Novel Intraoperative Technique to Visualize the Lower Cervical Spine: A Case Series

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Abstract

Visualization of the lower cervical spine with a lateral radiograph poses a challenge secondary to encroachment of the shoulders. Applying traction to the arms or taping the shoulders down provides adequate visualization in most patients, but imaging the mid- to lower cervical levels presents a significant challenge in patients with stout necks. We present a variation of the lateral radiograph that is 30° oblique from horizontal and 30° cephalad from neutral and used in a series of patients with stout necks that require anterior instrumentation of the lower cervical spine. We reviewed intraoperative images of 2 patients who underwent anterior cervical spine surgery at our institution, and assessed type of procedure, body mass index, and outcome scores. Our variation provided improved visualization relative to a lateral view and was used intraoperatively to confirm correct-level hardware placement in both patients.

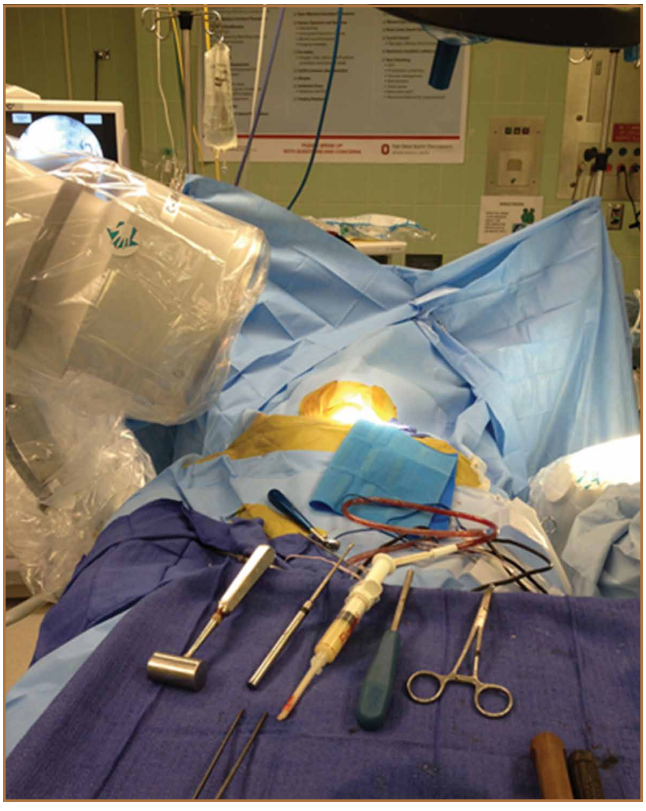
Two adequate views of the lower cervical vertebrae are necessary to confirm the 3-dimensional location of any hardware placed during cervical spine fusion. Visualizing the lower cervical vertebrae in 2 planes intraoperatively is often a challenge because the shoulders obstruct the lateral view.[1] Techniques have been described to improve lateral visualization, including gentle traction of the arms via wrist restraints or taping the shoulders down inferiorly.[2,3] These techniques have their inadequacies, including an association with peripheral nerve injury and brachial plexopathy.[4] In patients with stout necks, these methods may still be insufficient to achieve adequate visualization of the lower cervical vertebrae.

Invasive techniques to improve visualization have also been described. In 1 study, exposure had to be extended cephalad to allow for manual counting of cervical vertebrae when the mid- to lower cervical vertebrae had to be identified in a morbidly obese patient.[5] More invasive spine procedures are associated with higher rates of complications, increased blood loss, more soft-tissue trauma, and longer hospital stays.[6] We present a view 30° oblique from horizontal and 30° cephalad from neutral as a variation of the lateral radiograph that improves visualization of the mid- to lower cervical vertebrae. The authors have obtained the patients' informed written consent for print and electronic publication of these case reports.

Technique

We used either the Smith-Robinson or Cloward approach to the anterior spine. Both techniques use the avascular plane between the medially located esophagus and trachea and the lateral sternocleidomastoid and carotid sheath to approach the anterior cervical spine. Once adequate exposure was achieved, standard anteroposterior and lateral radiographs were obtained

Figure 1. Positioning of intraoperative 30°–30° oblique radiograph.



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to confirm the correct vertebral level. Gentle caudal traction was applied to the patient's wrist straps, and when visualization continued to be compromised, a view 30° oblique from horizontal and 30° cephalad from neutral was obtained (**Figure 1**).

Case Series

Case 1

A 54-year-old man with a body mass index (BMI) of 50 presented with neck and bilateral arm pain, with left greater than right radicular symptoms in the C6 and C7 distribution.

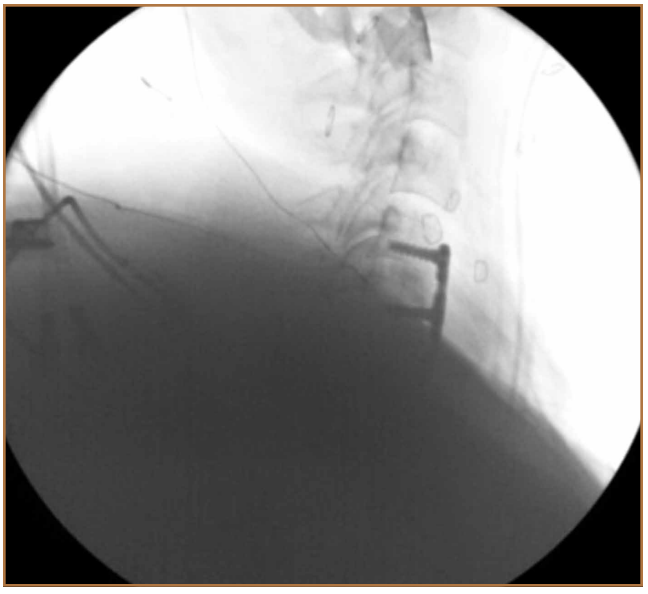

Figure 2. Intraoperative lateral radiograph, showing difficulty in visualizing the inferior cervical spine hardware.

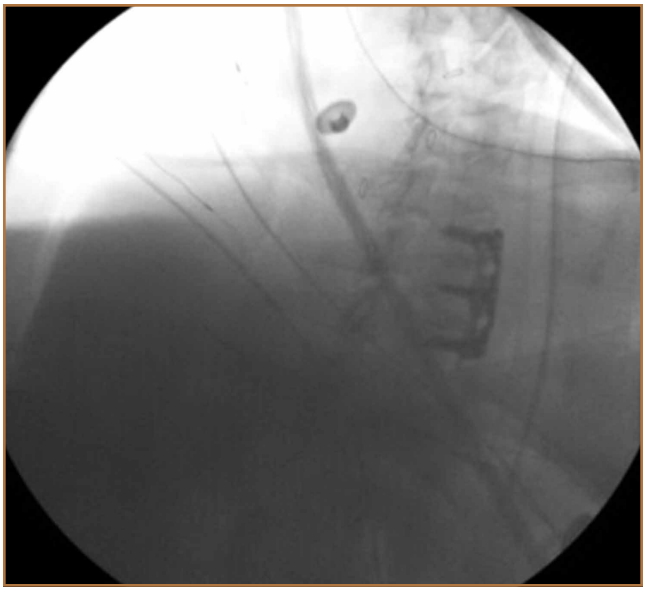

Figure 3. Intraoperative 30°–30° radiograph, showing correct placement of inferior cervical spine hardware.

Magnetic resonance imaging (MRI) showed disc herniations at C5-C6 and C6-C7 with spinal cord signal changes, and he underwent a C5-C6 and C6-C7 anterior cervical discectomy and fusion. Initial localization was determined using a lateral radiograph and vertebral needle. During hardware placement, anteroposterior and lateral fluoroscopic radiographs confirmed adequate placement of the superior screw, but visualization of the inferior portion of the plate and inferior screw was challenging (**Figure 2**). Our oblique 30°–30° view provided better visualization of the plate and screws in the lower cervical vertebrae than lateral imaging, and allowed confirmation that the hardware was positioned correctly (**Figure 3**). It took 1 attempt to achieve adequate visualization with the 30°–30° view.

Postoperatively, the patient's radiculopathy and motor weakness improved. Radiographs confirmed adequate hardware placement, and he was discharged on postoperative day 1 (**Figure 4**). Imaging at the patient's 6-week follow-up confirmed adequate fusion from C5-C7, anatomically aligned facet joints, and no hardware failure. The patient's Neck Disability Index was 31/50 preoperatively and 26/50 at this visit.

Case 2

A 51-year-old man with a BMI of 29 presented with a long-standing history of neck pain and bilateral arm pain left greater than right in the C6 and C7 dermomyotome. MRI showed a broad-based disc herniation with foraminal narrowing at C5-C6 and C6-C7, and the patient underwent a 2-level anterior cervical discectomy and fusion. This patient had pronounced neck musculature, and a deeper than normal incision was required.

Intraoperative lateral fluoroscopy was obtained to confirm the C5-C6 and C6-C7 level prior to discectomy. The musculature of the patient's neck and shoulder made visualization of the C6-C7 disc space difficult on the lateral radiograph (**Figure 5**). One attempt was required to obtain the 30°–30° oblique view, which was used to ensure correct placement of the screws and plate (**Figure 6**).

Postoperatively, the patient's pain had improved, and ra-

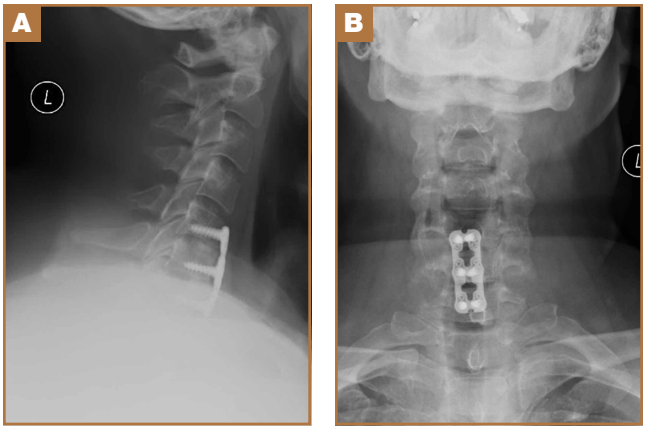

Figure 4. Postoperative (A) lateral and (B) anteroposterior radiographs, showing adequate hardware placement.

diographs confirmed adequate hardware placement. He was discharged 1 day after surgery (**Figure 7**). Imaging at the patient's 6-week follow-up confirmed adequate fusion from C5-C7, stable disc spaces, and anatomically aligned facet joints. His Neck Disability Index was 34/50 preoperatively and 32/50 at 2-week follow-up.

Discussion

The aim of this study was to describe an alternative to the lateral radiograph for imaging the cervical spine in patients with challenging anatomy or in procedures involving hardware placement at the lower cervical vertebrae. Techniques have been developed to assist with improved lateral visualization, including gentle traction of the arms via wrist restraints or taping the shoulders down inferiorly.[2,3] However, visualization in 2 planes continues to be a challenge in a subset of patients. It is particularly difficult to obtain adequate lateral radiographs of the cervical spine in patients with stout necks.[3] In patients with stout necks, there is more obstruction of the radiography path through the cervical spine. This leads to imaging that is unclear or may fail to show the mid- to lower cervical spine. The extent to which one should rely on the 30°–30° oblique technique for adequate visualization of the cervical spine depends on the anatomy of a particular patient. Historically, it is more challenging to obtain satisfactory lateral radiographs in patients with stout necks,[3] and these patients have benefited the most from using the 30°–30° degree oblique view.

Lack of visualization can lead to aborted surgeries or, potentially, surgery at the wrong level.[3] A 2008 American Academy of Neurological Surgeons survey indicated that 50% of spine surgeons had performed a wrong-level surgery at least once in their career, and the cervical spine accounted for 21% of all incorrect-level spine surgeries.[7] Intraoperative factors reported during cases of wrong-level spinal surgeries included misinterpretation of intraoperative imaging, no intraoperative imaging, and unusual anatomy or physical characteristics.[8] Such complications can lead to revision surgery and other significant morbidities for the patient.

In most patients, fluoroscopy allows confirmation of the correct level before disc incision.[3] However, operating at a lower cervical level in a patient with a short neck or prominent shoulders poses a significant problem.[3] A case report from Singh and colleagues[9] described a modified intraoperative fluoroscopic view for spinal level localization at cervicothoracic levels. Their method focuses on identifying the bony lamina and using them as landmarks to count spinal levels, whereas our 30°–30° oblique image is useful for confirmation of adequate hardware placement during anterior cervical spinal

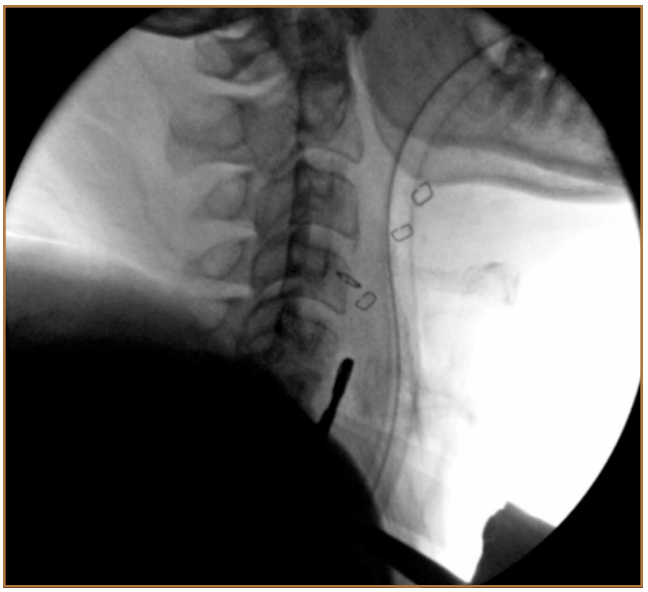

Figure 5. Intraoperative lateral radiograph, showing difficulty in visualizing the inferior cervical spine hardware.

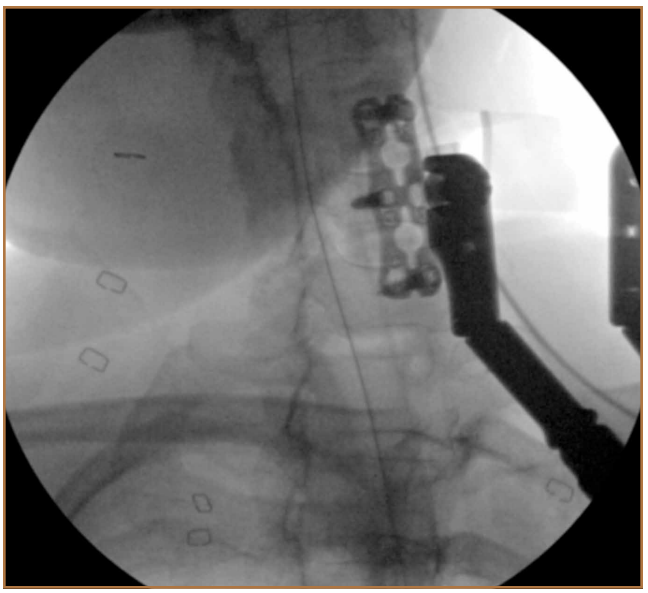

Figure 6. Intraoperative 30°–30° radiograph, showing correct placement of inferior cervical spine hardware.

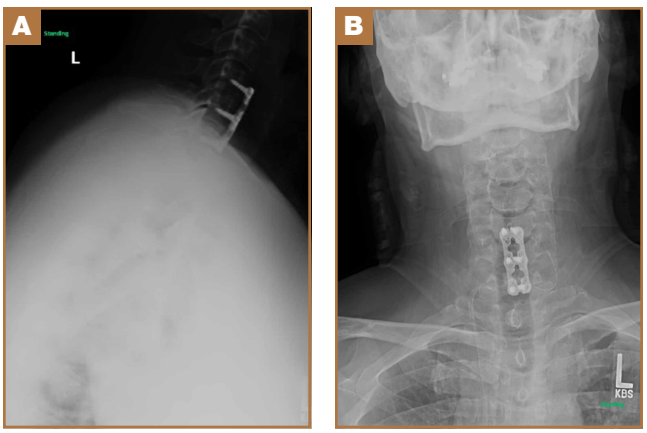

Figure 7. Postoperative (A) lateral and (B) anteroposterior radiographs, showing adequate hardware placement.

fusions. Often, the initial localization of cervical vertebral levels can be achieved with a standard lateral radiograph. We recognized the utility of the 30°–30° oblique view when we were attempting to visualize the inferior aspect of the plate and inferior screw placement.

In patients with stout necks, a lateral radiograph may show only visualization down to C4 or C5.[3] Even with applying traction to the arms or taping the shoulders down, it can be impossible to visualize C6, C7, or T1 because the shoulder bones and muscles obstruct the image.[3] Using a 30°–30° oblique view, we were able to obtain adequate visualization and assess the accurate placement of hardware.

Conclusion

A 30° oblique view from horizontal and 30° cephalad from neutral radiograph can be used intraoperatively in patients with challenging anatomy to identify placement of hardware at the correct vertebral level in the lower cervical spine. It is a noninvasive technique that can help reduce the risk of wrong-site surgeries without prolonging operation time. This technique describes an alternative to the lateral radiograph and provides a solution to the difficult problem of intraoperative imaging of the mid- to lower cervical spine in 2 adequate planes.

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This paper will be judged for the Resident Writer's Award.