The Lumbar Mamillo-Accessory Ligament

Its Anatomical and Neurosurgical Significance

NIKOLAI BOGDUK BSc(Med), MB, BS*

The anatomy of the lumbar mamillo-accessory ligament (MAL) was studied by gross dissection in six cadavers. The MAL bridges the mamillary and accessory processes of each lumbar vertebra and encloses the medial branch of the dorsal ramus in an osseofibrous tunnel. The tunnel maintains the proximal course of the medial branch in a constant relationship to bone. This constancy allows for accurate percutaneous techniques to stimulate, anesthetize or destroy the medial branch. The MAL morphologically appears to represent remnants of transversospinal elements in the lumbar region, and is ossified in over 10% of lower lumbar vertebrae. Ossification may interfere with some percutaneous denervation techniques. The MAL may be a site of entrapment of the medial branch and may be a source of low-back pain. [Key words: lumbar spine, mamillo-accessory ligament, medial branch of dorsal ramus]

BETWEEN the mamillary process and the accessory process on each side of every lumbar vertebra, there is a notch which is converted into a foramen, or short canal, by a band of fibrous tissue that covers the medial branch of the dorsal ramus. This band has no formal name,[17] and it has not been specifically described in major textbooks of anatomy[6-8,10,11,16,21] although it has been mentioned in descriptions of the lumbar dorsal rami.[2,5,13,15,18-20] Despite this relative neglect, this band of fibrous tissue is not without significance. Accordingly, this paper has been prepared to describe the morphology of this structure, state its anatomical and clinical significance, and to advocate a formal name for it—the mamillo-access.ry ligament.

From the Division of Neurology, Prince Henry Hospital, and the Department of Medicine, University of New South Wales, Sydney, Australia.

*Formerly Sandoz Research Fellow in Neurology, and currently NH & MRC Post-Graduate Medical Research Scholar.

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METHODS

Observations on the morphology of the lumbar mamillo-accessory ligament were made during a series of dissections of six adult embalmed cadavers, performed during studies of the lumbar dorsal rami.

During the study it was noted that on occasion the ligament was ossified. Therefore, the incidence of ossification of the ligament was studied by examining 293 lumbar vertebrae obtained from the collections of the Departments of Anatomy of the University of Sydney and the University of New South Wales.

Ossification of the ligament was interpreted to have occurred if spicules of bone, stemming from the accessory process, were observed to be directed toward the mamillary process, and/or vice versa. The extent of ossification was classified as follows: "nil" when there were no identifiable spicules (Figure 1A); "complete" where a complete bar of bone, regardless of thickness, bridged the mamillary and accessory processes, converting the notch into a foramen (Figure 1B); "partial" in all other cases in which appropriately orientated spicules were observed (Figure 1C).

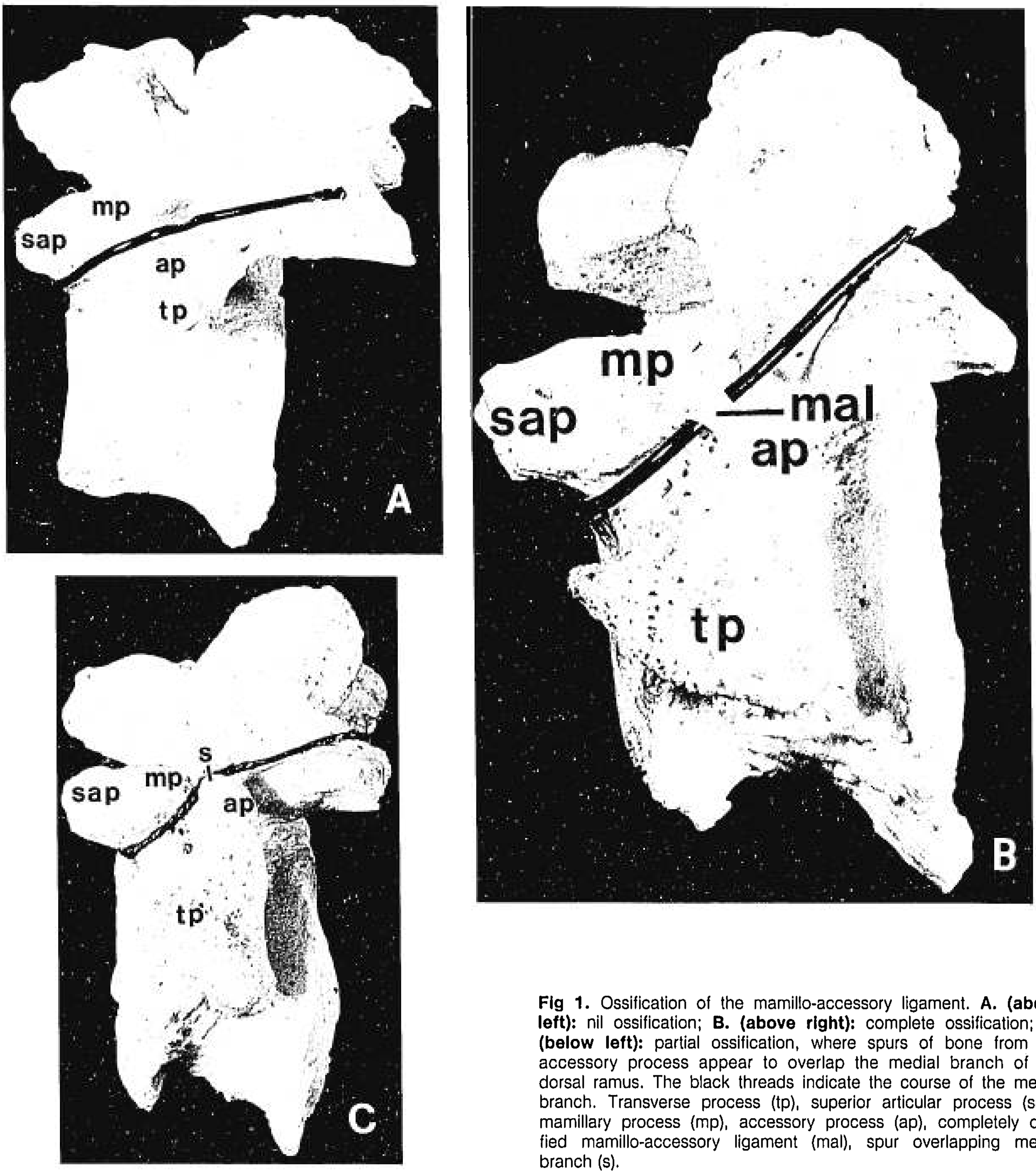

Fig 1. Ossification of the mamillo-accessory ligament. **A. (above left):** nil ossification; **B. (above right):** complete ossification; **C. (below left):** partial ossification, where spurs of bone from the accessory process appear to overlap the medial branch of the dorsal ramus. The black threads indicate the course of the medial branch. Transverse process (tp), superior articular process (sap), mamillary process (mp), accessory process (ap), completely ossified mamillo-accessory ligament (mal), spur overlapping medial branch (s).

It is noted that in this classification the term "complete" does not imply that the ligament itself was completely ossified. Indeed, the thinness of the bridge in some specimens suggested that only the central core of the ligament would have been ossified. Rather, "complete" refers solely to the extent of the bridging between the mamillary process and accessory process.

RESULTS

Gross Anatomy

The mamillo-accessory ligament (MAL) is a tight band of fibrous tissue about 1–2 mm thick, which bridges the rostral aspect of the tip of each accessory process and the ipsisegmental mamillary process of each

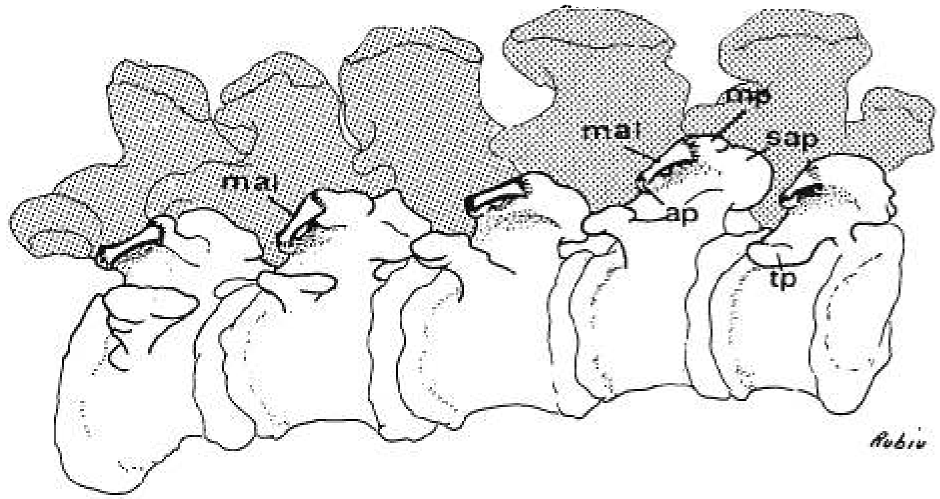

Fig 2. The lumbar mamillo-accessory ligaments. Transverse process (tp), superior articular process (sap), mamillary process (mp), accessory process (ap), mamillo-accessory ligament (mal).

lumbar vertebra (Figures 2 and 3). The ligaments lie deep within the intermuscular cleavage plane between the multifidus and longissimus thoracis muscles. They are better developed and more typical in form at the upper lumbar levels. Each ligament presents dorsal, ventral, lateral, and medial surfaces.

The dorsal surface of each ligament provides an attachment for the lateral fascia of multifidus. The ventral surface is related at every level to the medial branch of a dorsal ramus. The ligament at a given segment is related to the nerve of the next rostral segment, eg., the L4 ligament is related to the L3 medial branch. The lateral surface of each ligament is related to the lateral fibers of the longissimus thoracis muscle that insert into the root of the transverse process at each level. The medial fibers of the longissimus thoracis insert into the caudal aspect and tip of the accessory process, and some of these tendinous fibers pass over the apex of the process and continue rostrally through the ligament to reach the mamillary process (Figure 4A). The medial surface of each

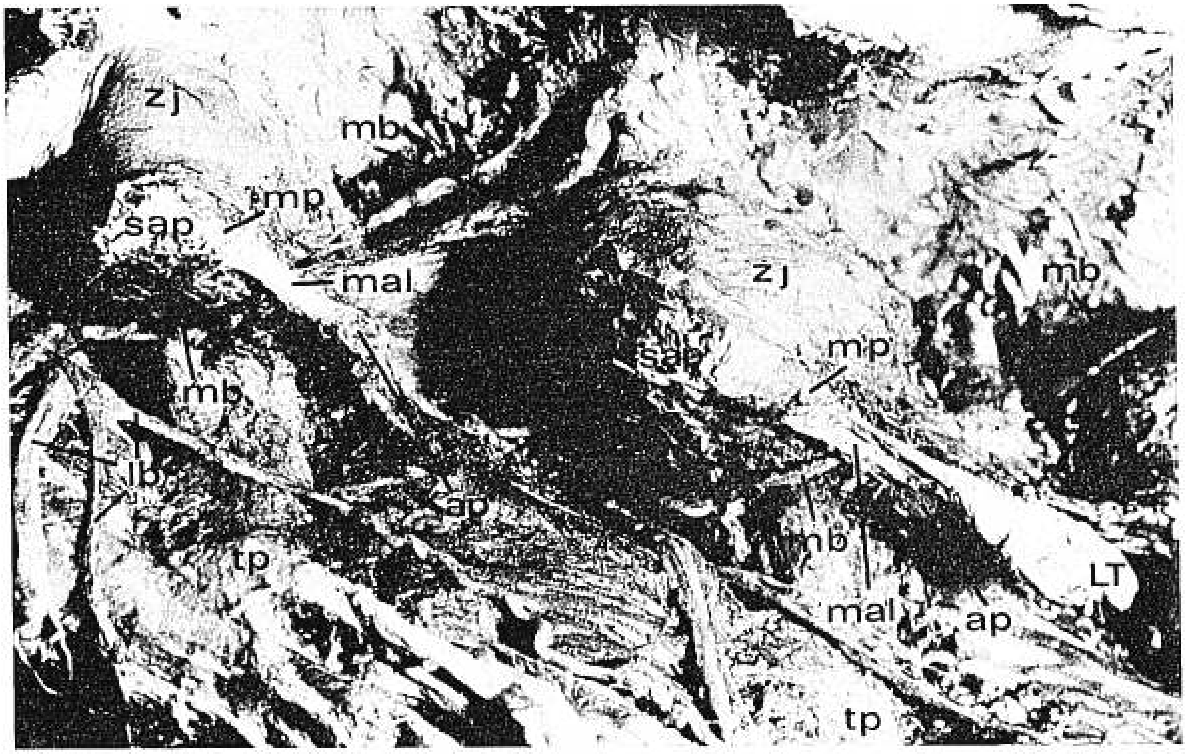

Fig 3. The left L2 and L3 mamillo-accessory ligaments. Zygapophyseal joint (zj), superior articular process (sap), transverse process (tp), accessory process (ap), mamillary process (mp), lateral branches of dorsal rami (lb), medial branches of dorsal rami (mb), tendon of longissimus thoracis (cut) (LT).

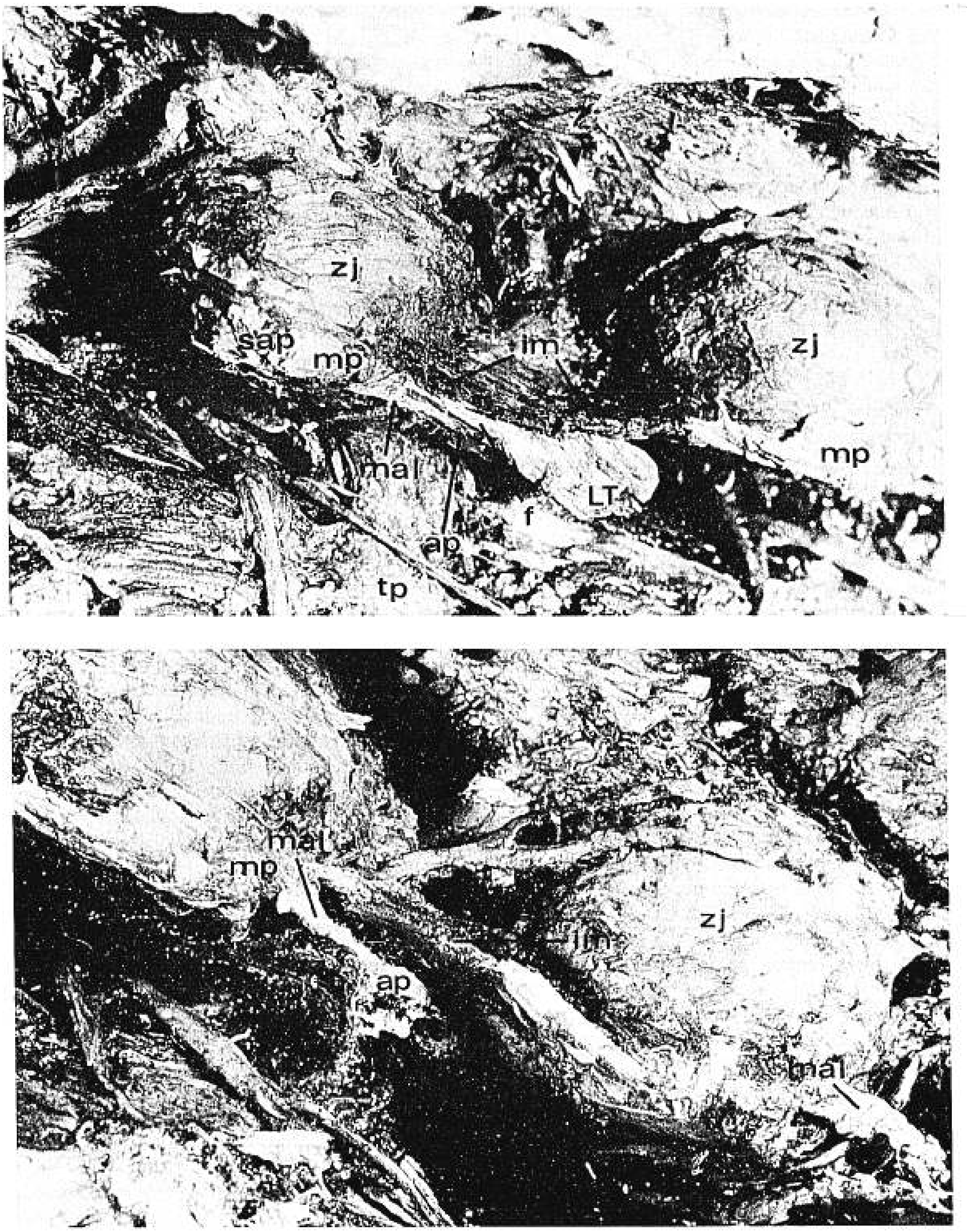

Fig 4A. The left L3 mamillo-accessory ligament, showing the attachment of the intertransversarii mediales (im) and the tendon of longissimus thoracis (LT) to it. Note the fibers (f) of longissimus which extend rostrally into the ligament. **B.** The left L4 mamillo-accessory ligament, with the intertransversarii mediales (im) related medially but not attached to it. Also seen is the L5 mamillo-accessory ligament.

ligament bears a variable relationship to the intertransversarii mediales muscles. This muscle may attach to the MAL along its entire length, or the muscle may have no attachment at all to the ligament and simply lies medial to it (Figure 4).

Ossification

The mamillo-accessory ligament shows a variable degree of ossification. Table 1 shows the specific incidence of ossification at each vertebral level. Ossification is confined to lower levels and is maximal in extent and frequency at the L5 level. Over 10% of ligaments at this level are completely ossified and a further 11–16% are partially ossified.

DISCUSSION

Interpretation of the morphology of the MAL is difficult. It appears mainly to be an independent ligament, though its partial continuity with the longissimus thoracis might suggest it is a prolongation of the attachment of this muscle. Comparison with other species is not helpful since the ligament is not represented in the cat, dog or monkey.[1] In these animals the accessory processes are long and project some distance caudally. No tissue, muscular or fibrous, connects the ipsisegmental accessory and mamillary processes. Comparison with the cervical region in man, however, suggests a possible homology.

In the cervical region a band of fibrous tissue appears to bridge the root of the transverse process and the adjacent superior articular process. It has been called a rudimentary ligament, the *transverso-articulaire.*[14] This ligament, where present, covers the medial branch of the dorsal ramus.[12] In position, apparent attachments, and relationship to the medial branch, it is remarkably similar to the MAL. Close dissection of the ligament transverso-articulaire, however, shows that it is not an independent ligament but comprises, in fact, tendons of origin of the semispinalis capitis, which arise from the transverse process and are applied, though not directly attached, to the side of the superior articular process. The lumbar MAL may, therefore, represent remnants of transversospinal muscle fibers in the lumbar region. The primitive course of these fibers could be interpreted as passing from an accessory process, through a mamillary process and then through superficial elements of the multifidus to reach a spinous process.

The anatomical significance of the MAL lies in its intimate relationship to the medial branch of the dorsal ramus at each level from T12 to L4. The medial branch of each dorsal ramus issues from the inferior opening of the dorsal leaf of the intertransverse ligament. It then runs caudally and dorsally, lying against bone in the groove formed by the junction of the root of the superior articular process and the root of the transverse process. Opposite the caudal end of the superior articular process, the nerve hooks medially around the zygapophyseal joint, passing through the notch between the mamillary and accessory processes, where it is covered by the mamillo-accessory ligament (Figure 3). Deep to the ligament, articular branches to the zygapophyseal joint arise.[18] Distally, the medial branch of the dorsal ramus runs a relatively more variable course across the vertebral lamina and enters the multifidus muscle.

Table 1. The Incidence of Ossification of the Mamillo-Accessory Ligament as Observed in 293 Specimens of Lumbar Vertebrae

Vertebral level	*Number and percent of specimens studied at each level*	*Extent of ossification*					
		Left side			*Right side*		
		Nil	*Partial*	*Complete*	*Nil*	*Partial*	*Complete*
L1	N = 54	54	—	—	54	—	—
	%N	100			100		
L2	N = 56	56	—	—	56	—	—
	%N	100			100		
L3	N = 58	55	2	1	56	—	2
	%N	95	3.5	1.7	96.5		3.5
L4	N = 64	57	5	2	58	5	1
	%N	89	7.9	3.1	91	7.9	1.6
L5	N = 61	44	10	7	44	7	10
	%N	72	16	11	72	11	16

Since the medial branch of the dorsal ramus is held by the MAL in the mamillo-accessory notch, there is little scope for variation in the proximal part of its course. The entrapment by the mamillo-accessory ligament precludes lateral deviation of the course of the medial branch and the nerve appears to be held against the lateral surface of the root of the superior articular process. Accordingly, the medial branch of the dorsal ramus at each level (T12–L4) consistently runs a direct course between the medial end of the superior edge of the transverse process and the mamillo-accessory notch, lying in the groove formed by the junction of the root of the superior articular process and the root of the transverse process.

Clinically, this constancy of position is significant. It means that the position of the medial branch of the dorsal ramus is readily observed radiologically by identifying the junction of the superior articular process with the transverse process. This fact has allowed the development of techniques wherein, under fluoroscopic control, electrodes may be introduced percutaneously onto the medial branch of the dorsal ramus and used to stimulate and/or divide the nerve in the management of low-back pain.[3,4,9]

Another clinical application relates to possible entrapment of the medial branch of the dorsal ramus, Bradley,[5] in referring to the osseofibrous canal formed by the MAL, comments that "it seems likely that nerve entrapment could occur at this point." Sunderland[19,20] has postulated that the medial branch, being held against the root of the zygapophyseal joint by the MAL, could be irritated by subluxations, or by proliferative or inflammatory conditions of the joint and thus be a source of low-back pain. Although each appears plausible, both of these phenomena still await direct demonstration. It would be important, when assessing Sunderland's postulate, to establish whether it was actually the entrapment and not the primary joint disturbance that was the source of symptoms.

A bridge of bone between the mamillary process and the accessory process has been noted previously as an occasional feature of lumbar vertebrae,[7] but this has not been related to the MAL and its ossification. The reason for ossification of the MAL or for its predilection for lower lumbar levels was not apparent in this study. It did seem to be associated with spondylotic proliferative changes in the vertebrae but, unfortunately, the specimens examined in this study all came from elderly donors and naturally showed some degree of spondylosis. There were not enough specimens from patients of younger ages or who were free of spondylosis to allow a valid statistical comparison.

The clinical significance of ossification of the MAL relates to percutaneous neurotomy of the medial branch of the dorsal ramus. Some authors illustrate that neurotomy electrodes should be directed onto the medial branch where it hooks around the zygaphophysial joint.[9] This is the point where the nerve is covered by the mamillo-accessory ligament. On the basis of the present data, it is evident that in over 10% of cases occurring at the L5 level (the level most frequently operated on) the nerve at this point would be protected to a greater or lesser degree by an ossified ligament. Any lesion made at this point might not incorporate the target nerve. Therefore, it is more appropriate to select a target at a more proximal portion of the nerve.[3,4]

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Address reprint requests to

Nikolai Bogduk, BSc(Med), MB, BS
Division of Neurology
The Prince Henry Hospital
Little Bay 2036
New South Wales,
Australia

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