Four-Rod Technique for Stabilization of Lumbar Spine in a case of Spine Metastases

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ABSTRACT

Objective: The occurrence of spine metastases often indicates disseminated disease and portends a short-term prognosis in cancer patients. This study discusses the challenges in the surgical management of spinal metastases and evaluates the effectiveness of a 'Four-rod' technique in a patient with disseminated renal cell carcinoma.

Case: A 40-year-old male with renal cell carcinoma and metastases presented with severe lower back pain and instability due to extensive vertebral destruction. Despite the poor prognosis, a 'Four-rod' construct was employed to stabilize the spine. Post-surgery, the patient experienced significant pain reduction and improved mobility.

Conclusion: The 'Four-rod' technique minimized complications such as pseudoarthrosis and implant failure. It proved effective in stabilizing the spine without increasing operative time or blood loss, thereby enhancing the patient's quality of life. This study underscores the importance of addressing spinal instability in patients with metastatic disease and suggests that multiple-rod constructs may offer superior outcomes.

Keywords: Spinal metastases, renal cell carcinoma, 'Four-rod' technique, spinal stabilization, quality of life

INTRODUCTION

Spinal metastases serve as indicators of an advanced disease state, often accompanying a patient's overall compromised health condition, which in turn heightens the risk of complications. However, advancements in medicine have led to improved outcomes for patients with spinal metastases, resulting in enhanced survival rates and extended life expectancy. It's estimated that spinal metastases affect up to 70% of cancer patients, with 10-20% presenting symptomatic cases characterized by pain, neurological deficits, and a decline in quality of life (1).

Intraoperative complications encompass an increased risk of implant failure due to the poor quality of diseased bone. Surgeries aimed at enhancing the quality of life often do not significantly alter the patient's prognosis. Nevertheless, given the inherent complexities of such procedures, numerous studies have been conducted to improve outcomes. Among the factors under scrutiny is the number of rods used to stabilize the spine, with the conventional two-rod construct frequently compared to a multiple-rod construct (2). In this context, we present a case of spine metastases treated with a rare 'Four-rod' technique, necessitated by the patient's involvement of multiple contiguous vertebral levels and poor bone quality.

The current algorithm for treating spinal metastasis is based on the NOMS (Neurologic, Oncologic, Mechanical, Systemic) framework (5). The neurologic component of this framework includes the evaluation of the grade of epidural spinal cord compression (ESCC) on MRI and neurological status of patient. Oncologic component describes the radiosensitivity of the primary tumor, mechanical component describes the mechanical stability of the spinal column, as evaluated by the spinal instability neoplastic score (SINS). Lastly the systemic component attempts to evaluate the general health of the patient, i.e., the ability to tolerate surgery. Spinal surgery is predominantly palliative and often aims to improve quality of life (1). This is often achieved by preserving the ambulatory status and controlling pain resulting from spinal instability (3). There are a plethora of surgical options ranging from vertebroplasty, decompression surgery alone, and hybrid therapy, where separation surgery is combined with Stereotactic Radiosurgery (4).
The presence of osteolytic lesions in the vertebral column frequently leads to compromised spinal stability, as evidenced in our case (3). Our patient exhibited destruction across three vertebral levels, resulting in severe pain attributable to instability. We present a rare case in which a ‘Four-rod technique’ was employed to stabilize an osteolytic and unstable spine affected by disseminated renal cell carcinoma.

CASE

A forty-year-old male presented to us with lower back pain associated with bilateral lower limb after a history of trivial trauma. He was bed-ridden post trauma due to the severe back pain. The patient was also a known case of left renal cell carcinoma with metastases to the liver and had a left nephrectomy done one month prior to the onset of back pain. Clinically the neurology of the patient was intact with no myelopathic signs. An antero-posterior plain radiograph (Figure 1) clearly showed bony destruction in the left L4 pedicle as the winking owl sign. The lateral plain radiograph showed a compression fracture of the L3 with osteolytic bone quality, suggesting metastatic malignant tumor of the spine (Figure 2). We then proceeded with an MRI of the whole spine that revealed bony metastasis involving L3 body and left pedicle, body of L1 and L2 with compression fracture of L3 and soft tissue component with no fat demarcation with the adjacent left psoas muscle. The soft tissue component was also seen to infiltrate the spinal canal with an extra-dural extension (Figure 3).

Figure 1: Plain AP radiographs with ‘winking-owl’ sign of the L3

Figure 2: Plain lateral radiographs showing compression fracture of L3 with osteolytic bone quality

Figure 3: MRI showing bony metastases involving L1-L3 with a soft tissue component infiltrating left psoas muscle and extending into spinal canal

We proceeded with lumbar spine reconstructive surgery employing a ‘Four-rod’ construct in conjunction with twelve pedicle screws. The patient was positioned prone, and a standard midline approach to the posterior spine was undertaken. Initially, laminectomy of L1-L3 was conducted, followed by separation surgery aimed at removing metastatic tumor tissue circumferentially to alleviate compression around the spinal cord. After ensuring hemostasis, we proceeded with the insertion of pedicle screws at the upper segment, encompassing bilateral T10-T12, and the lower segment, spanning L4-S1. Subsequently, the two inner rods were inserted through all pedicle screw heads and secured. The next step involved connecting the two outer rods with the inner rods using a connector at levels T11 and L4. Finally, the two inner rods were linked with a transverse crosslink (refer to Figure 4 and 5).

Postoperatively, the patient exhibited no weakness and could ambulate with a walking frame by the second day after surgery. The Visual Analogue Score (VAS), which was 8 prior to the operation, decreased to 3 upon discharge. At the two-week follow-up, the surgical site wound was clean, and the patient was able to walk with a walking stick.

Figure 4: Intraoperative photo showing completed four-rod construct
ple rods surgery in spine metastases is type according to the vertebal levels would be at higher risk to being able to ambulate with assistance. Therefore, we proceeded to stabilize the spine in line with the NOMS framework, as spinal instability is deemed an independent factor for fixation, regardless of prognosis (6).

In this case, the primary challenge stemmed from the extensive destruction of the vertebral column across multiple levels. This, combined with the osteolytic nature of the bone, led to severe destabilization of the spine (7). Therefore, we opted to utilize a four-rod construct to reinforce the spine, aiming for a more robust framework until bony fusion is achieved, thus mitigating potential complications.

Surgical complications are common in cases of spinal metastases with an incidence rate of 21.7%, according to Lau et al. in a study involving 106 cases of patients undergoing spinal reconstructive surgery for metastatic tumors (8). The same study says that patients over 40 and with lesions in three or more contiguous vertebral levels would be at higher risk for complication (8). In our case, the patient was 40 years old and presented with involvement spanning three levels from L1 to L3. Amongst the complications often quoted in literature is rod fracture and pseudoarthrosis. Rabinovich et al. reported a higher rate of rod fracture (21%) in patients who received two rod constructs as opposed to those with multiple rod constructs (5.8%) (9). It was shown that instances of rod breakage were extremely rare in cases where multiple rods were used. The same study also mentions that the incidence of pseudoarthrosis is lower when multiple rod construct is used due to its increased strength (9). According to Jian et al., the multiple-rod group exhibited a lower risk of revision surgery (10). Multiple rod constructs were often thought to increase operative time and blood loss, however Yamato et al. found no significant difference in volume of blood loss and operating time (11). As this patient had a compression fracture, there was a need to reconstruct the sagittal spinal alignment correctly. However, Jian et al. reported no significant difference in terms of radiographic parameters between patients in both the multiple-rod and two-rod constructs (10).

Lastly, the main indication for surgery in spine metastases is often relieving debilitating symptoms as well as improving quality of life. Bourghli et al. reported that the Oswestry Disability Index (ODI) is lower in multiple-rod construct group at 6 months and two years post-op (12). The implementation of the Four-rod concept ensured a remarkably strong stability, leading to a dramatic improvement in the patient’s quality of life. As a result, the patient experienced significant mobility enhancement, transitioning from a bedridden state to being able to ambulate with assistance. Hence, we can emphasize that multiple-rod constructs could enhance life quality better than those with two-rod constructs.

CONCLUSION

Spine reconstructive surgery in cases of metastatic tumors presents significant challenges, particularly due to potential complications. The Four-rod construct emerges as an effective solution for addressing spinal instability in cases involving metastases across multiple contiguous levels and exhibiting poor bone quality. Notably, it has been shown to enhance quality of life, diminish the risk of implant-related failure, and does not result in increased operating time or blood loss volume.

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Ethical approval: The present study was conducted in strict accordance with the principles outlined in the Declaration of Helsinki. Informed consent was obtained from the participant of this study.

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