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Growing rod technique for the treatment of the traumatic spino-pelvic dissociation; a technical trick

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Running head: Growing rod technique for spino-pelvic dissociation

CONFLICTS OF INTEREST The authors declare that they have no conflicts of interest to disclose.

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ABSTRACT

BACKGROUND CONTEXT: Traumatic spino-pelvic dissociation, sometimes referred to as U-shaped sacral fracture, is a very rare high-energy trauma. The surgical management of

spino-pelvic dissociation includes decompression, reduction, and fixation.

PURPOSE: We report a novel surgical technique for the treatment of spino-pelvic dissociation that uses growing rods and a pedicle screw system,which is often used to treat patients with early onset scoliosis.

STUDY DESIGN: Technical report of spino-pelvic dissociation surgery using spino-pelvic fixation and the growing rod technique.

PATIENT SAMPLE: 1 case.

OUTCOME MEASURE: Radiographic outcomes, including plain X-ray, three-dimensional (3D) computed tomography (CT) and magnetic resonance imaging (MRI) scan.

METHODS: This study was not supported by any financial sources. There are no conflicts of interest to disclose related to this study. The radiographic outcomes were compared preoperatively, postoperatively, and at the 1-year follow-up with bony union.

RESULTS: Growing techniques improved traumatic sacral angulation, displacement, and canal encroachment and provided sufficient structural support.

CONCLUSIONS: The growing rod technique for spino-pelvic dissociation under intraoperative neurophysiologic monitoring could be a useful alternative surgical option, especially in patients without neurologic deficit.

Keyword: growing rod, spino-pelvic dissociation, sacrum

Introduction

Traumatic spino-pelvic dissociation, sometimes referred to as U-shaped sacral fracture, is a very rare high-energy trauma.[1] The sacrum is the mechanical nucleus of the axial skeleton,

and it serves as the base for the spinal column and the keystone for the pelvic ring.[1] Surgical management of spino-pelvic dissociation includes decompression, reduction, and fixation.[2,3] We report a novel surgical technique for the treatment of spino-pelvic dissociation that uses growing rods and a pedicle screw system. This system is often used to treat patients with early onset scoliosis.[4,5]

Case presentation (Figure 1)

A 28-year-old woman was injured by a fall from height (10 m) that occurred because she was hallucinating under the influence of anti-psychotic medication. She sustained hemothorax accompanied by flail chests, lung contusion, and hemoperitoneum due to spleen and liver rupture. She underwent emergency operation for hemoperitoneum and received a chest tube to treat the hemothorax. She stayed in the surgical intensive care unit and underwent spino-pelvic surgery at 13-days post-trauma, as soon as her vital signs had stabilized. Fortunately, her motor and sensory function below the sacral fracture level was intact. The preoperative computed tomography(CT) scan showed no evidence of intraforaminal bone fragments, which could injure the nerve roots during fracture reduction.[1] Therefore, a growing rod system was selected for fracture reduction and fixation. [6]

Surgical Technique

After general endotracheal anesthesia, the patient was placed prone on a table (Jackson Spinal Table System, Osi, Union City, CA, USA), and all pressure points were carefully padded. The whole back and upper buttocks were prepared and draped in the usual sterile orthopedic manner.

During preoperative planning, (Figure 2) the insertion level of the proximal pedicle screws was determined on the preoperative lateral plain radiographs, giving consideration to the distal rod bending and minimal length of the growing rods (Growing rods system, GSS Medical, Seoul, Korea), preferably at the level of the thoraco-lumbar junction area. The fracture site demonstrated skin tenting with fluctuation from a mixture of hematoma formation and possible CSF leakage.

A skin incision was made over both iliac screw entry points bilaterally and the posterior midline of the designated proximal lumbar vertebrae level longitudinally.(Figure 2) The proximal pedicle screws were inserted with a free hand technique or under guidance of the C-arm. Then, the iliac screws were inserted under guidance of the C-arm from the posterior superior iliac crest to maximize the fixation force due to the larger screw diameter and longest screw length. We prefer the 8.5 mm diameter and 90 or 95 mm length of the iliac screws, the tips of which should be located within 1 cm of the sciatic notch, based on our experience of iliac screw insertion in patients with neuromuscular scoliosis and the poorest bone quality. Then, the sub-muscular growing rods were inserted and assembled. (Figure 2)

Under lateral guidance of the C-arm, bilateral simultaneous distraction of the growing rods was performed by the operator and first assistant surgeon. After adequate distraction and reduction of the proximal sacral fragments were confirmed, the growing rods were locked in position. The motor evoked potentials (MEP) monitor was checked before and after reduction. (Figure 3)

Postoperative care

Postoperative motor and sensory function remained intact. The patient was encouraged to sit up at 45 degrees from postoperative day 3 and to ambulate with walking aids at 6 weeks after

surgical treatment due to a co-existing pelvic ring fracture. Hardware removal occurred at postoperative year 1, after bony union was confirmed. (Figure 4) There were no degenerative changes in the involved intervertebral discs at postoperative year 1, compared with preoperative MRI scans. (Figure 5)

Discussion

The usefulness of spino-pelvic fixation for a transverse sacral fracture has been reported previously. [3,7-9] Our technique differs from that fixation technique because ours employs a powerful reduction force by the saw-tooth geared growing rods for the displaced and angulated sacral fragment. Thus, the mean distraction force of the growing rod system is higher and more controllable than that of manual distraction, which uses hand grip power. The hand grip power of men in their thirties (the age of most orthopedic residents or fellows) is 47±9.7 kg [10], which equates to approximately 460 N. In the patient who received growing rods, those distraction forces were probably much higher, over 500 N,[11] and would have been sustained by locking the saw-toothed gear. Considering that our case had a body weight of approximately 50 kg, the distraction force was strong enough to lengthen and support the trunk.

This surgical technique using growing rods for spino-pelvic dissociation has several merits.

First, the technique helps to reduce the displaced and angulated proximal sacral fragment and to recover the normal spino-pelvic relation biomechanically. Reduction could be attained by tightening the anterior longitudinal ligament, which extends to the S2 body and reduces the

sagittal rotation of the proximal sacral fragment. The reduction mechanism of the growing rods system also reverses the gravity and unopposed force of the psoas muscle, which increases the rotation and kyphotic deformity of the upper sacral fragment relative to the pelvis.[1] As noted above, the proximal pedicle screw insertion point is around the L1 level, which is above the origin of the psoas muscles; therefore, this technique also satisfies the reduction principle of fracture.[12] Unexpectedly, the posterior skin tenting around the fracture site improved *via* reduction of the fractured sacral posterior wall due to tightening of the posterior ilio-sacral ligament complexes during lengthening of the growing rods.

Second, this technique can easily restore spino-pelvic alignment at the time of surgical stabilization. The sagittal relationship of the lumbar spine and proximal sacral fragment to the iliac wing is hard to directly assess intraoperatively due to the lack of intact cortical bone at the sacral alar fracture planes to guide reduction.[1,3,13,14] Therefore, intraoperative assessment with a fluoroscope is necessary.[15] In our case, modulation of the entry point of the iliac screws and lordotic bending of the distal rods was helpful to realign the spine and pelvis. Also, the strong iliac screw insertion allowed for excellent rotational stability to maintain correct alignment.[16] The proximal pedicle screw insertion point is near the thoraco-lumbar junction, so lengthening of the growing rods minimally affects lumbar lordosis because the sacral fracture site is the weakest structural point.

Importantly, the minimally invasive technique does not expose the fracture site, which could cause massive bleeding and CSF leakage, thereby directly increasing the risk of postoperative complications.

Finally, by using the saw-tooth geared lengthening device, surgeons can control the amount of reduction quantitatively under guidance of the C-arm.

We tried to ensure neurologic safety under MEP monitoring. In case of changes in MEP monitoring, additional neurologic exploration should be considered.

In conclusion, this novel surgical technique for spino-pelvic dissociation that uses growing rods under MEP surveillance could be a useful alternative surgical option, especially in patients without neurologic deficit.

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Figure legends

Figure 1. Comparison between pre- and postoperative X-rays

Preoperative counter-clockwise rotation and posterior angulation of the proximal sacral fragment was reduced after 3-cm lengthening of the growing rods. The bilateral L5 pedicles are visible on anterior-posterior x-rays after reduction.

Figure 2. Preoperative planning, the mechanism of the growing rod, and minimally invasive growing rod insertion technique.

With consideration for the length of the growing rod, the designated proximal screw insertion point was marked. Rotation of the saw-tooth gear enables lengthening of the growing rod. The submuscular rod insertion technique is very helpful because it avoids opening of the

fracture site, which could cause massive bleeding and possible CSF leakage from a torn dural sac. Submuscular insertion of the growing rod also leads to minimal tissue damage of the normal lumbar segments.

Figure 3. Motor evoked potentials (MEP) monitoring during growing rods lengthening procedures

There were no significant signal changes from the baseline during and after procedures.

Figure 4. CT scans at preoperative, immediate postoperative, and 1-year postoperative follow-up

Bony union was confirmed at the 1-year follow-up in the three-dimensional reconstruction. The serial sagittal scans revealed postoperative indirect decompression of the spinal canal and maintenance of the sacral slope compared with preoperative scans.

Figure 5. MRI scans at preoperative and 1-year postoperative follow-up

The serial sagittal scans demonstrated no degenerative changes in the involved intervertebral discs compared with preoperative scans.