Medical Ultrasonography
2011, Vol. 13, no. 1, 54-58

Ultrasound-guided injections in the lumbar spine

Alexander Loizides[1], Siegfried Peer[1], Michaela Plaikner[1], Verena Spiss[1], Klaus Galiano[2], Jochen Obernauer[2], Hannes Gruber[1]

[1] Department of Radiology, [2] Department of Neurosurgery, Innsbruck Medical University, Anichstrasse 35, 6020 Innsbruck, Austria

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 şi a radiculopatiilor şi tinde să devină parte integrantă din abordarea multidisciplinară a tratamentului şi reabilitării pacienţilor cu durere. Injecţiile pararadiculare şi în articulaţiile faţetate ale coloanei lombare sunt efectuate de preferinţă sub ghidaj computer tomografic sau fluoroscopic. În această lucrare vom prezenta tehnica de ghidaj ecografic a acestor injecţii, o tehnică alternativă mai simplă şi mai uşor de învăţat.

Cuvinte cheie: ghidaj ecografic, injecţii pararadiculare, injecţii în articulaţiile faţetate

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].

Received 11.01.2011 Accepted 20.01.2011
Med Ultrason
2011, Vol. 13, No 1, 54-58

Address for correspondence: Alexander Loizides, MD
Innsbruck Medical University,
Department of Radiology
Anichstrasse 35, 6020 Innsbruck, Austria
Tel: +43/512/504/22761
Fax: +43/512/504/22758
E-mail: alexander.loizides@i-med.ac.at

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

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 pararadicular injection.

US-guided injections

The pararadicular 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 pararadicular 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 1st sacral to the 5th lumbar spinous process is defined. After definition of the 5th 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 "pararadicular 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 pararadicular 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-

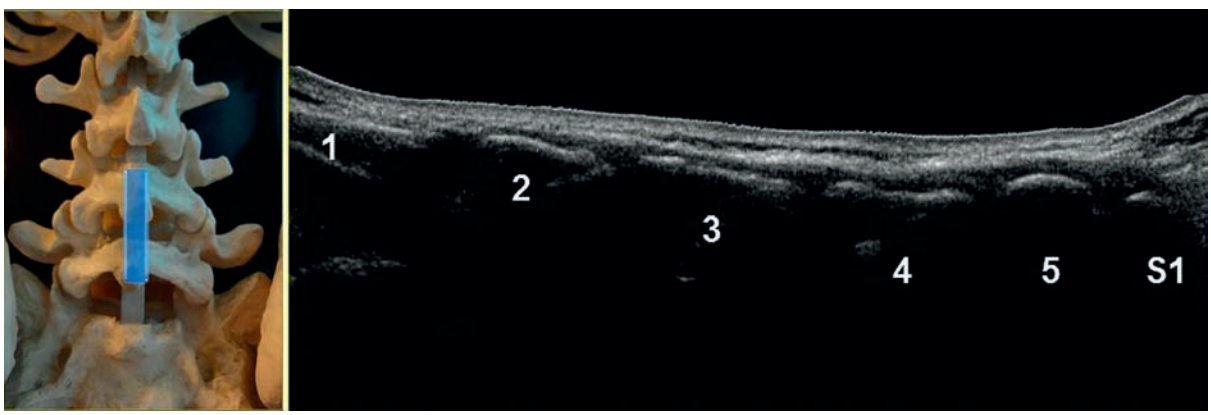

Fig 1. Posterior sagittal plane in an exact midline along the spinous processes: panoramic US image of the spinous processes (L1-S1).

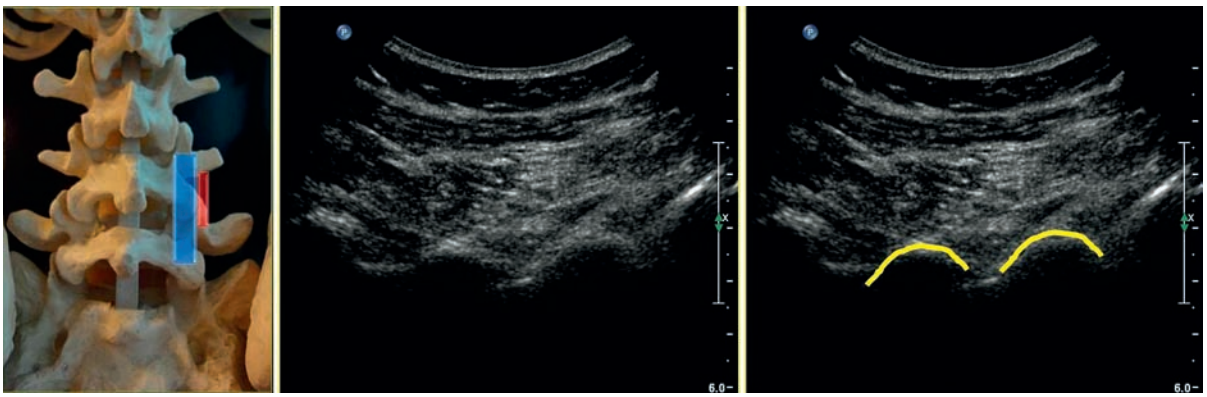

Fig 2. Posterior sagittal paravertebral plane of the zygapophyseal joints at level L4-L5 (yellow). Note the typical wavy configuration of the respective zygapophyseal joints.

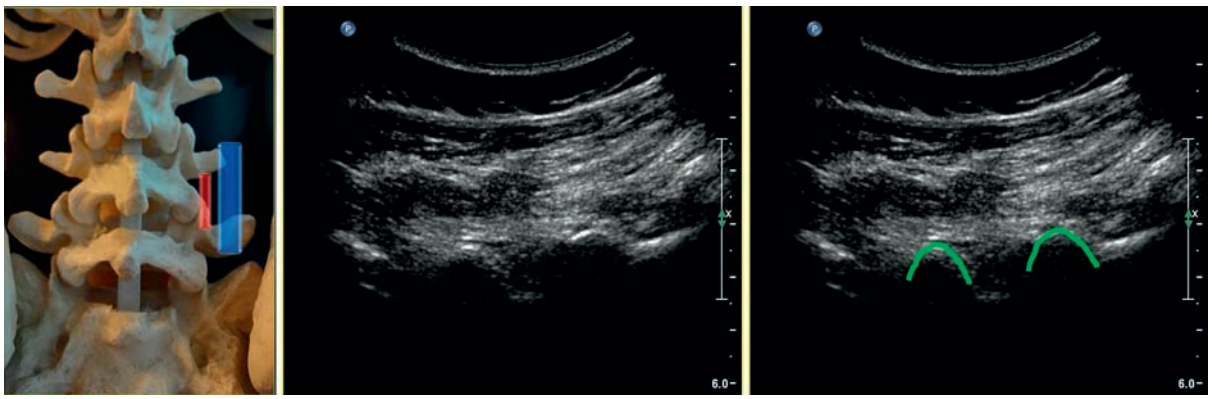

Fig 3. Posterior sagittal paravertebral plane of the transverse processes at level L4-L5 (green).

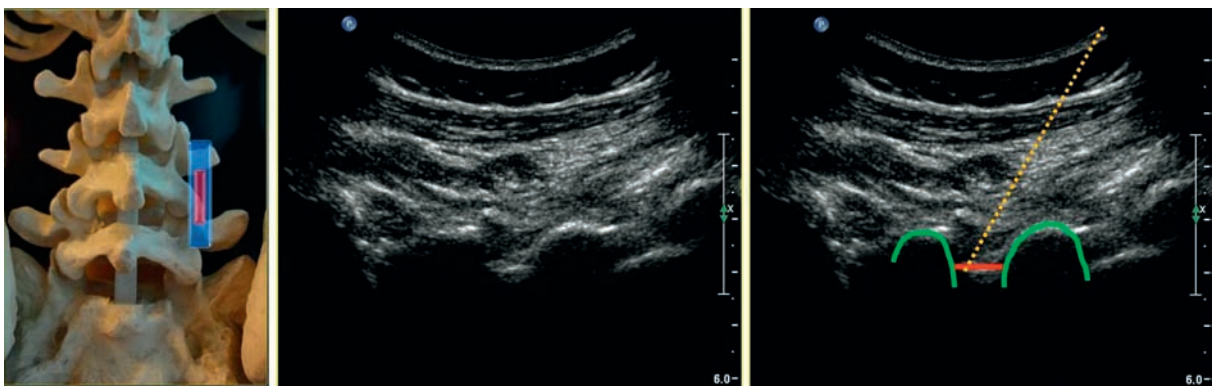

Fig 4. Posterior sagittal paravertebral plane of the PAP at level L4-L5. Transverse processes: green, intertransverse ligament: red, intended needle placement: orange.

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 pararadicular compartment.

Techniques of US-guided facet joint injections

In a midline scan along the spinous processes the typical transition from the 1st sacral to the 5th 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

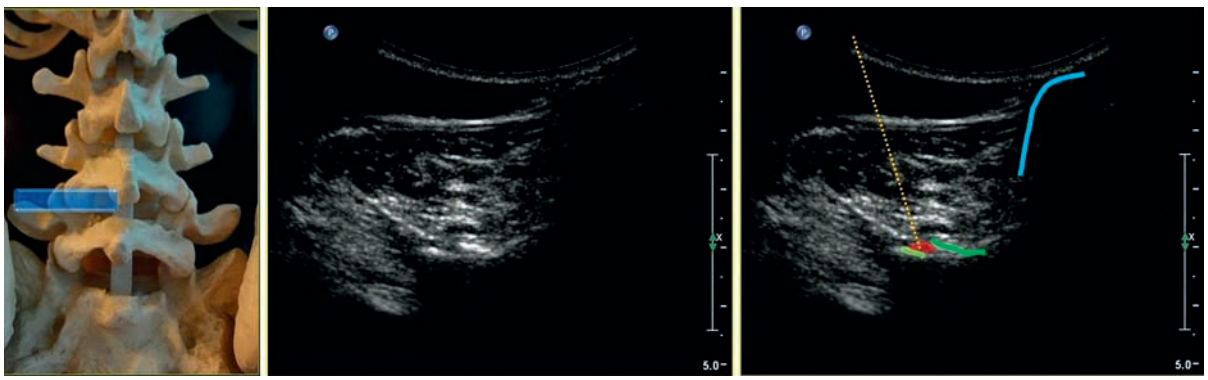

Fig 5. Posterior sagittal paravertebral plane of the PAP at level L4-L5. Transverse processes: green, intertransverse ligament: red, intended needle placement: orange.

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 repositioning 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 pararadicular and facet joint injections [11,21]. The presented technique for pararadicular 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 5th 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 pararadicular 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.

References

1. Bogduk N. On the definitions and physiology of back pain, referred pain, and radicular pain. Pain 2009; 147: 17-19.
2. Moore RA, Straube S, Derry S, McQuay HJ. Chronic low back pain analgesic studies--a methodological minefield. Pain 2010; 149: 431-434.
3. O'Neill S, Graven-Nielsen T, Manniche C, Arendt-Nielsen L. Ultrasound guided, painful electrical stimulation of lum-

bar facet joint structures: an experimental model of acute low back pain. Pain 2009; 144: 76-83.
4. Schiltenwolf M, Schneider S. Activity and low back pain: a dubious correlation. Pain 2009; 143: 1-2.
5. Carrino JA, Morrison WB, Parker L, Schweitzer ME, Levin DC, Sunshine JH. Spinal injection procedures: volume, provider distribution, and reimbursement in the U.S. medicare population from 1993 to 1999. Radiology 2002; 225: 723-729.
6. Kim PS. Role of injection therapy: review of indications for trigger point injections, regional blocks, facet joint injections, and intra-articular injections. Curr Opin Rheumatol 2002; 14: 52-57.
7. Derby R, Kine G, Saal JA, et al. Response to steroid and duration of radicular pain as predictors of surgical outcome. Spine (Phila Pa 1976) 1992; 17(6 Suppl): S176-S183.
8. Gangi A, Dietemann JL, Mortazavi R, Pfleger D, Kauff C, Roy C. CT-guided interventional procedures for pain management in the lumbosacral spine. Radiographics 1998; 18: 621-633.
9. Fritz J, Niemeyer T, Clasen S, et al. Management of chronic low back pain: rationales, principles, and targets of imaging-guided spinal injections. Radiographics 2007; 27: 1751-1771.
10. Silbergleit R, Mehta BA, Sanders WP, Talati SJ. Imaging-guided injection techniques with fluoroscopy and CT for spinal pain management. Radiographics 2001; 21: 927-939.
11. Galiano K, Obwegeser AA, Walch C, Schatzer R, Ploner F, Gruber H. Ultrasound-guided versus computed tomography-controlled facet joint injections in the lumbar spine: a prospective randomized clinical trial. Reg Anesth Pain Med 2007; 32: 317-322.
12. Galiano K, Obwegeser AA, Bale R, et al. Ultrasound-guided and CT-navigation-assisted periradicular and facet joint injections in the lumbar and cervical spine: a new teaching tool to recognize the sonoanatomic pattern. Reg Anesth Pain Med 2007; 32: 254-257.
13. Galiano K, Obwegeser AA, Bodner G, t al. Ultrasound guidance for facet joint injections in the lumbar spine: a computed tomography-controlled feasibility study. Anesth Analg 2005; 101: 579-583.
14. Galiano K, Obwegeser AA, Bodner G, et al. Real-time sonographic imaging for periradicular injections in the lumbar spine: a sonographic anatomic study of a new technique. J Ultrasound Med 2005; 24: 33-38.
15. Kirchmair L, Entner T, Wissel J, Moriggl B, Kapral S, Mitterschiffthaler G. A study of the paravertebral anatomy for ultrasound-guided posterior lumbar plexus block. Anesth Analg 2001; 93: 477-481.
16. Galiano K, Obwegeser AA, Bodner G, Freund MC, Gruber H, Maurer H, et al. Ultrasound-guided facet joint injections in the middle to lower cervical spine: a CT-controlled sonoanatomic study. Clin J Pain 2006; 22: 538-543.
17. Galiano K, Obwegeser AA, Bodner G, et al. Ultrasound-guided periradicular injections in the middle to lower cervical spine: an imaging study of a new approach. Reg Anesth Pain Med 2005; 30: 391-396.
18. Greher M, Scharbert G, Kamolz LP, et al. Ultrasound-guided lumbar facet nerve block: a sonoanatomic study of a new methodologic approach. Anesthesiology 2004; 100: 1242-1248.
19. Kapral S, Krafft P, Eibenberger K, Fitzgerald R, Gosch M, Weinstabl C. Ultrasound-guided supraclavicular approach for regional anesthesia of the brachial plexus. Anesth Analg 1994; 78: 507-513.
20. Kirchmair L, Entner T, Kapral S, Mitterschiffthaler G. Ultrasound guidance for the psoas compartment block: an imaging study. Anesth Analg 2002; 94: 706-710; table of contents.
21. Loizides A, Gruber H, Peer S, Brenner E, Galiano K, Obernauer J. A New Simplified Ultrasound Approach for Pararadicular Injections in the Lumbar Spine: A Computed Tomography Controlled Cadaver Study. AJNR Am J Neuroradiol 2011 (Accepted for publication).
22. Parke W. Applied anatomy of the spine. In: Rothman R, Simeone FA (eds). The Spine. Philadelphia, PA: WB Saunders Co; 1992: 35-88.
23. Rickenbacher J, Landolt AM, Theiler K. Rücken. In: Lang J, Wachsmuth W. (editor). Praktische Anatomie. Heidelberg, Germany: Springer-Verlag; 1982: 17-22.