THE MENINGOVERTEBRAL LIGAMENTS AS A BARRIER TO THE SIDE-TO-SIDE MIGRATION OF EXTRUDED LUMBAR DISC HERNIATIONS

R. SCAPINELLI

The hypothesis that side-to-side migration of an extruded lumbar disc herniation can be blocked or restrained by the presence of the ventral meningovertebral ligaments has been verified by the author by using the presently available methods of imaging of the spinal canal *in vivo*. The images obtained at levels L4-L5 and L5-S1 from nine patients showing this type of pathology and preoperatively assessed by transverse CT (eight patients) or MRI (one patient) seem to support the above assumption. These ligaments should not be confused with pathologic adhesions.

Keywords : anterior epidural space ; transverse CT and MRI of the lumbar spinal canal ; Trolard-Hofmann ligaments of the dura ; intervertebral disc herniation.

Mots-clés : espace épidural antérieur ; tomodensitométrie and RMN du canal lombaire ; ligaments duraux de Trolard-Hofmann ; hernie discale intervertébrale.

Once extruded, the free fragments of herniated lumbar intervertebral discs may follow a different destiny. More frequently the degenerated material remains near the point of rupture of the anulus fibrosus, almost in "cultivation" (sequestered herniation).

Small fragments may be digested and absorbed by granulation tissue (3). Not uncommonly, and especially when the hernia has originated posterolaterally, the extruded fragment migrates, and the migration can take place in many directions, namely towards the intervertebral foramen (intra- and extraforaminal herniations), caudally, cranially and dorsally, with possible rare perforation of the dural sac (1, 7).

The migration in the transverse plane, i.e. from one side to the other of the spinal canal, seems to be exceptional and has never been reported in the literature, despite the fact that the patients assume a lateral decubitus position for many hours a day. The reason for such particular and apparently strange behavior is unknown, nor has this question ever been raised in spite of its speculative and practical interest.

The purpose of this paper is to attempt an explanation of this phenomenon, and a hypothesis is advanced based on the ligamentous anatomy of the ventral epidural space (6) (fig. 1).

MATERIAL AND METHODS

In addition to the anatomical specimens collected and described in detail by the author in a previous publication (6), the lumbar vertebral columns from 3 male cadavers aged 49, 55 and 65 years were similarly dissected and each vertebra was separated by transecting the corresponding disc and opening the joints between the articular processes. The dural sac, with the cauda equina roots removed, was transversely sectioned at the various levels. In each specimen gentle backward traction of the ventral wall of the dura was then applied in order to open the anterior epidural space and to

Institute of Orthopaedics and Traumatology, University of Padua, Padua, Italy.

Correspondence and reprints : R. Scapinelli, Istituto di Clinica Ortopedica e Traumatologica, Università di Padova, Via Giustiniani 3, 35128 Padova, Italia.

expose, microscopically examine and photograph the meningovertebral ligaments (fig. 2a). A number of these ligaments from different lumbar vertebrae were afterwards removed together with their corresponding attachments for histological examination.

The records of 47 consecutive patients (18 women and 29 men) who had undergone surgery for lumbar disc herniations from September 1989 to July 1991 at this Institute were reviewed retrospectively with regard to level, location and type of herniation. In 16 out of 47 (13 males, 3 females) an extruded disc herniation was found at operation. The level was L5-S1 in twelve, L4-L5 in three and L2-L3 in one. All the patients of this group were preoperatively assessed with cross-sectional computed tomography (CT) of the lumbar spine and in three by radiculography as well.

In addition to our series of CT scans the preoperative magnetic resonance images (MRI) from a 40-year-old female patient treated elsewhere for extruded intervertebral disc herniation in L5-S1 was also available.

The scans were carefully reviewed focusing on the relationship between the extruded material and the structures of the spinal canal and especially the ventral meningovertebral ligaments that were sometimes visible. The ability of the transverse CT to visualize these ligaments was demonstrated by the author both in normal and pathologic spines (6).

RESULTS

a. Anatomical studies

In the lumbar vertebrae from the 49-, 55- and 65-year-old cadavers the presence of the ventral meningovertebral ligaments was confirmed, connecting the anterior surface of the dural sac to the posterior longitudinal ligament, covering the vertebral body and the intervertebral disc. Their topography and configuration correspond to that previously described by Trolard (8), by Hofmann (2) and by the author (6). Generally speaking these ligaments are situated in the sagittal or parasagittal plane and are formed by single or multiple fibrous bundles (figs. 1 and 2a), each of which constitutes a segmental fenestrated membrane or a discontinuous septum. At level L5-S1 the septum, often thicker than the dural wall, is usually single and divides the anterior epidural space into two halves (fig. 2a). The intervals between the various bundles are filled with fat and venous plexuses. In our anatomical specimens the original craniocaudal oblique direction was lost, and the ligaments were seen to lie relaxed in the epidural space. When distended by elevation of the dura they could reach a considerable length, which varied from about 5 to 9 mm. Their density and mechanical resistance to stretching increase in the lower lumbar region, where they cannot be ruptured or separated from the posterior longitudinal ligament even by strong dorsal traction exerted on the anterior wall of the dura or by direct pulling with a forceps.

In the upper lumbar region the ligaments were mostly represented by multiple, less dense slips.

Histological examination showed that the meningovertebral ligaments are fibrous structures composed of dense bundles of connective tissue fibers, covered on both sides by loose fat and areolar tissue.

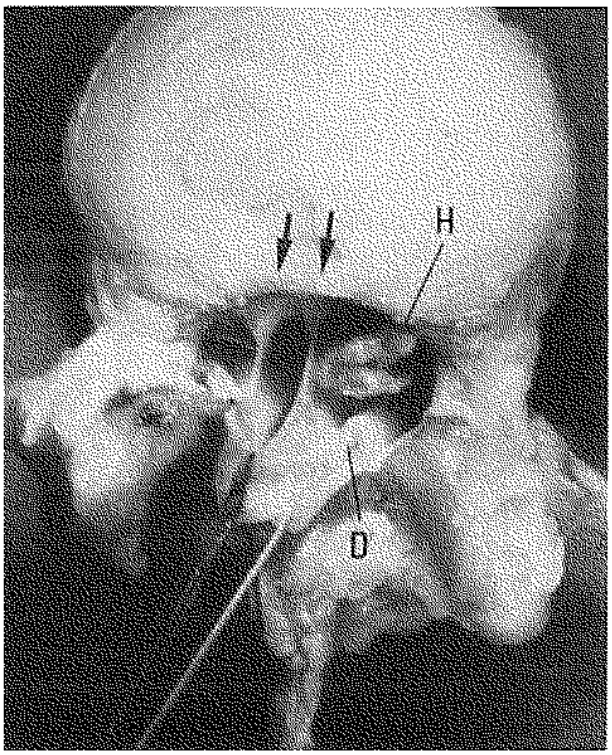

Fig. 1. — Artefact showing how the meningovertebral ligaments (arrows) could act as a barrier against side-to-side migration of extruded lumbar disc herniation. A free fragment of an L4-L5 disc hernia (H) removed at operation from a patient, was placed into the right epidural space of an autopsy specimen, after elevating the dural sac (D) posteriorly.

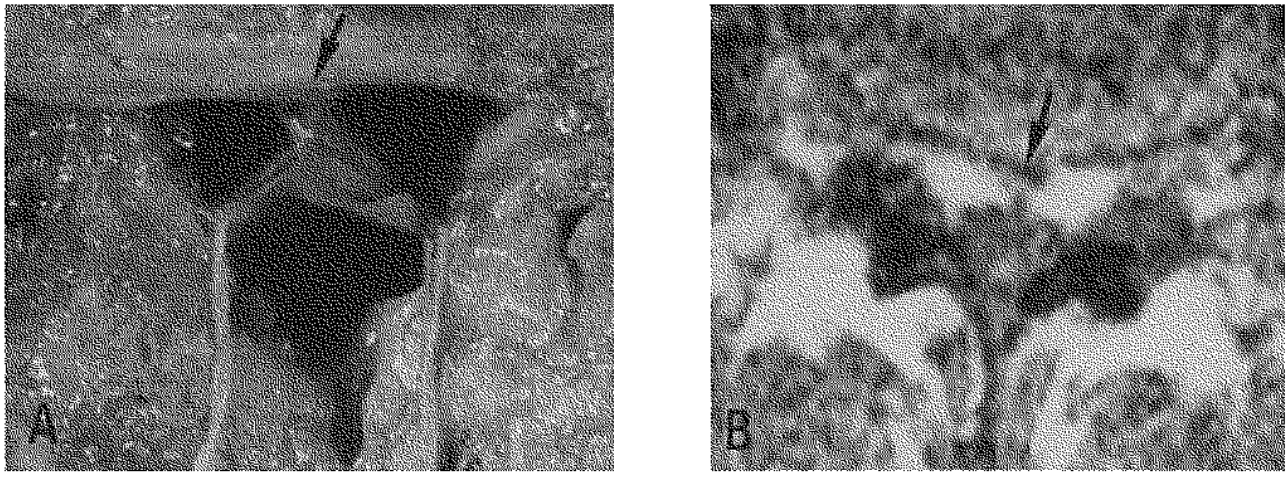

Fig. 2. — (a) At level L4-L5 and L5-S1 the ventral meningovertebral ligament (arrow) very frequently forms a median septum, dividing the anterior epidural space into two halves. Autopsy specimen from a 65-year-old man. (b) Transverse MRI on a normal spinal canal at level L4-L5 in a male patient aged 44. Note the perfect delineation of the ventral meningo-vertebral ligament (arrow).

b. Radiological studies

In 8 out of the 16 patients (7 men, 1 woman) operated in our service for extruded lumbar disc herniation, the characteristic isodense images of both the discal material and the ventral meningovertebral ligaments were concomitantly recognizable in the preoperative transverse CT scans of the spinal canal (figs. 3, 4, 5). With regard to the origin of the hernia, three were extruded at level L4-L5, and five at level L5-S1. In these patients the disc herniation was always in a posterolateral position, and migration occurred mostly in a caudal direction or towards the intervertebral foramen. In only one patient the free fragment from L5-S1 had migrated slightly cranially. A substantial compression of the dural sac and nerve root was seen in all the cases. In each patient the corresponding ventral meningovertebral ligament formed an evident and clearly distinguishable median sagittal septum extending from the dura to the anterior wall of the spinal canal, contiguous to the L4-L5 or L5-S1 extruded disc material (figs. 3 to 5) and often slightly deformed by mechanical compression (fig. 4).

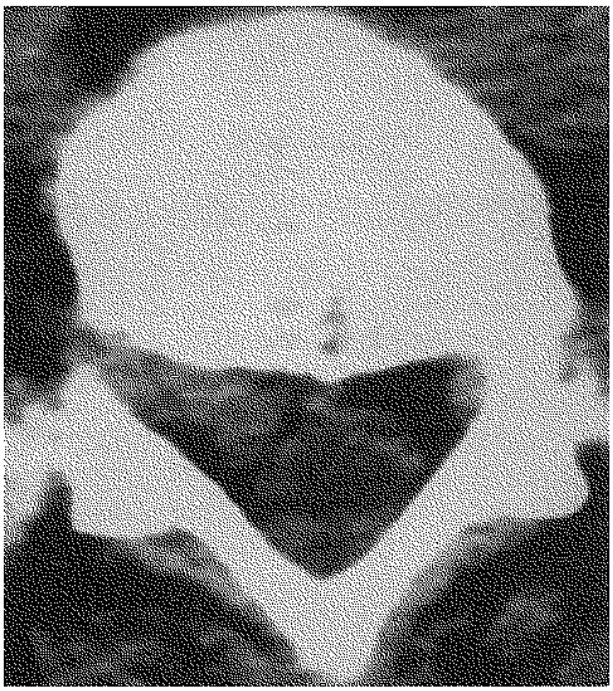

Fig. 3. — Woman aged 45. Preoperative cross-sectional CT through the lower part of the body of L5, showing a large extruded disc fragment on the right side (reader's left) of the vertebral canal and lateral recess. The image of the meningovertebral ligament is evident, forming a median septum, which limits transverse migration of the fragment.

Fig. 4. — Man aged 44. Preoperative transverse CT, showing on the right side (reader's left) of the L5 vertebral foramen a round fragment, extruded from the L4-L5 intervertebral disc and migrated caudally. The ventral meningovertebral ligament offers a barrier to side-to-side migration of the fragment itself and is slightly bent by mechanical compression.

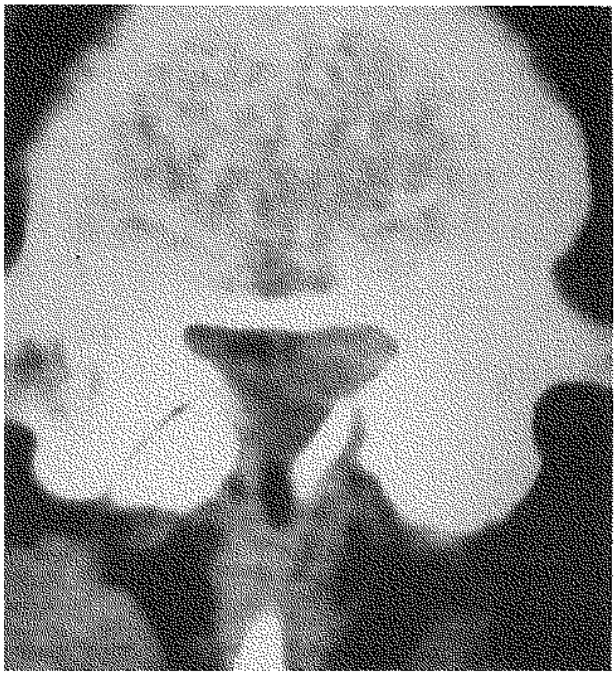

Fig. 5. — Man aged 60. The preoperative transverse CT through the cranial part of L5 shows the left half (reader's right) of the vertebral foramen occupied by a large free fragment extruded from the disc L4-L5. It presses the ipsilateral anterior surface of the dural sac and is medially contiguous to a distended meningovertebral ligament, which seems able to impede the access of the fragment to the opposite half of the spinal canal.

The epidural fat was absent or greatly reduced on the side occupied by the hernia, but a very thin layer of fat was usually still present between the extruded material and the ipsilateral surface of the meningovertebral ligament, allowing sufficient individualization of the ligament itself (figs. 3, 4, 5). In two patients the medial profile of the herniated disc fragment partially overlapped the image of the ligament, perhaps because a small amount of the discal tissue had penetrated across its fenestrations (6).

In the remaining half of the patients, in whom the CT image of the extruded disc herniation was not accompanied by that of the meningovertebral ligament, this could be identified on the scans taken at a more cranial or caudal level.

In the only female patient in whom an extruded L5-S1 disc herniation had been preoperatively assessed by MRI elsewhere, the meningovertebral ligament was recognizable as a midline structure of low signal intensity, contiguous to the extruded disc material (fig. 6). This image closely resembles that visible by MRI under normal conditions (fig. 2b).

DISCUSSION

As anatomical knowledge leads us to expect, the hypothesis that the meningovertebral ligaments may play a role in impeding side-to-side migration of posterolateral extruded disc herniation in the lumbosacral region seems to the author to be convincing and acceptable (figs. 1 and 2a).

These fibrous structures being rather difficult to demonstrate by direct vision at operation, at the present time the only way to confirm *in vivo* the

above-mentioned hypothesis was that of resorting to the present methods of imaging, such as transverse CT and magnetic resonance, which give excellent delineation of the soft tissues of the spinal canal (figs. 3 to 6).

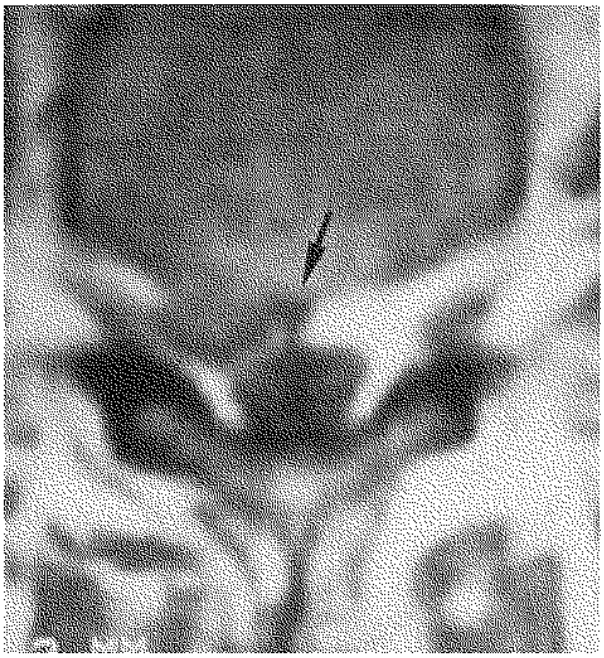

Fig. 6. — Transverse MRI showing coexistence of the images of a right (reader's left) disc herniation between L5-S1 and the meningovertebral ligament (arrow). The latter forms a median septum, extending from the anterior surface of the dura to the anterior wall of the spinal canal. It is probably able to prevent migration of the extruded material towards the opposite side of the canal.

Observing the CT scans of the patients in this series and the magnetic resonance images of the single outside patient, we can understand the way in which these ligaments can act as a valid barrier to transverse displacement of the extruded disc herniation. In the lumbosacral region they usually form a midline septum (6), whose mechanical resistance to distension is sufficiently strong to prevent side-to-side dislocation of the extruded material, which is forced to remain in the ipsilateral half of the canal and to find an easier way of migration downwards, upwards or laterally.

When the ligaments are represented by multiple bands it is likely that they become attached to one another by the pathologic tissue (fig. 1).

Only small parts of the extruded herniation may have a remote possibility of crossing the midline, through the holes or gaps between the various segmental bands forming the meningovertebral ligaments, normally filled with fat and venous plexuses. The above function of barrier does not apply in the case of central disc herniations, where these ligaments are displaced dorsally together with the posterior longitudinal ligament.

The Trolard and Hofmann ligaments are normal structures, present in every subject from birth (2), with individual variations. They are endowed with the specific function of holding the dural sac close to the ventral surface of the spinal canal and causing it to follow the axes of vertebral movement, although with some degree of independence. It may also be supposed that these ligaments limit side-to-side displacement of the anterior peridural fat, and this could contribute to maintaining constant the thickness of this tissue, which protects the neural elements.

It is very likely that they are sensitive structures, and in this regard we have an ongoing investigation to ascertain the degree and the type of their innervation, which could be of clinical interest (5) and which probably derives from the sinuvertebral nerves, like the posterior longitudinal ligament and the dura mater.

It is probable that other pathologic tissues possibly extruded into the epidural space and different from disc material, for instance granulomatous tissue and hematomata, may encounter the resistance of these fibrous connections. It cannot be excluded that the natural barrier offered to disc fragments by the meningovertebral ligaments may sometimes be secondarily reinforced by osteophytes or by pathologic adhesions.

Lumbar dural adhesions in nonpathologic spines have been described at autopsy by some authors (1, 4, 5), but their frequency, shape and location leads the author to suspect that at least a great many of them are, in reality, meningovertebral ligaments, which undergo loss of their craniocaudal obliquity after transverse sectioning of the dural sac. The term "adhesions" should be rejected in indicating the Trolard-Hofmann ligaments, because it refers to pathologic conditions, secondary to spinal diseases or previous surgery (7).

Very firm adhesions of this type have been casually observed by the author in the upper lumbar and lower thoracic spinal canal of an adult male patient, showing on autopsy ; marked wedge deformity of the T11 vertebral body following an old fracture, with severe spondyloarthritis of the lumbar region. From T11 to L3 the ventral surface of the dura mater was fused to the posterior longitudinal ligament and the two structures could not be separated, even by applying strong traction.

REFERENCES

1. Blikra G. Intradural herniated lumbar disc. J. Neurosurg., 1969, 31, 676-679.
2. Hofmann M. Die Befestigung der Dura Mater im Wirbelcanal. Arch. Anat. Physiol. (Anat. Abteilg.), 1898, 403-412.
3. Lindblom K., Hultqvist G. Absorption of protruded disc tissue. J. Bone Joint Surg., 1950, 32-A, 557-560.
4. MacMillan J., Schaffer J. L., Kambin P. Rules and incidence of communication of lumbar disc with surrounding neural structures. Spine, 1991, 16, 167-171.
5. Parke W. W., Watanabe R. Adhesions of the ventral lumbar dura. An adjunct source of discogenic pain ? Spine, 1990, 15, 300-303.
6. Scapinelli R. Anatomical and radiologic studies on the lumbosacral meningovertebral ligaments of humans. J. Spinal Disorders, 1990, 3, 6-15.
7. Teng P., Papatheodorou C. Intrathecal dislocation of lumbar intervertebral disc. Neurochirurgia, 1964, 7, 57-63.
8. Trolard. Recherches sur l'anatomie des méninges spinales, des nerfs sacrées et du film terminale dans le canal sacré. Arch. Physiol., 1888, 2, 191-199.

SAMENVATTING

R. SCAPINELLI. Rol van de meningo-vertebrale ligamenten bij het tegenhouden van de migratie van extruderende herniae nuclei pulposi.

De hypothese dat de migratie van een extruderende hernia nuclei pulposi kan gestopt of tegengehouden worden door de aanwezigheid van de ventrale meningovertebrale ligamenten, werd door de auteur bevestigd aan de hand van in vivo uitgevoerde onderzoeken van het wervelkanaal met behulp van de huidige beeldvormingtechnieken. De beelden, bekomen t.h.v. L4/L5 en L5/S1 bij 9 patiënten met deze pathologie en preoperatief geëvalueerd met CT Scan (8 patiënten) of MRI (1 patiënt) bevestigen de hypothese. Het beeld van de ligamenten mag niet geïnterpreteerd worden als "pathologische adherenties".

RÉSUMÉ

R. SCAPINELLI. Rôle de barrière des ligaments méningo-vertébraux dans la migration des hernies discales extrudées.

L'hypothèse que la migration d'une hernie discale lombaire peut être arrêtée ou retenue par la présence des ligaments méningo-vertébraux, a été confirmée par l'auteur à l'aide des techniques actuelles d'imagerie vertébrale, in vivo. Les images obtenues au niveau L4-L5 et L5-S1, chez 9 malades, présentant ce type de pathologie, évalués en pré-opératoire à l'aide de tomodensitométrie transversale (8 patients) ou de RMN (1 patient) ont confirmé cette hypothèse. Les ligaments ne peuvent être confondus avec des adhérences pathologiques.