Article published online: 2024-12-11

Seven Golden Steps for Performing Safe and Effective Percutaneous C-Arm-Guided Vertebral Intervention

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Indian J Radiol Imaging

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Abstract

Percutaneous C-arm-guided diagnostic or therapeutic vertebral intervention has advantages of real-time monitoring of needle progression in vertebrae in craniocaudal or caudocranial angulation. To minimize the complications of nerve root or spinal cord damage, stepwise methodical intervention is pertinent. In this technical report, we demonstrate the seven golden steps for a safe and effective C-arm-guided vertebral intervention.

Keywords

- vertebral intervention
- C-arm fluoroscopy
- vertebral augmentation

Introduction

Percutaneous C-arm-guided vertebral interventions demand high precision and skill to achieve the desired result with minimal complication. C-arm allows real-time monitoring of needle progress as compared to computed tomography (CT) and due to its higher temporal resolution allows instantaneous changes in needle trajectory and protection of critical structures located at fixed bony landmarks (e.g., spinal canal, neural foramina).

A meticulous planning of the approach for a particular vertebra is pertinent owing to differential anatomy of the vertebral pedicles and facet joints. The pedicles are thin and slender in the cervical and thoracic spine and their diameters increase consistently as one advances inferiorly toward the sacrum. Furthermore, the orientation of the facet joints, which become more angulated in the sagittal plane from the cervical spine (45 degrees) to the lumbar spine (90 degrees), necessitates alteration in trajectory for entry into the vertebral body.[1] However, the transpedicular approach is still the most feasible route for entry into the lumbar and thoracic vertebrae.

Technique

The usage of these following seven steps makes for safe, effective, and technically adequate vertebral interventions.

1. For transpedicular vertebral intervention, a barrel view of the pedicle should be first and foremost achieved by oblique projections and configuring the facet joint medial to the pedicle. (►**Fig. 1**) This is done so as to avoid entering the facet joint during needle advancement.[2]
2. The pedicle should be placed equidistant from the superior and inferior endplates of the vertebra, using craniocaudal tilts of the C-arm, thereby avoiding its overlap with the vertebral body (►**Fig. 1**) and preventing off-angle trajectories.
3. Bone biopsy needle is placed over the center of the barrel (pedicle) to maintain a considerable distance from inferior

DOI https://doi.org/10.1055/s-0044-1796645.
ISSN 0971-3026.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

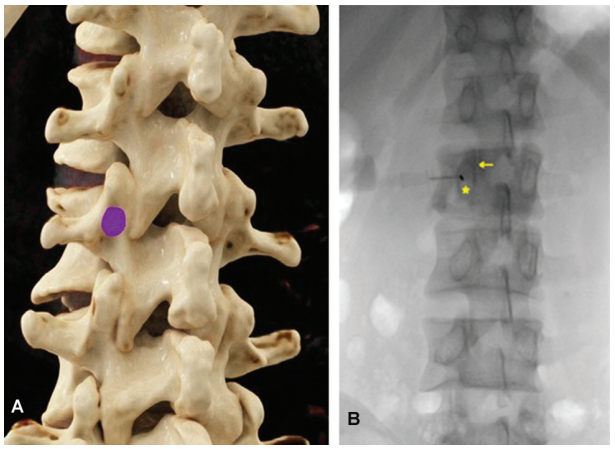

Fig. 1 (A) Volume-rendered oblique image of the lumbar spine demonstrates the Scotty dog configuration of the posterior vertebral elements with the pedicle (*shaded*) forming the eye of the dog. (B) Fluoroscopic spot view shows the needle (bent at 90 degrees) in the center of the pedicle (*asterisk*) with the facet joint placed medial to it (*arrow*). Furthermore, the pedicle is equidistant from the superior and inferior vertebral endplates.

and medial cortex of the pedicle. If the medial cortex of the pedicle is breached, it increases the risk of cerebrospinal fluid leaks/nerve root injury/cord damage, while an inferior breach increases the risk of dorsal root ganglion injury in the neural foramina (►**Fig. 2**).

4. After fixation of bone biopsy needle into the vertebral pedicle, it is advanced until it reaches the posterior vertebral body cortex. At this landmark, a true anteroposterior projection is a good practice to document clear margins between the needle and the inferior/medial cortices of the pedicle. This reassures the safety of their trajectory (►**Figs. 3** and **4**).
5. Once the needle is advanced into the vertebral body, one should aim to reach the needle tip as close to midline as possible (using spinous processes as surrogate markers). Therapeutic interventions such as vertebroplasty can be done via the unipedicular approach if it is near the midline.

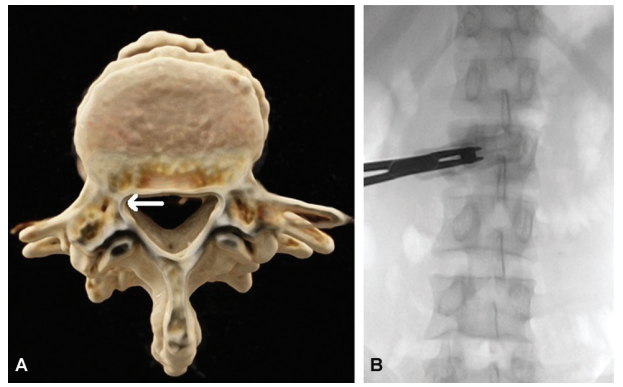

Fig. 2 (A) Volume-rendered axial image of the lumbar spine demonstrates the importance of preserving the medial pedicle cortex (*white arrow*) in order to prevent catastrophic damage to nerve roots/cord/thecal sac. (B) Fluoroscopic spot image demonstrates end-on view of bone biopsy needle with a clear margin between the medial and inferior cortices of the pedicle to protect the spinal canal and the neural foramen from injury, respectively.

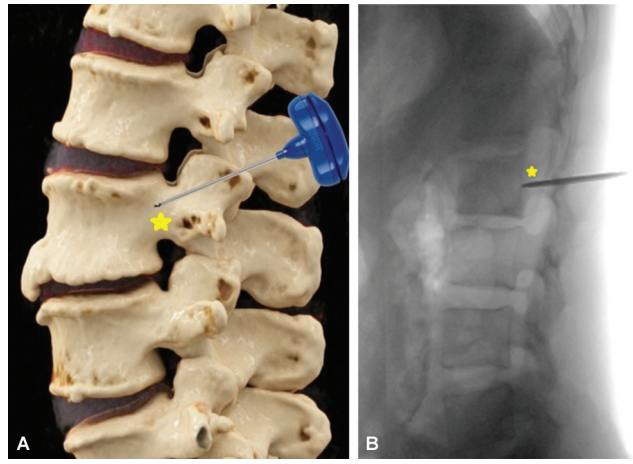

Fig. 3 (A) Volume-rendered sagittal image of the lumbar spine with superimposed bone biopsy needle overlap and (B) the fluoroscopic spot image demonstrate the course of the needle through the pedicle (*asterisk*) as it reaches the posterior vertebral body cortex.

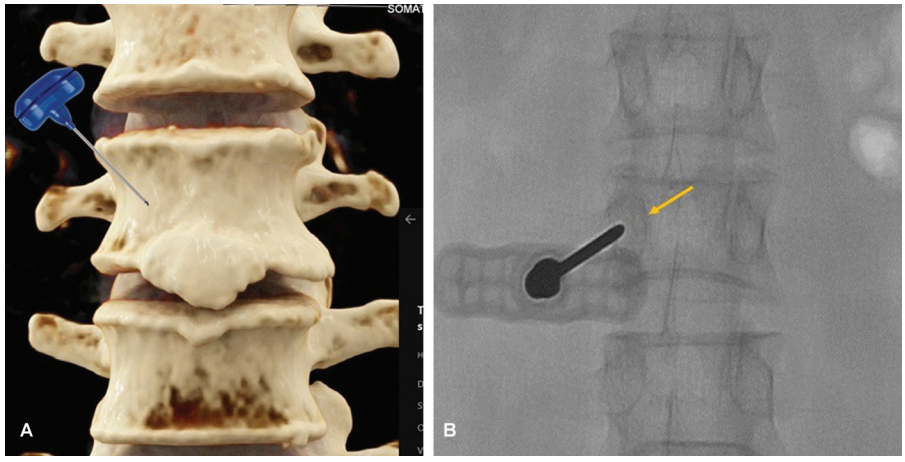

Fig. 4 (A) Volume-rendered coronal image of the lumbar spine with superimposed bone biopsy needle overlap demonstrates the importance of taking a true anteroposterior projection after reaching the posterior vertebral body cortex. (B) Fluoroscopic spot image demonstrates clear margin between the needle and the medial cortex of the pedicle (*arrow*) reassuring of a safe trajectory. The needle can now be advanced into the vertebral body without any risk of spinal canal/neural foramen injury.

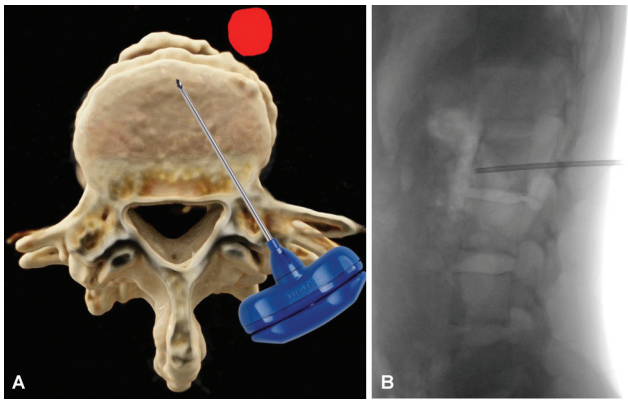

Fig. 5 (A) Volume-rendered axial image of the lumbar spine with superimposed bone biopsy needle overlap demonstrates the importance of preserving the anterior cortex of the vertebral body in order to avoid injury to the closely draped adjacent overlying aorta. It also reinforces the preference for left vertebral pedicle in order to protect the aorta from injury. (B) Fluoroscopic spot image in lateral view shows a considerable safe zone between the needle tip and the anterior vertebral body cortex.

6. While in the vertebral body, care should be taken to not advance the needle tip beyond the anterior cortex. This reduces the likelihood of injury to the prevertebral structures, including the descending aorta, which is closely draped along the anterolateral aspect of the vertebral bodies (►**Fig. 5**).
7. The left pedicle is preferred for the transpedicular approach as it protects the left-sided aorta from injury in case of an inadvertent anterior cortex breach (►**Fig. 5**).[3,4]

Discussion

C-arm-guided vertebral interventions offer a safer and minimally invasive approach. If done in a stepwise manner, it improves efficacy and safety of diagnostic and therapeutic techniques like biopsies and vertebral augmentation.

Presentation
The manuscript was presented as an electronic poster at the 12th Annual Conference of the Musculoskeletal Society of India in Jaipur, Rajasthan, India (August 16–18, 2024).

Funding
None.

Conflict of Interest
None declared.

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