

Fundamental Neurosurgery

Wrong-level surgery: A unique problem in spine surgery

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Abstract

Background: Even though a lot of effort has gone into preventing operating at the wrong site and wrong patient, wrong-level surgery is a unique problem in spine surgery.

Methods: The current method to prevent wrong level spine surgery performed is mainly relied on intra-operative X-ray. Unfortunately, because of the unique features and anatomy of the spinal column, wrong level spine surgery still happens. There are situations that even with intraoperative X-ray, correct level still cannot be reliably identified.

Results: Examples of patient whose surgery can easily be performed on the wrong level are illustrated. A protocol to prevent wrong-level spine surgery preformed is developed.

Conclusion: The consequence of wrong-level spine surgery not only generates another surgery of the intended level; it is usually also associated with lawsuit. Strictly following this protocol can prevent wrong-level spine surgery.

Key Words: Spine surgery, wrong-level surgery, wrong-sided surgery

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INTRODUCTION

According to one medicolegal study regarding wrong-level spine surgery, 99% of cases ended up in litigation. Even though 54% of the cases are settled out of court, nonetheless they were associated with an indemnity ranging from \$62,000 to \$1,500,000.^[2] To prevent this very costly, unintended mistake committed by the surgeon, a lot of effort has gone into preventing operating at the wrong site, wrong patient and wrong surgery through the Joint Commission's Universal protocol and other measures. Each hospital also has specific protocol to make sure the intended surgery is performed on the intended patient. However, according to a very recent

published article about a systematic review of avoiding wrong site surgery, the conclusion was very discouraging. It said "There is no evidence to support the JC checklist, NASS checklist or other preventative measures with respect to their effectiveness in preventing a wrong site surgery. The overall strength of the evidence to establish the efficacy of preoperative measures including checklists for preventing wrong site surgery is very low."^[1] Because of the unique anatomy of the spinal column, only spine surgery has the problem of wrong-level surgery performed. The Sign Your Site initiative or Pause Before Making Incision policy may prevent wrong site surgery, but still cannot prevent wrong level spine surgery.

MATERIALS AND METHODS

The current method to prevent wrong-level spine surgery performed is by intra-operative X-ray which allows the surgeon to count the spine level one by one. Unfortunately, regardless of the above effort, wrong level spine surgery, albeit very uncommon, still happened.^[5] There are some factors unique for spine surgery that can lead the surgeon to commit this error. These factors are as follows:

1. Adjacent spine levels that can look identical inside the surgical wound.
2. Congenital abnormal variant of spine anatomy in some patients such as four or six lumbar spines,^[3] lumbarized sacrum, or congenital fusion of spinous processes.
3. Very abnormal spine anatomy or deformity such as scoliosis and osteoporosis making it difficult to count the correct level.
4. Adequate intra-operative X-rays are not possible in morbidly obese patients.
5. Poor X-ray quality due to the C-arm machine or the incompetence of the X-ray technician.

It is impossible to predict the many different possible ways in which an error will occur and even harder to predict the context or causative factors of each mistake. When unpredicted errors occur it may be difficult to build safeguards into a written protocol if the factors which caused or contributed to the error are unique to the case. Having said that, wrong level spine surgery caused by the above factors is avoidable if every spine surgeon tries his/her very best to prevent it to happen. Being compulsive to obtain a good quality X-ray so that the surgeon can reliably count the correct level is a must.^[4] Knowing the congenital abnormal variant of spine anatomy of the patient based on the pre-operative imaging studies is also a prerequisite to preventing wrong-level surgery. However, there are still situations that the intended levels for surgery cannot be sure. This is especially common in the thoracic spine. Even though computer-assisted image guidance can help to reduce the risk of wrong level surgery,^[6] this technology is not readily available in all hospitals, and it is not practical to apply to all spine surgeries.

RESULTS

So far the published articles emphasize on “intraoperative imaging after exposure and marking of a fixed anatomic structure” to prevent wrong level spine surgery,^[1,4] but there are situations even this measure would not be enough. Here illustrates two thoracic spine surgeries which posed difficulty in determining the correct levels during the surgery. Without the help of computer-assisted image guidance, different measures are generated

in order to make sure the correct levels were operated. The first case is about a patient who had a T7--T8 calcified disc fragment that compressed on the spinal cord [Figure 1]. Because the bony anatomy was normal in this case, it would be difficult to locate the disc level of T7--T8 during the surgery by using intra-operative X-ray only. Request was made to the interventional radiologist to place fiducial markers at the right T7 and T8 pedicle before the surgery, thus facilitating in identifying the correct levels during the surgery [Figure 2].

The second case is more difficult because the lesion is located at the T3 and T4 level. Intraoperative x-ray localization at these levels is very difficult because the patient's shoulders obstruct the view. In this case even though the MRI shows gross abnormality in the vertebral body of T3 and T4 [Figure 3], the intra-operative X-ray shows no bony abnormality in the vertebral body [Figure 4]. Fiducial markers were not placed before the surgery, and computer-assisted image guidance was not available. Under this type of situation, an attending radiologist was requested to come into the operating room to assist in identifying the levels of T3 and T4. After numerous attempts by the radiologist at different angles of imaging and with different radiation intensity, the correct levels were able to be confirmed so that the correct surgery could be performed [Figure 5].

DISCUSSION

No spine surgeon, no matter how experience he or she is, dare to say wrong-level spine surgery would never happen to him or her. One can argue wrong site surgery or wrong side surgery is purely due to carelessness of the surgeon. On the other hand, the unique anatomy of the spine can be a set-up of wrong level surgery performed even when the surgeon pays a conscious effort to identify the correct level. And yet, a mistake is a mistake in front of the court



Figure 1: T2-weighted sagittal MRI showing a calcified T7-T8 disc compressing on the spinal cord

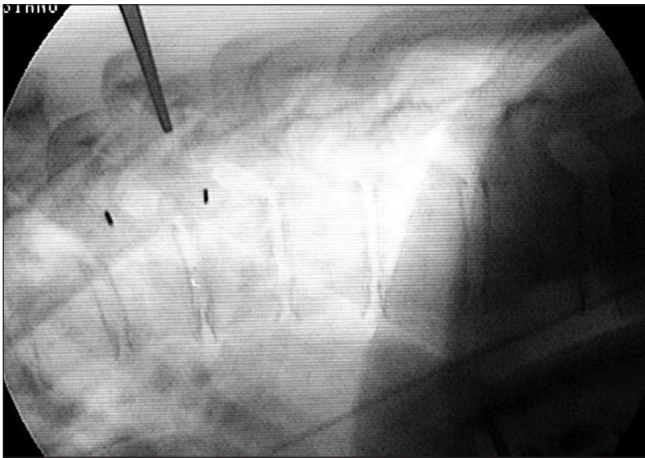


Figure 2: Intra-operative X-ray image showing fiducial marker at T7 and T8 pedicle.



Figure 3: T2-weighted sagittal MRI showing tumor involvement at the vertebral bodies of T3 and T4

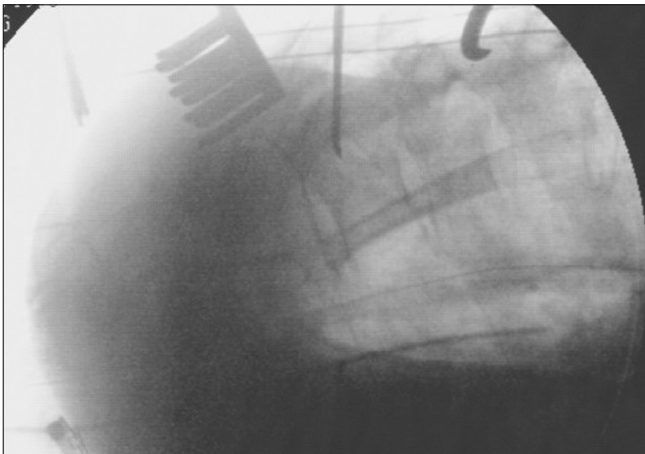


Figure 4: Intra-operative X-ray shows no obvious bony abnormality at the T3 and T4 vertebral bodies

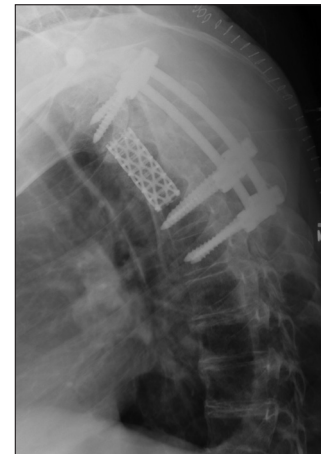


Figure 5: Postoperative X-ray to show T3 and T4 corpectomy with posterior instrumentation

of law, and it has proven that this type of mistake is not only financially costly, but it also generates disciplinary action against the surgeon from the State Licensing Board. Even though intraoperative X-ray to identify the correct level can prevent the majority of wrong-level surgery, I developed a protocol here which I believe can prevent wrong-level spine surgery.

1. Prevention of wrong-level spine surgery starts in the doctor office. Make sure the patient is scheduled and consented for the correct side and correct level(s). It is the ultimate responsibility of the surgeon to make sure his/her office staff schedule the surgery correctly.
2. Pre-operative imaging studies to identify the intended level(s) of surgery, and also to identify any congenital abnormality in anatomy.
3. For those places that still use viewing boxes in the operating room (OR), it is the responsibility of the surgeon to ensure the proper placement of X-rays and scans on the viewing boxes. It is too easy for an OR

staff with not much knowledge in spine imaging to put the scan left and right reversed.

4. Reliable intra-operative X-ray quality so that the level(s) of interest can clearly be counted without doubt.
5. When difficulty in counting the levels is anticipated, request fiducial markers be placed by interventional radiologist before the surgery (e.g., Case 1).
6. When encountering difficulty in counting the correct levels during surgery, ask for assistance from the radiologist (e.g., Case 2).
7. Intra-operative X-ray to confirm the intended levels of surgery is performed. When instrumentation is used, postoperative X-ray to verify proper placement of instrumentation and the levels is recommended, preferably before the incision is closed.

Spine surgeons must realize that wrong-level spine surgery can happen in both simple and complex spine cases, therefore conscious effort must be made for every

spine surgery performed. When there is doubt about the correct level during the surgery, pause and always ask for help such as from our radiologist colleagues.

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