

Basic Science

Lateral extent and ventral laminar attachments of the lumbar ligamentum flavum: cadaveric study

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Abstract

BACKGROUND CONTEXT: Cadaveric descriptions of the deep layer of the lumbar ligamentum flavum (LF), extending between contiguous borders of adjacent laminae and into the lateral spinal canal region are limited.

PURPOSE: To provide detailed descriptions of the lumbar LF.

STUDY DESIGN: Cadaveric dissection.

METHODS: The deep ligamentum flava of 14 formalin-fixed human cadaver lumbar spines (140 levels) were examined to assess their laminar attachments and lateral extents in relation to the intervertebral foramen.

RESULTS: The variable attachment of the deep layer of the LF with respect to the cephalad and caudad laminae was identified and described. At each successive caudal level of the lumbar spine, the deep layer appeared to become a more prominent feature of the posterior vertebral column, lining more of the laminae to which it is attached and encroaching further into the posteroinferior region of the intervertebral foramen at its lateral margins.

CONCLUSIONS: We describe our observations of the deep LF in the human lumbar spine. These observations have clinical relevance for the interpretation of radiologic imaging and the performance of adequate decompression in the setting of spinal stenosis. © 2014 Elsevier Inc. All rights reserved.

Keywords:

Ligamentum flavum; Lumbar region; Intervertebral foramen; Lamina; Spinal canal; Anatomy

Introduction

The ligamentum flavum (LF), or yellow ligament, is present from the second cervical vertebra through to the first sacral vertebra. With the vertebral laminae between

which it spans, the ligament forms the dorsal surface of the spinal canal [1].

The classical anatomical description of the LF was proposed by Naffziger et al. in 1938 [2]. They described it as attaching to the inferior and anteroinferior surfaces of the cephalad lamina and inserting into the superior and posteroinferior surfaces of the caudal lamina. Other authors have since proposed important additions to its anatomical description. Grifka et al. [3] divided the LF into three regions, the pars interspinalis, pars interlaminar, and pars capsularis, according to the landmarks it spanned. Others have made observations regarding the dual superficial and deep layers of the flavum between which lies an avascular plane [4–8].

To date however, detailed gross anatomical descriptions of the LF in the lateral spinal canal region remain scarce. For example, the lateral margin of the LF is usually

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described as extending to the neural foramen before fusing with the adjacent facet joint capsule, with little mention of its spatial relation or variations [4,6,8,9]. These texts describe the flavum in simple terms, extending between contiguous borders of adjacent laminae with no further elaboration [9]. A detailed description of the LF in this region may help surgeons and radiologists better understand its significance and role in lateral spinal canal stenosis.

Materials and methods

The ligamentum flava of 14 formalin-fixed human cadaver lumbar spines (five levels with two sides each, totaling 140 levels) were examined to assess their laminar attachments and lateral extents. The sample consisted of nine men and five women with a mean age of 68 years (range, 49–91). The cadavers were examined up to 2 years postmortem and fixation with 10% formaldehyde.

Twelve specimens were placed in a prone position. The lumbar spines were accessed with dissection through the paravertebral muscles down to the vertebrae. The spinous processes were removed, and the remaining bone of the posterior vertebral arch was incised in the midline and carefully opened to expose the contents of the vertebral canal and the canal's internal borders. The LF was then studied in relation to its encroachment into the intervertebral foramen and its laminar attachments.

On two specimens, en bloc resection of two lumbar spines was performed. Soft tissue, including paravertebral muscles, spinal cord, nerve roots, and dura, were dissected. Sagittal, axial, and coronal sections were made to examine the LF in detail.

Institutional ethics approval was obtained for this study.

Results

Laminar attachments

As observed by Olszewski et al. [5], we found the LF to be composed of a superficial and deep layer. Olszewski et al. described the superficial layer attached to the inferior edge of the cephalad lamina and inserted inferodorsally to the superior and posterosuperior (external) edges of the caudal lamina.

The deep (internal) LF layer was more variable in its attachments and insertions and was the focus of this study. Toward the midline, its fibers ran vertically, whereas laterally, they ran more obliquely (down and out). These fibers were attached to the cephalad lamina's inferior border in 112/140 (80%) levels or to its ventral (internal) midregion in 28/140 (20%) levels (Table 1; Fig. 1). This latter, higher, cephalad attachment was increasingly noted with each progressive caudal level.

The deep LF layer inserted into the caudal lamina's superior border in 49/140 (35%) levels or to its ventral

Table 1
Rostrocaudal attachments of the ligamentum flavum by lumbar level

| Lamina | Attachment | L1–L2 | L2–L3 | L3–L4 | L4–L5 | L5–S1 | Total |
|-----------------|-----------------|-------|-------|-------|-------|-------|-------|
| Superior lamina | Inferior border | 26 | 29 | 23 | 20 | 17 | 112 |
| | Midregion | 2 | 2 | 5 | 8 | 11 | 28 |
| Inferior lamina | Superior border | 19 | 10 | 10 | 6 | 4 | 49 |
| | Midregion | 9 | 18 | 18 | 22 | 24 | 91 |

midregion in 91/140 (65%) levels (Table 1). This latter, lower, caudal attachment was more prominent with each progressive caudal level (Fig. 2).

The aforementioned patterns revealed that in 14/140 (10%) lumbar laminae studied (L2–L5), there was no intervening interosseous gap, that is, the deep LF sometimes gave the appearance of a continuous ligament.

The most frequently identified type of rostrocaudal pattern for the deep LF was one in which it attached to the inferior border of the cranial (superior) lamina and inserted into the midregion of the caudal (inferior) lamina (75/140 cases, 54%) (Table 2).

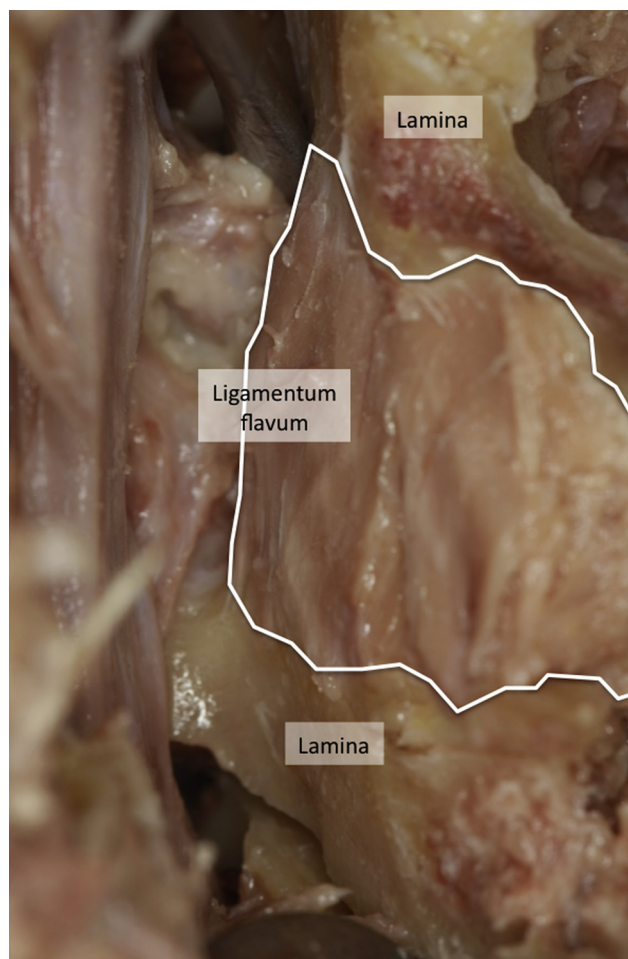


Fig. 1. After the spinous process is removed and the posterior spinal column is levered open, the ligamentum flavum is visible for inspection. In this specimen, the flavum attaches from the ventral midregion of the cephalad lamina and inserts into the superior border of the caudal lamina.

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