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Original article

Usefulness of a pre-procedure ultrasound scanning of the lumbar spine before epidural injection in patients with a presumed difficult puncture: A randomized controlled trial

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ABSTRACT

Ultrasound (US) is widely used in rheumatology to study and guide injection of peripheral joints. It can also provide useful information about the anatomy of the lumbar spine. Studies have shown that US examination of the spine was a useful tool to help perform epidural anaesthesia. The purpose of the study was to determine if the selection of the optimum puncture level by US may facilitate epidural steroid injection in case of presumed difficult puncture (BMI > 30 kg/m^2, age > 60 years or lumbar scoliosis).

Methods: We performed a prospective randomized controlled study. Eighty patients were randomized in two groups: US group ($n = 40$) which underwent a pre-procedure spinal US to determine the optimal lumbar level for injection or control group ($n = 40$) for which the level of injection was determined by palpation. Primary endpoint was the pain during the procedure assessed using the Visual Analogue Scale (VAS).

Results: We found a positive correlation between depth of the epidural space and BMI ($P < 0.001$) and a negative correlation between size of the interspinous spaces and age ($P < 0.01$). Visibility of the epidural space was not altered by obesity or age. We observed a trend toward a reduction in pain intensity during the procedure in the US group compared to the control group with a mean difference at −0.94 [−1.90; 0.02] but the difference was not significant ($P = 0.054$).

Conclusion: US of the lumbar spine was feasible in patients with lumbar conditions even in obese and old ones and allowed the visualization of the epidural space. However, pre-procedure US examination did not reduce pain during the procedure.

1. Introduction

Epidural injections are one of the most commonly performed interventions in rheumatology practice. They are mainly used to treat radicular pain from herniated discs or spinal stenosis [1]. Three different routes of administration are currently available: interlaminar, transforaminal, and caudal. Although usually easy to perform, steroid epidural injection through the interlaminar space can sometimes be challenging, more particularly in old and obese patients. Indeed, performing this procedure relies primarily on the palpation of anatomical landmarks, which might be obscured in the context of obesity or anatomical variation. Multiple needle insertions and redirections are known to increase pain and discomfort for patients [2]. Finally, accidental dural puncture can occur and lead to post-dural puncture headache [3]. Although X-ray guidance could be an option to guide epidural injection, it delivers a radiation dose to the patient and the physician. Ultrasound (US) has recently demonstrated its ability to produce a reliable and accurate depiction of the lumbar spine anatomy. It has also emerged as one of the new tools to perform guided spine injections. First descriptions of the US spinal anatomy have been reported in the 1980s [4,5]. Although the images were of poor quality by today's standards, the authors were able to define the lamina, ligamentum flavum, spinal canal and vertebral body. These studies have reported a strong relationship between the epidural space depth measured by US and the insertion depth of the needle, confirmed more recently by other authors [6,7]. US can also help to identify

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the interspinous spaces where palpation has been shown to be frequently inaccurate [8]. Pre-procedure US scanning of the lumbar spine is currently widely used to help perform epidural anesthesia or lumbar puncture [9–11]. A recent meta-analysis has confirmed that US could reduce the risk of failed or traumatic procedures and decrease the number of attempts and redirections of the needle [12].

US of peripheral joint is now widely used in rheumatology practice. In contrast, few studies have explored the interest of lumbar spine US in rheumatic diseases. We recently suggested that US could detect changes in the facet joints such as joint space irregularity, osteophytes, and calcifications [13]. It can also show interspinous bursitis or changes in the paravertebral muscles [14,15]. Most studies have focused on the use of US to guide various spine procedures. Ultrasound has been notably used to guide facet joint [16] and peri-radicular injections [17]. We also showed in 30 consecutive patients that real-time US guidance of steroid injections via the sacral hiatus was safe and accurate [18]. As pre-procedure US scanning of the lumbar region has been shown to be useful in obstetric epidural anesthesia or before a lumbar puncture, we asked the question whether it could also be useful before an interlaminar steroid epidural injection. Indeed, patients presenting with low back conditions are older and have a higher risk of degenerative changes in the lumbar spine and the usefulness of this imaging needs to be confirmed in this population. The objective of our study was to determine if a pre-puncture ultrasound examination of the spine may facilitate the injection and thus decrease the pain associated with the procedure.

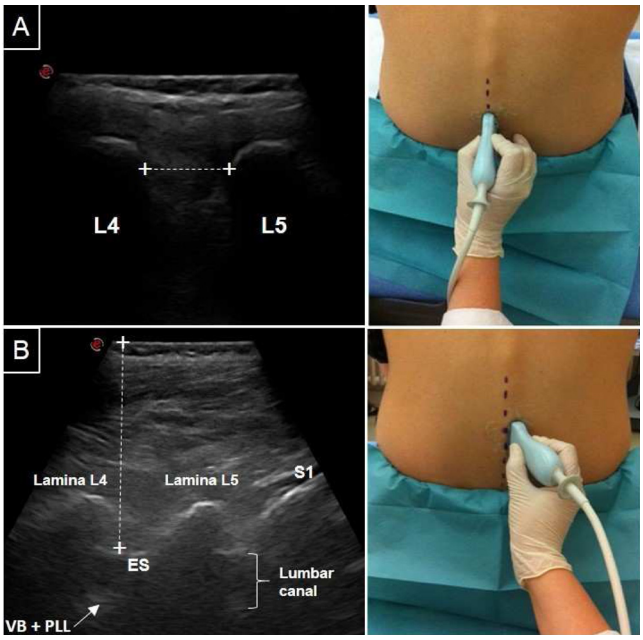

Fig. 1. Technique for measuring the distance between two spinous processes (A) and the depth of the epidural space (B) (ES: epidural space; VB: vertebral body; PLL: posterior longitudinal ligament).

2. Methods

2.1. Design

We conducted a monocentric, prospective, randomized, single-blind, controlled study (NCT01832844). The purpose of the study was to determine if a pre-puncture examination of the lumbar spine with US could reduce the pain during epidural injection when puncture is presumed difficult. The study was conducted between April 2013 and January 2014 in the department of Rheumatology of the Nantes University Hospital. The study was approved by the local ethics committee. Informed consent was obtained from each patient before inclusion in the study. There was no change to the design or protocol during the course of the trial.

2.2. Participants

All patients hospitalized for steroid epidural injection for the treatment of sciatica due to disc herniation or lumbar stenosis were assessed for eligibility. Inclusion criteria used to define a presumed difficult puncture were BMI (Body Mass Index) > 30 kg/m^2, age > 60 years or lumbar scoliosis (Cobb angle > 10°) [19,20]. Patients with a history of spinal surgery or spinal malformation like spina bifida, pregnant women, patients taking anti-platelet drugs and those participating in another study were excluded. Patients were allowed to continue analgesics if previously prescribed. They were also allowed to receive premedication with benzodiazepines in case of anxiety.

2.3. Assessment and interventions

A total of 80 patients were randomized (n = 40 per group). Patients were allocated in 2 groups: US group and control group using a randomization with blocks, online with Capture System software. After randomization, patients remained blinded to their group allocation. Patients of the US group underwent a pre-puncture examination of the lumbar spine by two experimented operators (CDL and BLG) using an ESAOTE MyLab 70x Vision with a linear ultrasound probe (3–11 MHz). In order to have a wider field of view, we used the trapezoid mode of our probe. On a seated patient, ultrasound examination started with a longitudinal median view through the spinous processes. The spinous processes were seen as a series of hyperechoic lines with upward convexity and posterior acoustic shadowing. To identify the vertebral levels, we first located the sacrum, seen as a continuous hyperechoic line and then moved up to its superior edge to identify the L5-S1 interspinous space. The probe was then moved cranially to identify the L4-L5 and L3-L4 interspinous spaces. The minimal distance between two spinous processes was measured on the longitudinal view at the three lower lumbar levels (Fig. 1A). Next, we performed a longitudinal paramedian oblique view to locate the epidural space. The transducer was positioned vertically 1–2 cm lateral to the spinous process and the ultrasound beam was directed obliquely toward the midline. The spinal canal was visible between the interlaminar spaces. The delineating structures were the ligamentum flavum and dura mater posteriorly and the posterior vertebral-body cortex and posterior longitudinal ligament anteriorly. The epidural space was a thin hypoechoic line between the two hyperechoic lines produced by the ligamentum flavum and the posterior dura mater (Fig. 1B). Using this view, we measured, at each lumbar level, the depth of the epidural space. Finally, visibility and accessibility of the epidural space were rated using a semi-quantitative score: 0 for “not”, 1 for “moderate” or 2 for “good” [21]. The score of “2” was the clear appearance of the epidural space as a thin hypoechoic line between the two hyperechoic lines produced by the ligamentum flavum and the posterior dura mater. The score of “0” corresponded to the absence of visibility of the epidural space. The score of “1” corresponded to the intermediate visibility. In this case, the epidural space was located using the hyperechoic structures but the thin hypoechoic line could not be well defined. According to these data, we determined the optimum level to perform the epidural injection. Patients of the control group underwent a ‘fake’ US examination (making the probe touch the skin without recording images) to remain blinded to their group allocation and the level of injection was selected using the traditional landmark technique. An interlaminar