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True AP imaging during lumbar medial branch radiofrequency neurotomy: A technical note

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ABSTRACT

Background: Optimal outcomes following lumbar medial branch radiofrequency neurotomy (LMBRFN) require close and parallel electrode placement to the targeted medial branch. True segmental fluoroscopic imaging is critical for LMBRFN performance. A true lateral imaging technique for LMBRFN has been described, and its interobserver reliability has been established. However, a similarly detailed technique for true AP imaging has yet to be proposed.
Objective: This technical note proposes a clear and concise true AP imaging technique for LMBRFN.
Technique: True AP lumbar imaging involves viewing the spinous process in the midline or midway between the pedicles and aligning cortical bone to create a sharp, superior endplate image. Maneuvering the fluoroscope can produce true AP imaging if the initial AP image is untrue. Oblique (axial plane) fluoroscopic rotation allows the spinous process to be positioned appropriately in the midline. Right versus left oblique rotation is informed by the position of the spinous process relative to the midline. Tilt (longitudinal plane) fluoroscopic rotation produces a sharp superior endplate. Cranial versus caudal tilt is informed by the pedicles' position relative to the vertebral body's upper zone.
Conclusions: When combined with true lateral imaging, the currently proposed AP imaging technique may yield reliable true segmental imaging during LMBRFN. This true AP segmental imaging process may also be applied to other lumbar spine procedures.

1. Introduction

Lumbar medial branch radiofrequency neurotomy (LMBRFN) is a commonly performed interventional spine procedure during which radiofrequency (RF) thermal energy is directed through an electrode placed in a cannula to coagulate specific segmental lumbar medial branches previously shown to be the source of an individual's low back pain [1]. For optimal results, the cannula's active tip is positioned parallel and close to the medial branch, which runs along the base of the superior articular process at its junction with the transverse process [2]. A detailed, step-by-step fluoroscopic technique for proper RF cannula positioning has recently been described [3]. True segmental (AP and lateral) imaging is necessary for cannula placement and final positioning before thermal lesioning [3,4]. While a true lateral segmental imaging technique appears to have substantial interobserver agreement [5,6], a detailed approach to true AP imaging has yet to be described. The true AP imaging technique described herein represents an attempt to provide reliable guidance for corrective fluoroscopic maneuvers after initial imaging during LMBRFN.

2. True AP imaging technique

Fluoroscopy is the preferred imaging technique for LMBRFN [3]. True AP imaging must consider each segment separately due to the lumbar spine curvature caused by lordosis and scoliosis [6]. For this technical note, "true segmental lumbar fluoroscopic AP imaging" will be assumed, and "true AP imaging" will be substituted. For true AP imaging, the spinous process should be positioned midway between the pedicles, and the superior endplate (SEP) cortical bone should be parallel to the X-ray beam, providing a crisp, linear image with overlapped anterior and posterior endplate margins (Figs. 1 and 2). This process is commonly called "sharpening" the endplate or producing a "sharp" endplate. However, initial AP imaging often produces an untrue image. Decisions regarding corrective fluoroscopic maneuvers with repeat

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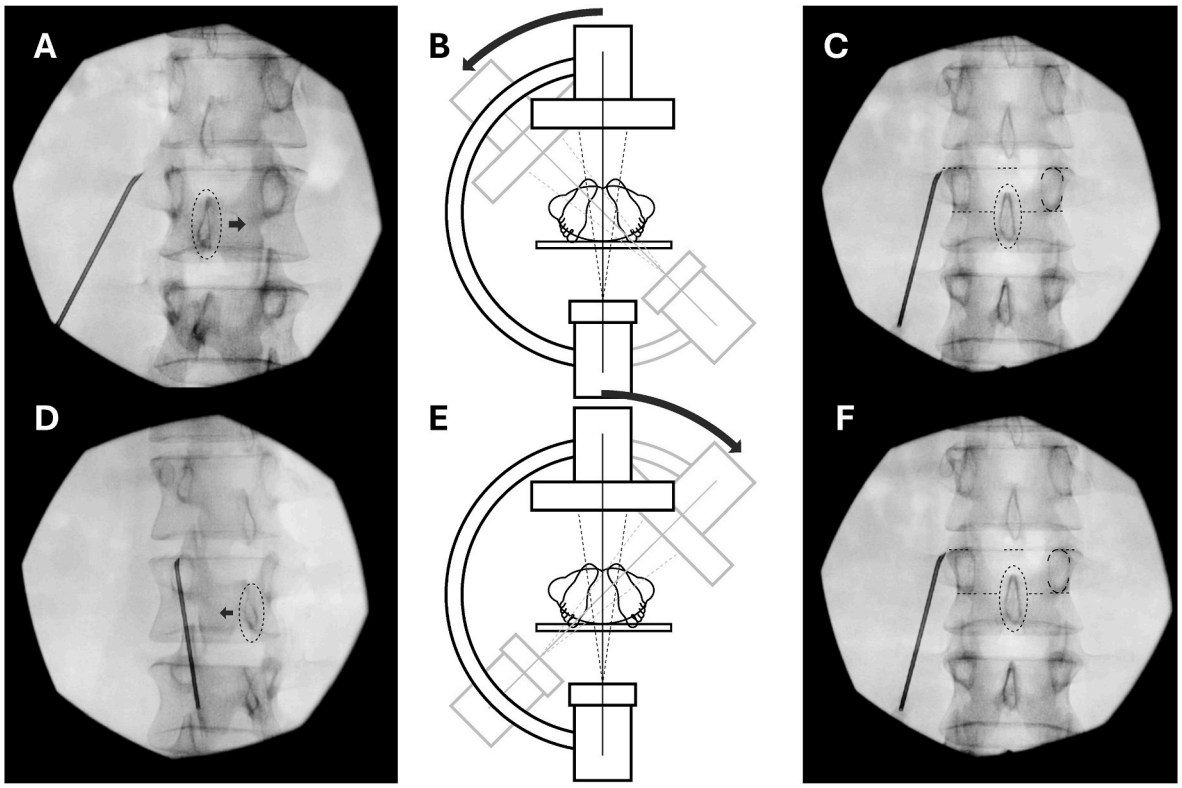

Fig. 1. True AP fluoroscopic imaging and corrective oblique (axial plane) maneuver during LMBRFN.

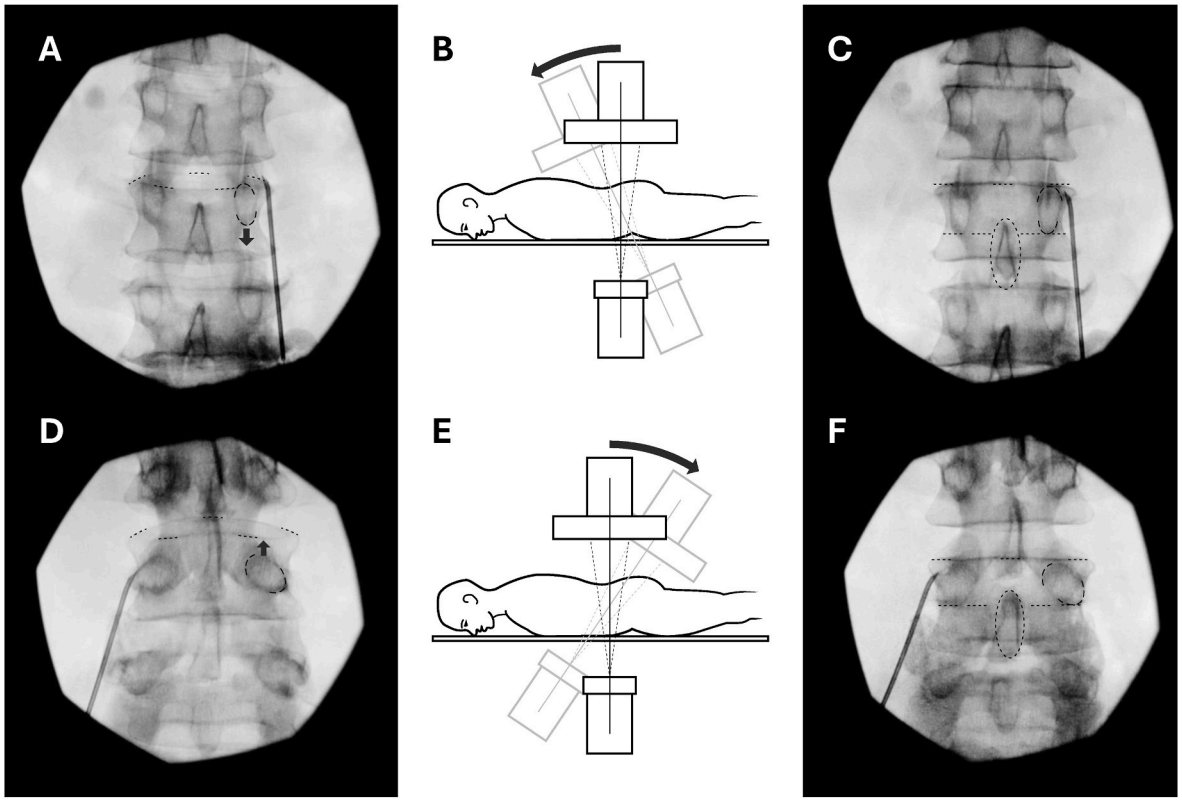

Fig. 2. True AP fluoroscopic imaging and corrective tilt (longitudinal plane) maneuver during LMBRFN.

imaging are required to produce the desired true AP image. The decision-making process for true AP imaging follows: If the spinous process is initially imaged to the left or right of the midline, the proper initial corrective fluoroscopic maneuver to establish true AP imaging is oblique (axial plane) rotation (Fig. 1). The position of the spinous process relative to the midline informs the direction of obliquity. If the spinous process is to the left of the midline (Fig. 1A), left obliquity is the initial corrective maneuver (Fig. 1B and C). Conversely, if the spinous process is to the right of the midline (Fig. 1D), right obliquity is the appropriate correction (Fig. 1E and F).

Once the spinous process is imaged correctly in the midline, SEP sharpness should be considered to complete the true AP imaging process. If the SEP is not sharp or appears as an oval, tilt (longitudinal plane) rotation is the proper initial corrective maneuver (Fig. 2). The direction of tilt is informed by the position of the pedicles, which should lie in the uppermost portion (zone) of the vertebral body and immediately subjacent to the superior intervertebral disc (Fig. 2C–F). If any portion of the pedicles is imaged within the suprajacent disc (Fig. 2A), cranial tilt is the proper correction (Fig. 2B), moving the pedicle images in a caudal direction to occupy the appropriate portion or zone of the vertebral body and effectively sharpening the SEP (Fig. 2A–C). Conversely, If the pedicles are imaged in the inferior vertebral body or below the indicated zone (Fig. 2D), caudal tilt is the proper maneuver (Fig. 2E), moving the pedicles in a cephalic direction for true imaging (Fig. 2D–F).

Decision-making for true AP imaging should be flexible and adjusted depending on the initial AP image. If the spinous process is correctly midline, the SEP should be evaluated. If it is sharp, the image is true, and no correction is necessary. However, if the spinous process is correctly midline but the SEP is not sharp, the appropriate tilt maneuver should be applied based on the pedicles' position (Fig. 2). Likewise, If the SEP is sharp, the spinous process position relative to the midline should be assessed. If the spinous process is not midline, the appropriate oblique maneuver should be applied to establish true imaging (Fig. 1).

For efficient AP fluoroscopic imaging, the image collector should be positioned directly above and perpendicular to the neutrally positioned patient before obtaining the initial image. L3 most often represents the apex of the lumbar lordosis. Slight adjustments in fluoroscopic tilt will usually sharpen the L3 SEP. Progressively greater cranial fluoroscopic tilt is generally required to align SEP cortical bone for the more inferior medial branch targets with the greatest cranial tilt for the L5 dorsal ramus target. Also, proper fluoroscope/patient positioning generally results in minimal oblique (axial plane) fluoroscopic rotational movements to produce true imaging.

3. Discussion

In a recently published technical manual, several lumbar procedural step-by-step instructions indicate the need for true AP imaging for both needle/device placement and final saved images; however, a detailed approach to achieve such imaging has not been provided [3]. The proposed true imaging technique may also apply to other lumbar spine procedures, including interlaminar and transforaminal epidural access, medial branch blocks, facet joint access, disc access, and vertebral body procedures.

A true AP imaging technique for lumbar spine interventions has previously been described [7]. The previously described technique emphasizes right or left fluoroscopic oblique movements to position the spinous processes in the midline by evaluating the spinous process cortical bone density and cephalad or caudal fluoroscopic tilt to produce a sharp SEP but does not provide explicit instruction regarding the directionality of fluoroscopic maneuvers [7]. Based on the relationships of specific spine structures or alignment of cortical bone as seen on initial imaging, our approach differs from its predecessor by providing specific guidance regarding right or left oblique rotation and cranial or caudal tilt to establish true AP imaging.

Furthermore, our currently proposed true AP imaging process may enhance LMBRFN efficiency, reduce fluoroscopy radiation exposure, and improve technical performance and procedural documentation. A study is underway to evaluate this imaging technique's interobserver reliability and real-world clinical utility.

A potential weakness of this proposed technique is the inability to sharpen the SEP in some instances, such as when the endplate is uneven due to a compression fracture or bony irregularities and cannot be easily imaged as a sharp line. Nevertheless, tilt fluoroscopic maneuvering allows imaging of the pedicles in the upper vertebral body zone and acquiring as sharp an endplate as possible to achieve near-true AP imaging.

4. Conclusions

True segmental imaging is essential for LMBRFN performance and documentation [3–5]. Based on the initial imaging of specific spine structures, this technique seeks to inform physicians regarding subsequent fluoroscopic maneuvers for reliable true AP imaging. When combined with true lateral imaging, this true AP imaging process may yield consistent true segmental imaging for LMBRFN and other lumbar spine procedures. A currently underway interobserver agreement study may help establish the utility of the true AP imaging approach during LMBRFN.

As depicted in (C,F), a sharp SEP (upper dashed line) and centered spinous process (encircled by dashes) indicate true imaging. With true imaging (C,F), the representative right pedicle (long dashes) occupies the vertebral body upper zone (parallel dashed lines). As depicted in (A, D), the spinous process is malpositioned (not located midway between the pedicles), indicating untrue imaging. Oblique imaging allows the spinous process to be positioned midway between the pedicles for true imaging (C,F). In (A), the spinous process is left of the midline. In this instance, left oblique fluoroscopic rotation (B) is the proper corrective maneuver to move the spinous process to the right (arrow, A) for its proper midline position (C). Conversely, in (D), the spinous process is positioned to the right of the midline. Here, right oblique fluoroscopic rotation (E) is the appropriate maneuver to move the spinous process to the left (arrow, D) to achieve its proper position (F).

As depicted in (C,F), aligned SEP cortical bone (upper dashed line) and centered spinous process (encircled by dashes) indicate true imaging. With true imaging (C,F), the representative right pedicle (long dashes) occupies the vertebral body upper zone (parallel dashed lines). As depicted in (A,D), the unaligned SEP, outlined by short dashes in an oval pattern, and the malpositioned pedicles indicate untrue imaging. In (A), the upper portion of the right pedicle is seen superiorly within the suprajacent disc; cranial tilt (B) is the proper corrective maneuver to move the pedicle image (arrow, A) caudally within the vertebral body upper zone, yielding a sharp SEP (C). In (D), the right pedicle is seen in the mid-vertebra and caudal to the vertebral body upper zone (F). Here, caudal tilt (E) is the proper corrective maneuver to move the pedicle image (arrow, D) in a cephalic direction to appear within the upper vertebral body zone and create a sharp SEP (F).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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