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Review

Ultrasonography of the lumbar spine: Sonoanatomy and practical applications

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ABSTRACT

Ultrasonography of the bones and joints has gained considerable ground in the field of rheumatology over the past decade and is now used in everyday practice both for diagnostic purposes and to guide local injections. However, the use of ultrasonography is virtually confined to the peripheral joints, whereas spinal diseases make a major contribution to rheumatology practice. Studies have established that ultrasonography of the lumbar spine is feasible. Adequate equipment and familiarity with spinal sonoanatomy are required. In this update, we suggest starting with a systematic examination of the lumbar spine to assess the various anatomic structures, from the thoracolumbar fascia superficially to the posterior part of the vertebras at the deepest level. The ligaments, erector spinae muscles, facet joints, and transverse processes can be visualized. Ultrasonography can serve to guide injections into the facet joints, about the nerve roots, and into the iliolumbar ligaments; as well as to identify relevant landmarks before epidural injection. Although diagnostic applications are more limited at present, systematic studies of abnormal ultrasonography findings will allow evaluations of the potential usefulness of ultrasonography for diagnosing spinal disorders. The depth of the spinal structures limits the ability to obtain high-resolution images. However, future technical improvements in ultrasound transducers and machines, together with the growing number of physicians trained in ultrasonography, can be expected to benefit the development of spinal ultrasonography in the near future.

1. Introduction

Ultrasonography of the bones and joints is now a well-established tool for the diagnosis, follow-up, and management of various inflammatory and mechanical disorders encountered by rheumatologists in their everyday practice. However, the use of ultrasonography in rheumatology is largely confined to the peripheral joints and tendons. Inflammatory and degenerative disorders of the lumbar spine account for a substantial proportion of rheumatology patients and might benefit from the use of ultrasonography. The earliest descriptions of ultrasound findings at the spine were published in the 1980s. More specifically, the ultrasound features of the epidural space were described in 1980 by Cork et al. [1], and ultrasonography is now widely used to guide catheter placement for epidural or spinal anesthesia, most notably in obstetrical and pediatric patients [2–4]. Studies have established the usefulness of ultrasonography for guiding local glucocorticoid injections, particularly into the facet joints. Thus, in office-based practice, ultrasonography may hold promise as an alternative to fluoroscopy for examining the lumbar spine and guiding injections into the epidural space and facet joints.

Ultrasonography of the lumbar spine is not included in current curricula available to rheumatologists and radiologists. As with all techniques, formal training and subsequent regular use are necessary to ensure proficiency. The objective of this update is to discuss a systematic approach to the ultrasonographic assessment of the lumbar spine. After a description of the various ultrasound landmarks, we present a number of abnormal images that we have collected during our practice. Finally, the literature on approaches and accuracy of ultrasound-guided injections into the lumbar spine are discussed.

2. Ultrasonography of the lumbar spine

2.1. Technical considerations

Use of a low-frequency transducer is mandatory, given the deep location of the anatomic structures of interest. In addition, overweight and obesity are common in patients with lumbar spine disorders, and a thick layer of adipose tissue is an obstacle to ultrasound wave penetration. Transducer frequencies ranged from 2 to 9 MHz in published studies. Convex transducers increase the field of view, particularly toward the deeper layers, but hinder the assessment of superficial structures such as the spinous processes, particularly in slim patients. To prepare this update, we used a

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linear 3–11 MHz probe, with the trapezoid mode when needed to expand the field of view.

The patient can be either seated or bent forward or in the prone position with a cushion under the abdomen to compensate for the lumbar lordosis. The seated position with the trunk bent forward opens up the interspinous spaces and is therefore best for visualizing the epidural space. The prone position in contrast, is preferable for performing local injections, particularly into the facet joints.

2.2. Step-by-step assessment of the lumbar spine

2.2.1. Longitudinal median view through the spinous processes (Fig. 1)

The objective is to visualize the spinous processes and to identify the vertebral levels. The transducer is placed on the midline, along the spinous processes, in the longitudinal direction. Under the skin and subcutaneous tissue, a thin hyperechoic line corresponding to the thoracolumbar fascia is visible. Deep to this line, the spinous processes are seen as a series of hyperechoic lines with upward convexity and posterior acoustic shadowing. The L5 spinous process is a useful landmark, as it is often smaller and more pointed than the other spinous processes, which are increasingly flat and wide from L4 to L1. Another helpful means of identifying the vertebral levels consists in locating the sacrum, seen as a continuous hyperechoic line, then moving up to its superior edge, which is at the L5-S1 interspinous space. In each interspinous space, the interspinous ligament is visible as a hyperechoic structure made of parallel fibrils. The epidural space and spinal canal may be visible on this view if the interspinous space is sufficiently wide (see description below).

2.2.2. Transverse view through the spinous processes (Fig. 2)

This view shows the bony structures of the posterior vertebra: spinous process, laminae, facet joints, and transverse processes. The transducer is placed on the midline, along the spinous processes, in the transverse direction. The spinous process is seen as a convex hyperechoic line with posterior acoustic shadowing. On either side of, and deep to, the spinous process, the laminae produce two horizontal hyperechoic lines with posterior acoustic shadowing. Lateral to each lamina, the facet joint is visible as a hypoechoic zone between two bony structures or, in some cases, only as a thin echo-free line corresponding to the joint capsule. In the convexities formed by the lamina and spinous process on each side, the paraspinal muscles are visible as two masses in contact with each other but having different degrees of echogenicity: the deepest and most hyperechoic mass in contact with the spinous process is the multifidus muscle, and the more superficial mass is composed of the erector spinae muscles (iliocostalis and longissimus, whose fibers cannot be distinguished from each other). Lateral and deep to these muscles, two oblique hyperechoic lines correspond to the transverse processes.

Positioning the transducer between two spinous processes eliminates the acoustic shadowing, thus allowing visualization of the spinal canal, which is bounded by two hyperechoic parallel lines. The epidural space is above the dura mater, which is seen as a hyperechoic line. The deepest line is the posterior longitudinal ligament and posterior cortex of the vertebral body (Figure S1 in the online supplement to this article).

2.2.3. Longitudinal paramedian oblique view (Fig. 3)

This view shows the spinal canal and the depth of the epidural space. The transducer is positioned vertically 1–2 cm lateral to the spinous process and the ultrasound beam is directed obliquely toward the midline. The spinal canal is visible between the interlaminar spaces. The delineating structures are the ligamentum flavum and dura mater posteriorly and the posterior vertebral-body cortex and posterior longitudinal ligament anteriorly. The epidural space is a thin hypoechoic line between the two hyperechoic lines produced by the ligamentum flavum extending between the laminae and the posterior dura mater located at a deeper level.

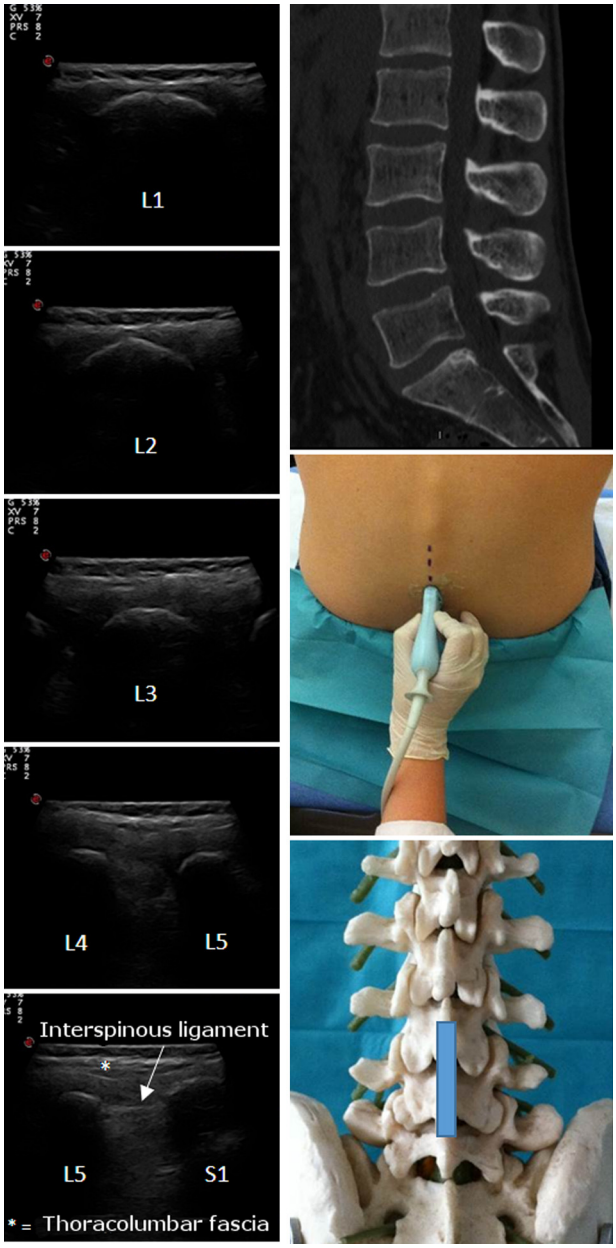

Fig. 1. Longitudinal view through the spinous processes. The spinous processes and interspinous ligaments are visible. The superficial hyperechoic band is the thoracolumbar fascia. Note the smaller and more pointed spinous process of L5 compared to the other lumbar vertebras.

2.2.4. Longitudinal view through the facet joints (Fig. 4)

Placing the probe vertically 3–4 cm away from the spinous processes shows the facet joints as a series of lumps. Each lump is formed by the inferior articular process of a vertebra overlying the superior articular process of the vertebra immediately below it; this superior articular process is largely concealed by acoustic shadowing from the inferior articular process of the suprajacent vertebra. The joint capsule is visible as a thin echo-free line that envelops