- mammilo-accessory foramen, SAP- superior articular process, TP- tranverse process

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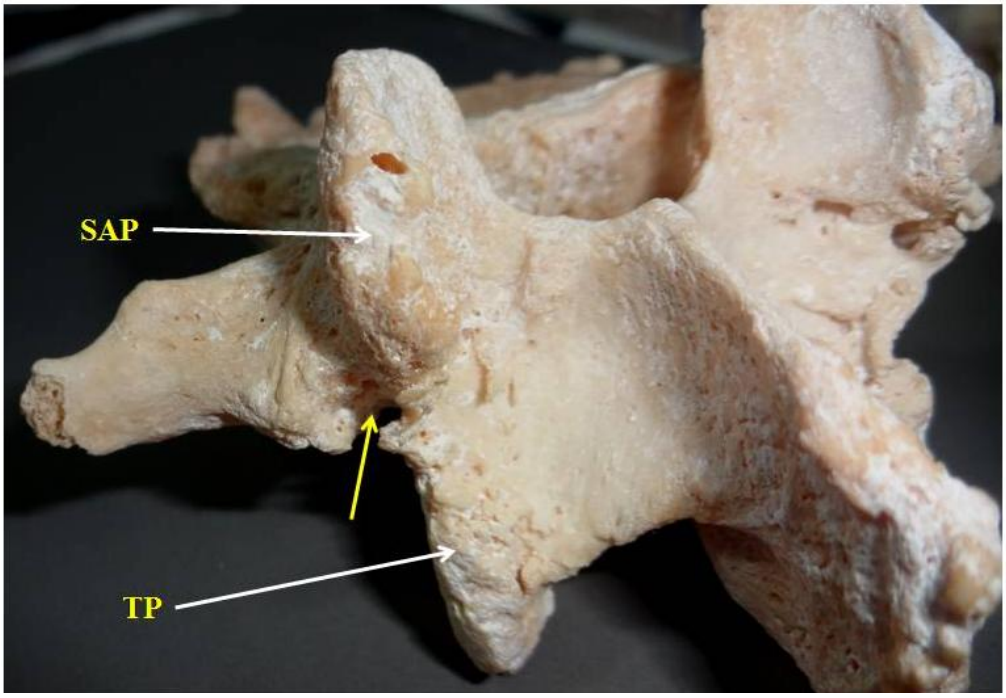

Figure-2 fifth lumbar vertebra showing mammilo-accessory foramen category II, ¾ circle

SAP- superior articular process, TP- tranverse process

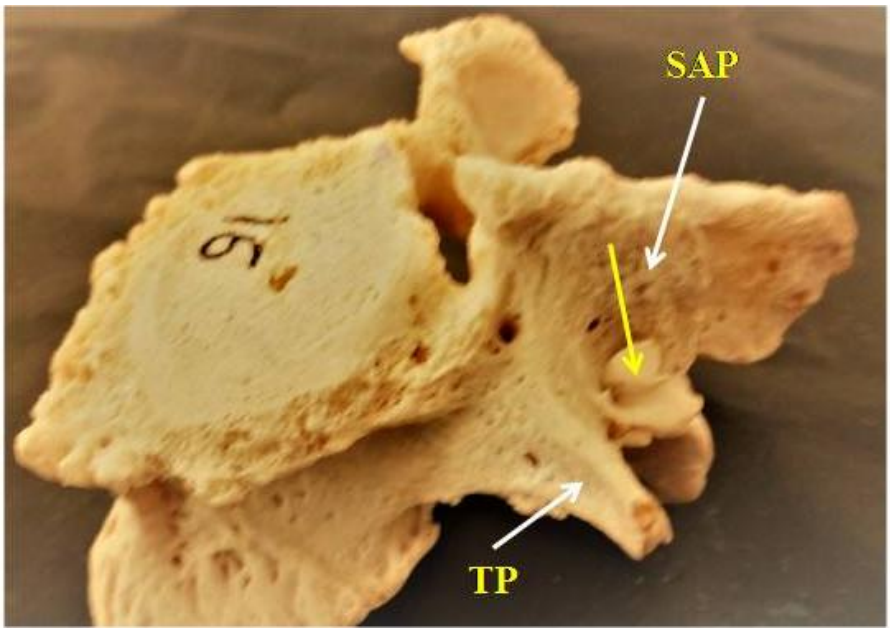

Figure-3 fifth lumbar vertebra showing complete Mammilary-accessory foramen

SAP- superior articular process, TP- transverse process

Figure-4 showing vertical foramen in CT scan of fifth lumbar vertebra. White arrow is in this foramen

Table 1: Occurrence of sidewise complete and incomplete MAFs in L-5 vertebrae (28)

category	Side wise and	% incidence	Authors

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	Bilateral n/%	R vert/%	L vert/%	T Vert./ %	
MAF	Nil	2/7.1	1/3.6	3/10.7	Present study
¾ circle	2/7.1%	5/17.9	5/17.9	12/42.8	Present study
>1/2 circle	5/17.9	6/21.4	10/35.8	21/75	Present study
MAF	-	-	-	/10	Bogduk
¾ circle	-	-	-	-	Not available
>1/2 circle	-	-	-	-	Not available
MAF		/13.5	/26		Maigne et al.
¾ circle					Not available
>1/2 circle					Not available

Table legend:

Table 1 showing side wise incidences of three categories of Mammilary-accessory foramen

n/%= number of vertebrae/ percentage of incidence, MAF= Mammilary-accessory foramen, R=right side of vertebra, L= left side of vertebra, vert.= vertebrae, T= total

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