Spine Tips & Tricks: Increasing Sacropelvic Fixation with the "Four Rods" Technique in Parkinson's-Related Camptocormia

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Introduction

Operative care of significant spinal deformity and instability frequently requires pelvic instrumentation in order to maintain the desired correction. However, spinopelvic constructs are exposed to substantial cantilever forces at the base of the spine that are at a higher risk of failure if the surgeon does not account for these additional stresses. Several methods have been used to overcome this obstacle, each with their own advantages and disadvantages. Here we describe a case report demonstrating the use of the "four rods" technique of spinopelvic instrumented fusion[1] in a patient with Parkinson's-related camptocormia with painful spinal sagittal imbalance. This method allowed for spinal fixation that not only decreased the patient's painful symptoms but also facilitated early upright ambulation while minimizing the risk of construct failure.

Case Report

The patient is a 57 year old male with a history of nonoperatively treated adolescent idiopathy scoliosis and Parkinson's disease well-controlled with pharmacologic therapy who presented to clinic complaining of lower back pain and stiffness as well as bilateral radicular pain radiating to the buttock (right side worse than left) with worsening symptoms in the past year. Prior nonoperative therapies, including physical therapy, optimization of his Parkinson's medication regimen, and spinal facet injections, were ineffective in relieving his pain. On examination, the patient had no evidence of lower extremity myelopathy with no pathologic

Figure 1. Preoperative radiographs (AP and lateral) demonstrating significant deformity.

reflexes and had a negative straight leg raise bilaterally. He had clinically evidence of scoliosis with decrease in interval between the ribs and pelvis on the right to 5 cm, a shoulder imbalance with the right slightly inferior, and a loss of lumbar lordosis when viewed from the side. He was also found to have camptocormia (from the Greek for "bent trunk"), a condition defined by extreme forward flexion of the thoracolumbar spine that may worsen during walking or standing but completely disappears when the patient lays supine. Originally described as a psychogenic disorder in soldiers returning from World War I[2], it has more recently been associated with Parkinsonism and other movement disorders.[3] Preoperative imaging demonstrated a 17° right sided thoracic curve from T5-T11 and a 25° left sided lumbar curve from T11-L5 with moderate-to-severe neuroforaminal narrowing at the L2/L3 level. Therefore, after a long discussion with the patient, a plan was made to proceed with surgical intervention involving instrumented posterior spinal fusion from T3 to pelvis with Smith-Peterson osteotomies at T12/L1, L1/L2, L2/L3, and L3/L4 in order to correct the sagittal imbalance. Given the length of the construct and the low level of the osteotomies, spinopelvic fusion the "four rods" technique was deemed appropriate and necessary.

For the procedure, the patient placed under general anesthesia. Neuromonitoring leads were placed for intraoperative evaluation at which point the patient was arranged prone on an open top radiolucent table with a "break" in the center to allow for manipulation of the curvature during surgery. The patient was prepped and sterilely drapped in the typical fashion. On the approach, significant hemorrhage well-controlled with Floseal was noted. Although the patient was given tranexamic acid prior to incision, this bleeding was believed to be due to the patient's neuromuscular disorder leading to lack of vasoconstriction of the vasculature. Once hemostasis was achieved, the "four rods" technique was implemented. Polyaxial lumbosacral pedicle screws were inserted bilaterally at the L1, L2, L3, L4, L5, and S1 level after which four pelvic screws including bilateral anatomic pelvic and S2/iliac screws were placed. Screw fixation was then extended up to the T3 level with transverse process hooks at the T3

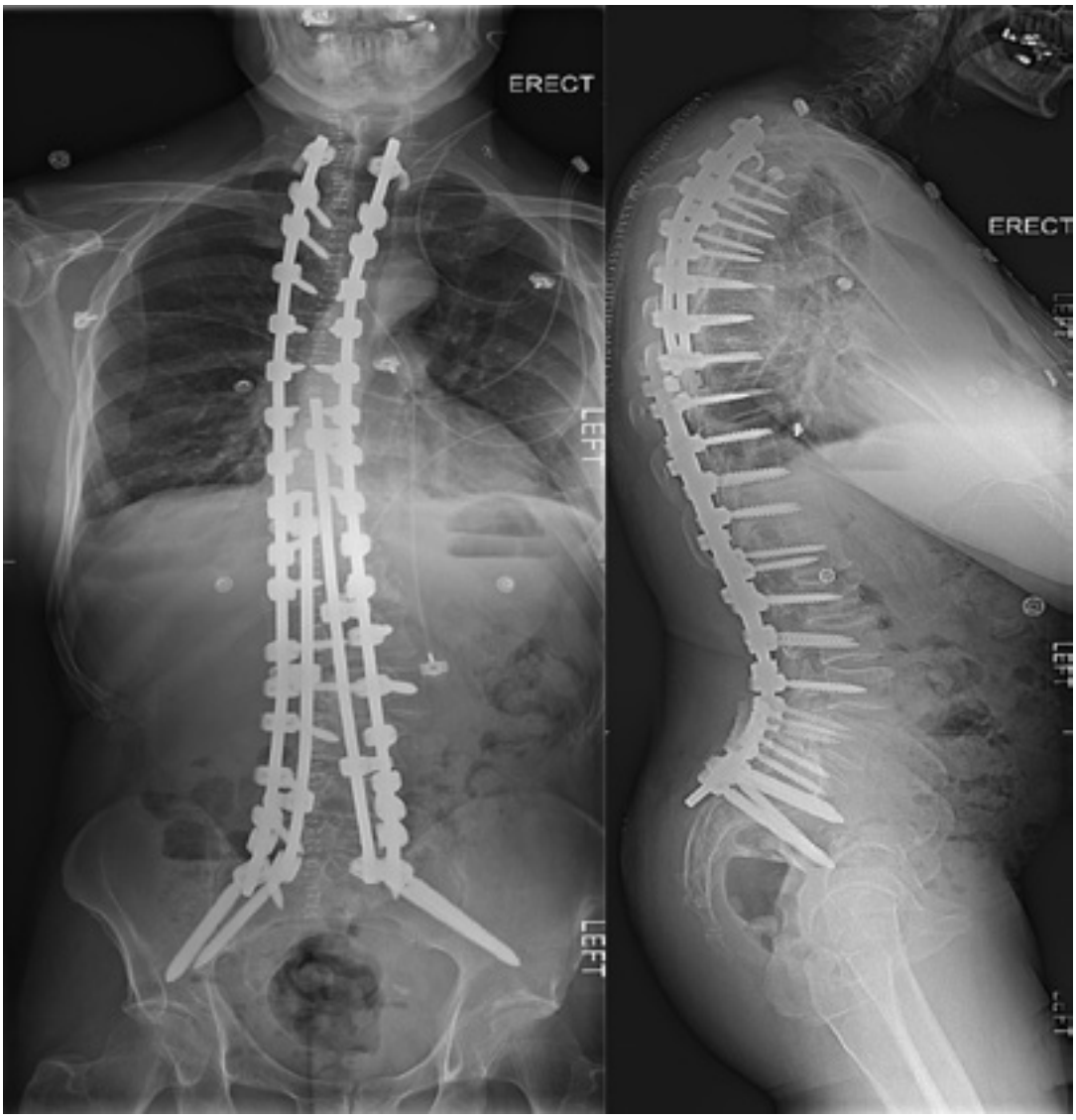

Figure 2. Postoperative radiographs (AP and lateral) demonstrating the "four rods" technique of spinopelvic fusion.

level for additional support. All screws were then individually checked under fluoroscopy and with motor evoked potentials (MEPs) to ensure they were fully contained within the pedicles and avoiding nerve root injury. At this point Smith-Peterson osteotomies were performed at the T12/L1, L1/L2, L2/L3, and L3/L4 levels to afford -20° of lordosis. Rods were then measured and bent to maintain the corrected sagittal balance. Bilateral single rods were placed from the T3 to pelvis levels with additional bilateral rods crossing the lumbopelvic junction from T11 to pelvis on the right and T9 to pelvis on the left. The correction was again checked under fluoroscopy and the wound was irrigated. Posterolateral fusion was performed from T3 to sacrum with local bone graft, cancellous allograft, and bone morphogenetic protein (BMP). A layered closure was then performed over a drain. Blood loss was estimated to be 2500 mL, and the patient received 750 mL albumin, 4000 mL of crystalloid, 6 units of Cell Saver, 2 units of RBCs, 1 unit of FFP, and 1 unit of platelets. Postoperatively he was placed on a phenylephrine drip for blood pressure support which was discontinued due to reflexive bradycardia. He required a further 2 units of RBCs on postoperative day 1 with midodrine to continued hypotension which responded appropriately; midodrine was discontinued. The patient was made weightbearing as tolerated and progressed well with physical therapy but given his baseline Parkinson's disease was recommended for placement in an acute rehabilitation facility to which he was discharged on postoperative day 5.

Discussion

Spinopelvic fixation is often necessary for complete correction of significant sagittal alignment deformities, especially long fusions extending to the sacrum or those requiring corrective osteotomies.[4] However, this coincides with the area defined by McCord et al[5] as the lumbosacral pivot point, identified on sagittal radiographs as the posterior superior corner of the S1 vertebra. As such, enormous cyclical dynamic forces are exerted at this interval as patients attempt to stand upright and walk postoperative. This frequently leads to construct failure, pseudarthrosis, and continued painful symptoms and as such demands supplemental rigid support. Several options have historically been described for lumbosacral and spinopelvic fixation include sacral sublaminar devices, S1 and S1 pedicle screws, sacral alar screws, iliosacral screws, Jackson intrasacral rod technique[6], Galveston iliac fixation[7], and iliac screw fixation.[4] However, while these methods have shown success in the past, many require extensive dissection laterally leading to an increase in potential space and the possibility of hematoma formation in order to properly achieve the desired effect.

The "four rods" technique described originally by Shen et al is a variation on iliac screw fixation that does not require further dissection beyond that of a typical posterior approach to the spine and sacrum.[1] As the name indicates, four rods are placed across the lumbopelvic junction in order to maximize the strength of the construct. The rods are designated as either "medial" or "lateral" and are supported by polyaxial screws in the lumbar spine and pelvis. In order to create the required channels to allow for four parallel rods in the constrained space of the posterior spine the lumbar screws are placed in alternating Roy-Camille "straight ahead" or Magerl "lateral-to-medial converging" orientations. This positions the screw heads either more medial or more lateral, respectively, and allows for rods to be place parallel without significantly increased the profile of the construct. In addition, four total pelvic screws (2 into each iliac wing) are placed in a Galveston-like orientation, aiming toward the anterior inferior iliac spine, although in the case currently described an S2/iliac screw was used given the anatomy of the patient. Rods are then bent accordingly and locked into the polyaxial screws to achieve the desired spinal curvature.

There are disadvantages to the "four rods" technique. In order to disperse the forces across the construct and avoid screw pullout the supplement rods typically are extended from the pelvis proximally to at least the L2 level, which may be more cephalad than other techniques. However, crosslinking the rods to the ipsilateral and/or contralateral rods can reduce this risk and potentially decrease rod length. In addition, construct prominence may be an issue unless the screws (particularly those in the pelvis) are properly recessed to avoid symptomatic hardware.

Overall, the "four rods" technique represents a relatively accessible method of increasing distal construct stability when extending fixation across the lumbosacral junction and allows for early independent motion, thereby decreasing the risk of postoperative morbidity typically associated with such procedures. Given the relative ease of conceptualizing the design as well as the incorporation of common operative techniques in spinal surgery, the "four rods" method should find more widespread use in cases involving spinopelvic fixation.

References

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