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## Ultrasound-guided injections in the lumbar spine

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### Abstract

Injection therapies play a major role in the treatment of low back pain and radiculopathy and are becoming integral parts of a multidisciplinary approach in treatment and rehabilitation of patients with pain. Pararadicular- and facet-joint injections in the lumbar spine are preferentially performed with computed tomography (CT) or fluoroscopy-guidance. In this paper we present an alternative, simple and easy to learn US-guided technique for injection therapy in the lumbar spine.

**Keywords:** ultrasound guidance, pararadicular injection, facet-joint injection.

### Rezumat

Tratamentul injectabil joacă un rol major în terapia durerii lombare joase și a radiculopatiilor și tinde să devină parte integrantă din abordarea multidisciplinară a tratamentului și reabilitării pacienților cu durere. Injecțiile pararadiculare și în articulațiile fațetate ale coloanei lombare sunt efectuate de preferință sub ghidaj computer tomografic sau fluoroscopic. În această lucrare vom prezenta tehnica de ghidaj ecografic a acestor injecții, o tehnică alternativă mai simplă și mai ușor de învățat.

**Cuvinte cheie:** ghidaj ecografic, injecții pararadiculare, injecții în articulațiile fațetate

### Introduction

Lower back pain and radiculopathy are very common conditions - in fact most individuals will experience neck and/or low back pain at least once in their life, and with increasing age a greater number of patients with such symptoms are seen by family physicians and in outpatient clinics [1-4]. Aside from physical therapy and other rehabilitative methods, injection therapy targeted to the facet joints or to the nerve roots is well established in the treatment of lumbar radiculopathy. However, this

has been performed without image guidance for many years. Nowadays minimally invasive, imaging guided techniques have entered the tool-box of the pain physician and because of their ease of use and better success rates are becoming an integral part of multidisciplinary pain management [5,6].

Imaging guidance has increased the precision of spinal injection and computed tomography (CT) or fluoroscopy are to date preferentially used [7-10]. Ultrasound (US) has proven at least sufficiently reliable and accurate in the demonstration of lumbar paravertebral anatomy [11-15]. The feasibility of US-guided injection therapy at the spine has also been demonstrated in several studies [11-14,16-19].

### Indications

Accepted indications for instillation therapy of lumbar roots are lateral and intraforaminal disc hernia, failed back surgery syndrome (FBSS) and chronic nerve irritation by inoperable bone alterations. For the lumbar facet

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joints indications are acute facet joint impairment due to microtrauma and instability and facet joint osteoarthritis including facet joint hyperplasia.

### Lumbar anatomy

The lumbar vertebral column comprises five vertebra and individual discs. The lumbar vertebral body is large and kidney-shaped. It is wider transversely than anteroposteriorly and is slightly larger anterior than posterior. The lumbar body and the posterior arch enclose the triangular vertebral foramen. Unlike the bifid cervical and rather pointed thoracic spinous processes the lumbar spinous processes are rather quadrangular and project backwards. The fifth lumbar spinous process is frequently the smallest one, and its transverse process the most massive. The lumbar zygapophyseal joints are formed by the articulation of the inferior articular processes with the superior ones. The normal, unimpaired articular facets are covered by articular cartilage and are coated by their synovial, articular capsule.

The so called “intertransverse ligaments” extend from the upper border of one transverse process to the lower border of the according costal process above. They are very important landmarks for a paravertebral injection.

### US-guided injections

The paravertebral injections in the lumbar spine are performed with the patient in a prone position. These ultrasound interventions are performed on a standard ultrasound device using a broadband curved 9-4 MHz or alternatively a 5-1 MHz array transducer depending on the patient's body mass. The whole procedure is done under sterile conditions: the patient is cleansed and covered

with sterile drapes, the ultrasound transducer is placed in a sterile sheath and sterile ultrasound gel is used.

### Techniques of US-guided paravertebral injections

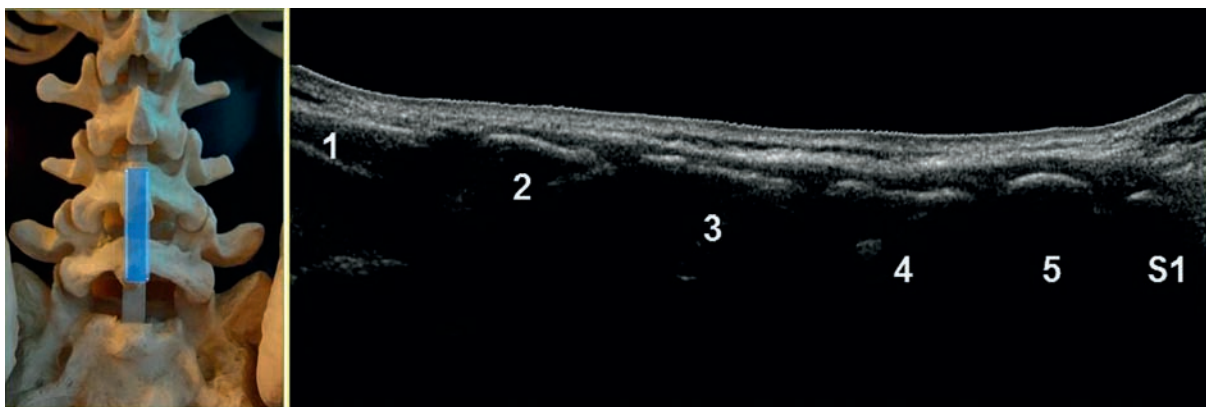
Three (para-) sagittal scans are performed stepwise to define the necessary anatomical landmarks for the injection as follows:

1) In an exact midline scan along the spinous processes the typical transition from the 1<sup>st</sup> sacral to the 5<sup>th</sup> lumbar spinous process is defined. After definition of the 5<sup>th</sup> lumbar spinous process, the respective spinal segment for the injection is localized by (cephalad) counting of the spinous processes (fig 1).

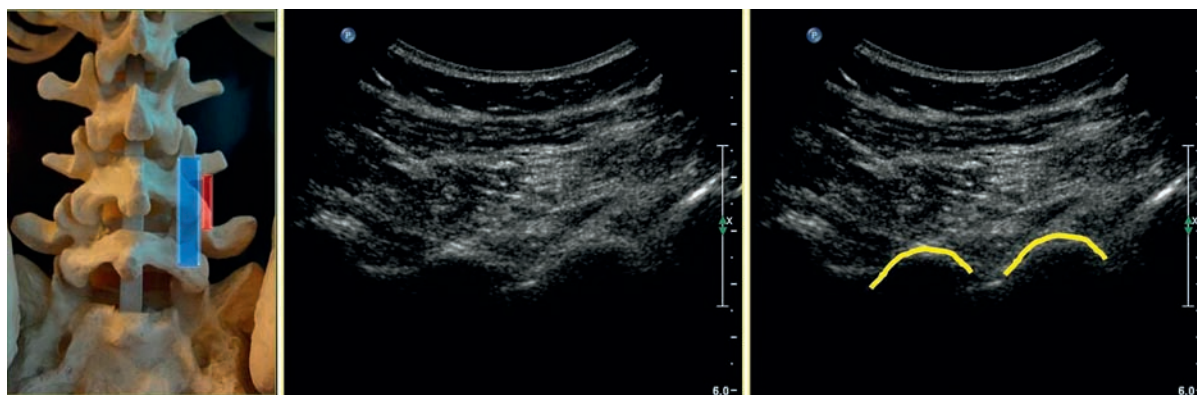
2) From the midline position explained above, the transducer is offset laterally in a paravertebral parasagittal orientation towards the transition from the vertebral arch to the zygapophyseal joints (fig 2).

3) Then the transducer is advanced further until the costal (transverse) processes are shown (fig 3) and centred over the segment of interest. In this final scan plane (called the “paravertebral aditus plane”- PAP) the intertransverse ligament is seen as a thin hyperechoic band between two adjacent transverse processes (fig 4). The spinal nerve – if identified at all – is presented in the PAP ventral to the intertransverse ligament as a slightly hypoechoic roundish structure surrounded by hyperechoic fat.

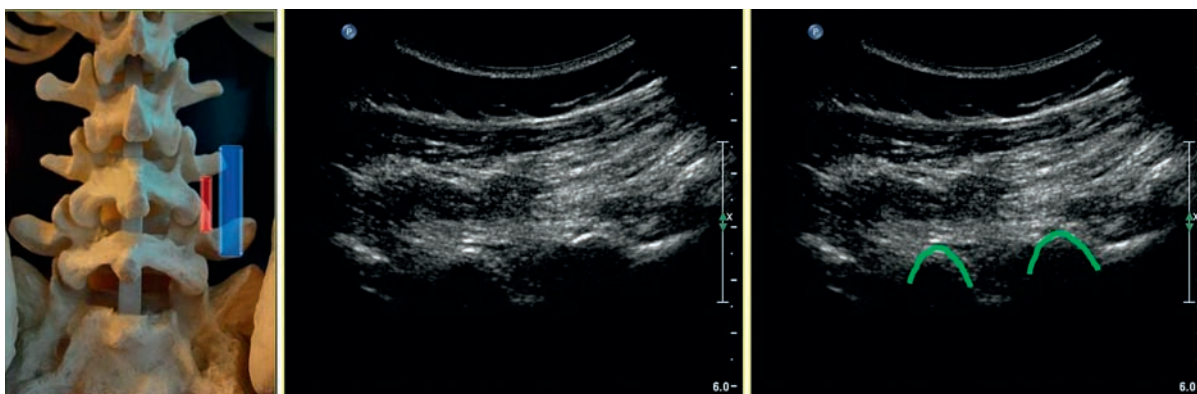
In the PAP at the targeted segment a 20 to 22 G spinal needle is advanced into the paravertebral space under real-time US guidance: the needle is inserted using a free-hand-in-plane puncture technique (the needle is advanced strictly parallel to the long axis of the transducer to advance it within the scanning plane) which was originally developed and described for the psoas compart-



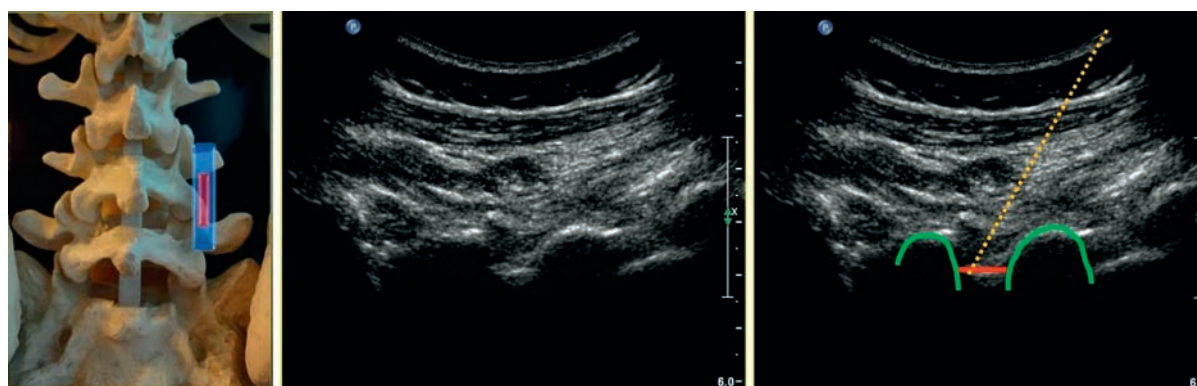
**Fig 1.** Posterior sagittal plane in an exact midline along the spinous processes: panoramic US image of the spinous processes (L1-S1).



**Fig 2.** Posterior sagittal paravertebral plane of the zygapophyseal joints at level L4-L5 (yellow). Note the typical wavy configuration of the respective zygapophyseal joints.



**Fig 3.** Posterior sagittal paravertebral plane of the transverse processes at level L4-L5 (green).



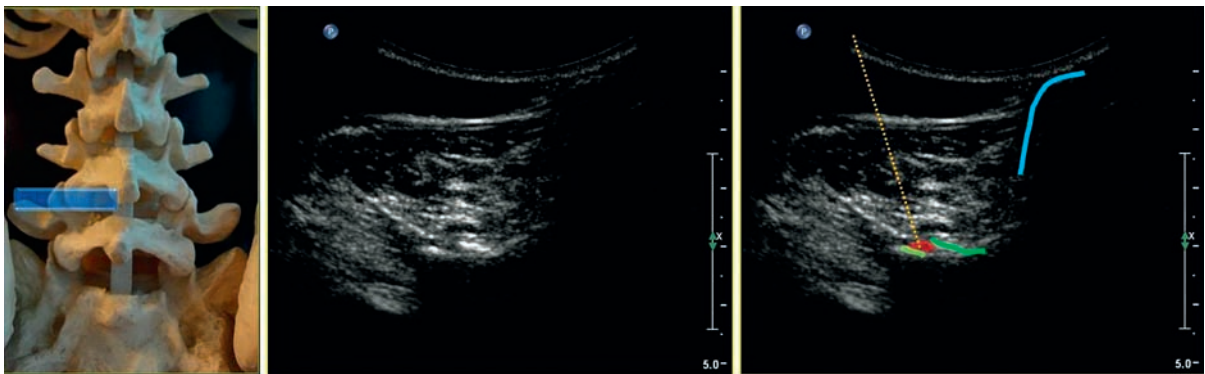
**Fig 4.** Posterior sagittal paravertebral plane of the PAP at level L4-L5. Transverse processes: green, intertransverse ligament: red, intended needle placement: orange.

ment block [20]. In our setting the tip of the needle is advanced until it reaches the respective intertransverse ligament. Thereafter the needle tip is advanced barely through the ligament. After placement of the needle, 1 ml of a corticosteroid solution (e.g. betamethasone 4 mg/ml) is injected in the respective paravertebral compartment.

### Techniques of US-guided facet joint injections

In a midline scan along the spinous processes the typical transition from the 1<sup>st</sup> sacral to the 5<sup>th</sup> lumbar spinous process is defined according to the procedure specified above: after the respective lumbar segment is defined, the transducer is rotated axially centred on the according





**Fig 5.** Posterior sagittal paravertebral plane of the PAP at level L4-L5. Transverse processes: green, intertransverse ligament: red, intended needle placement: orange.

spinous process and then moved laterally to the respective facet joint. The lamina of the vertebral arch, facet joint, inferior articular process and mamillary process are then delineated. Subsequently a 22 G spinal needle is inserted 3-4 cm laterally from the midline and lateral to the transducer in in-plane-technique (see above) which enables a visualization of the complete needle path (fig 5). If the needle tip deviates from its intended course, the in-plane technique allows also for accurate and easy re-positioning under ultrasound guidance. After the needle tip reaches the respective facet joint (intraarticular bone contact) 1 ml of an even mixture of 0.5 % bupivacaine hydrochloride and of betamethasone (4 mg/ml), is injected.

These new approaches are reliable, safe and accurate in placing a therapeutic needle for lumbar paravertebral and facet joint injections [11,21]. The presented technique for paravertebral injections is rather simple to perform as it uses the intertransverse ligament as an anatomical landmark which is easy to localize.

A variation of the above mentioned technique was proposed by Galiano *et al* [14]. The author proposes an axial approach to the respective spinal level. To localize the different spinal levels, also posterior sagittal sonograms are obtained and thus the 5<sup>th</sup> lumbar spinous process defined. After the definition of the respective level the spinous process and adjacent structures (lamina of the vertebral arch, zygapophyseal articulations, inferior and superior facets, transverse process and vertebral isthmus) were delineated (according to this presented procedure) the probe was rotated to get according transverse sonograms of the region and level of interest and also to possibly identify the corresponding spinal nerves. The puncture needles were then advanced under transverse sonographic guidance to the regions of the according lumbar spinal nerves. While this technique is optimally

suited for lumbar zygapophyseal joint injections because of the ideal visualization of the joint space in a transverse scan plane, the authors of this paper report difficulties with nerve root injection in the upper lumbar segments. In the upper lumbar vertebrae the isthmus is straighter and the laminae of the vertebral arch are narrower. Therefore the space between the transverse processes is small and the vertebral isthmus can appear as a straight fissure [22,23]. In contrast to this approach our technique does not rely on the depiction of the vertebral lamina but the intertransverse ligament. The latter is an easy to find anatomical landmark even in the upper lumbar spine: in the PAP scans the respective intertransverse ligament is seen as a thin hyperechoic, well defined band between two adjacent transverse processes.

**In conclusion** imaging guided paravertebral and facet joint injections are to date mainly performed under CT or fluoroscopic guidance. US is already used successfully to guide a variety of instillation procedures in different anatomical regions showing many benefits: direct visualization of the target of interest, real-time needle guidance, visualization of the spread of local anaesthetics and thus minimal risk of complications, a potential for dose reduction of local therapeutics, shortening of procedure time and the lacking of exposure to ionizing radiation.

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