

Introduction

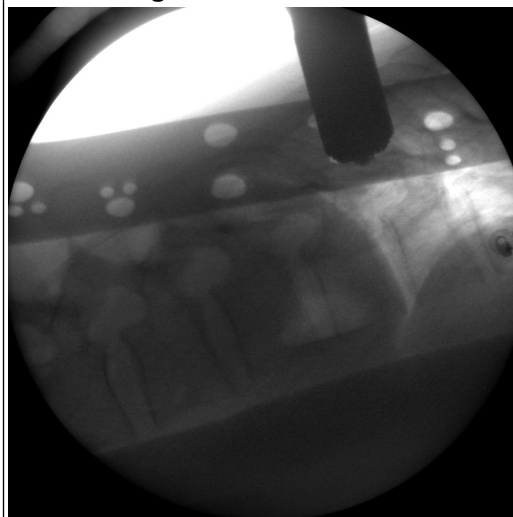
Intraoperative localization of the correct spinal level remains an ongoing challenge for spine surgeons. Although there are many invasive and non-invasive strategies to deal with marking levels appropriately for identifying an index level, pre-operative or intra-operative fluoroscopy remains the mainstay in the majority of centres. There are potential drawbacks to using invasive techniques to aid in localization, such as disc needle-puncture,^{1,2,3} as well as increased radiation exposure for the patients with real-time image navigation. Therefore, non-invasive techniques that provide good accuracy and prevent wrong-level operations are desirable.

Upper lumbar and thoracic spine localization can be especially error prone as one must count up or down from known levels. Counting is often done with mobile, radio-opaque instruments that are moved cranial or caudal while counting. Using such a mobile marker can introduce additional error and result in confusion of levels and therefore, wrong level surgery. We present a novel, inexpensive, and effective solution for intra-operative localization using a radio-opaque ruler.

Methods

The localizing ruler is made from stainless-steel that is light and semi-rigid with patterns of holes that vary in size and arrangement to provide unique markers along its length. The

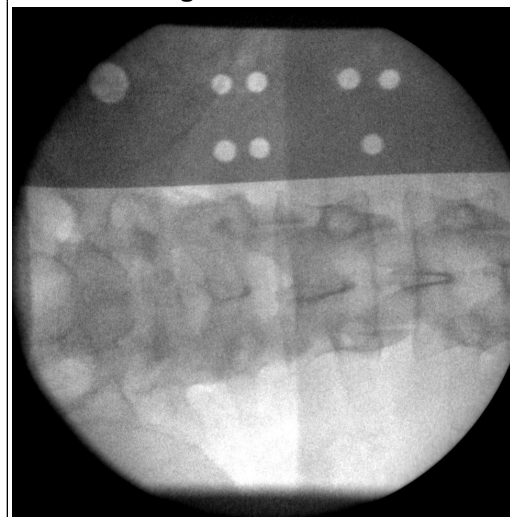
Figure 1: Lateral View



Use in the lateral position provides a working backdrop

flexibility of the ruler allows it to be partially contoured to the patients' body on the anterior, posterior, or lateral positions. To reduce counting errors, we use a patterned marked radio-opaque metal ruler secured to the side or back of the patient to 'label' vertebral levels during counting (see figures). This ruler has unique cut-outs at regular intervals that provide a backdrop during fluoroscopy that are correlated to vertebral bodies. The known reference level can be identified by correlating the vertebral body with the nearest cut-out to provide a stationary reference. Once the reference level is used to count to the level desired, the ruler once again provides the backdrop necessary to have a stable procedural reference.

Figure 2: AP View



Starting from the sacrum provides the reference for counting cranially

Results

This versatile technique has been used in both anterior-posterior and lateral fluoroscopy for localization in the cervical, thoracic, and lumbar spine. The majority of its use has been during minimally invasive techniques and provides an elegant solution to ensure that one remains at the appropriate level during and after repositioning the tubular retractor system, as well as when operating on multiple levels from a single incision. Perhaps the most useful application is in localization of the upper thoracic spine in obese patients where soft-tissue density limits the visualization of the vertebral bodies. The marking ruler provides a stable reference point to reliably count levels and non-invasively mark the operative level

for re-checking. This ruler has also reduced fluoroscopy times by obviating the need to count multiple times from the reference level to the index level.

Conclusions

We present a simple and inexpensive method for increasing accuracy in the intra-operative localization of spinal segments. We believe this method increases surgeon confidence in the correct spinal level and reduces errors in localization during fluoroscopic counting.

Learning Objectives

By the conclusion of this session, participants should be able to:

- 1) Understand the use of this novel ruler in counting vertebral levels.
- 2) Apply this simple technique for intraoperative localization.

References

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