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Technical Note

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Lumbo-sacro-pelvic Fixation Using Iliac Screws for the Complex Lumbo-sacral Fractures

Fractures of lumbo-sacral junction involving bilateral sacral wings are rare. Posterior lumbo-sacral fixation does not always provide with sufficient stability in such cases. Various augmentation techniques including divergent sacral ala screws, S2 pedicle screws and Galveston rods have been reported to improve lumbo-sacral stabilization. Galveston technique using iliac bones would be the best surgical approach especially in patients with bilateral comminuted sacral fractures. However, original Galveston surgery is technically demanding and bending rods into the appropriate alignment is time consuming. We present a patient with unstable lumbo-sacral junction fractures and comminuted U-shaped sacral fractures treated by lumbo-sacro-pelvic fixation using iliac screws and discuss about the advantages of the iliac screws over the rod system of Galveston technique.

KEY WORDS : Iliac screw · U-shped sacral fracture · Lumbo-sacro-pelvic fixation.

INTRODUCTION

Sacral fractures are common injuries in patients sustaining spinal trauma and are associated with a high rate of neurologic deficits. Denis et al.[3] classified sacral fractures as Zone I, II, and III injuries depending on the anatomic relationship of the fracture and the sacral neuroforamina and Roy-Camille et al.[9] described the pathologic anatomy of transverse sacral fractures. Nork et al.[7] further categorized the U-shaped sacral fractures that are characterized by two vertical fracture lines through the sacral foramina with a transverse fracture line separating upper and lower sacral segments.

Proposed therapeutic methods of sacral fractures include bedrest, bracing and surgical stabilization. If the sacral fractures are combined with unstable injuries in the lumbo-sacral junction, mechanical stabilization of lumbo-sacral spine is required. Neurosurgeons are familiar with posterior lumbo-sacral fixation. However, solitary fixation point in the sacrum by S1 pedicle screw has often proven to be insufficient in patients with fractures of sacrum, long neuromuscular deformity or high grade spondylolisthesis[4,8,11].

Although various augmentation techniques such as divergent sacral ala screws and S2 pedicle screws would be considered to improve lumbosacral stabilization, sacro-pelvic fixation can be an excellent alternative for patients with comminuted fractures involving sacral ala and the upper sacrum. Original Galveston surgery, as a type of sacro-pelvic fixation, is technically demanding and bending rods into the appropriate alignment is time consuming[6].

We present a patient with unstable lumbo-sacral junction fracture and U-shaped sacral fracture treated by lumbo-sacro-pelvic fixation using iliac screws with discuss about the advantages of the iliac screws over the rod system of Galveston technique.

CASE REPORT

A 26-year male worker was brought to the emergency room with severe back pain by industrial injury. He was told to be crushed by a huge steel door that he had been painting on. Physical examination exposed multiple dirty abrasive wounds on his back. Neurological examination demonstrated complete paralysis of dorsiflexion of the right ankle and toes. The anal tone and perineal sensation were grossly intact and there was no pathologic reflex. The lumbar magnetic resonance image (MRI) obtained at outside hospital showed multiple fractures on bilateral lumbo-sacral regions and huge hematomas in bilateral paravertebral

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areas (Fig. 1A). Computed tomography (CT) was performed to investigate injuries of bony structures and demonstrated multiple fractures involving multiple transverse and spinous processes of lumbar vertebrae and bilateral L5/S1 facet joints. There were also vertical fractures involving bilateral sacral ala and transverse fractures through the mid-sacrum (Fig. 1B). The bony fragment from the sacral ala was displaced anteriorly and superiorly on the right side. We considered impingement of the right L5 spinal nerve by bony fragment and huge hematoma as causes of his foot drop.

Operation

We explored the right L5 nerve through paramedian approach. Stabilization surgery for unstable lumbo-sacral fractures was postponed because he was neurologically stable except his right foot and due to multiple contaminated wounds on his back. The right paramedian incision was made at 5 cm lateral from the midline at L5-S1 levels. Large amount of fresh blood was gushed out immediately after fascial incision. Discontinuation of paravertebral muscles and fracture of L5 transverse process were noted. Both ends of completely avulsed L5 nerve were seen in the extra-foraminal zone under the surgical microscope. There was slightly movable bony fragment from the sacral ala, however, the fragment was apart from the L5 nerve. We felt that there was no way to repair the avulsed lumbar nerve. The wound was massively irrigated and closed.

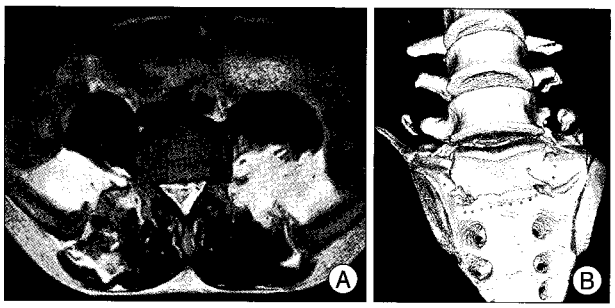

Fig. 1. Preoperative images. A : Huge retroperitoneal hematoma with high signal intensity is noted posteriorly to bilateral psoas muscles on the T2-weighted magnetic resonance image. B : Three-dimensional computed tomography reconstruction of lumbosacral vertebrae demonstrates multiple fractures of transverse processes. Gray dots indicates U-shaped comminuted sacral fractures.

The patient underwent a stabilization surgery 3 weeks later because of delayed healing of contaminated back wounds and surgical wound. Long midline incision was made from the L3 to the lower sacral level. Lumbo-sacral muscles were dissected and bilateral posterior iliac crests including posterior superior iliac spine (PSIS) were exposed. L4 and L5 pedicle screws (CD Horizon Legacy, Medtronic Sofamor Danek, TN, USA) were applied and L4 lamina and L4/5 facet joints were decorticated as fusion beds instead of fractured transverse processes. Other fracture lines were noted on the bilateral sacral ala, however, S1 pedicles were carefully tapped just beside the fracture line. Although the sacral screws were safely placed in the pedicle, the sacral body and ala were very soft and the sacral fixation did not seem to be solid (Fig. 2A).

Lateral dissection was further performed to reach the medial aspect of the iliac wing at its very distal aspect for the purchase of the iliac screw. The postero-lateral aspect of the iliac wing was partly exposed to help with the trajectory of the pathway down the iliac bone. The starting point for the screw located 1 cm inferior to the PSIS was rongeured off to the depth of about 1.5 cm to make a pit for the screw head (Fig. 2B). Then, using the iliac probe with the tip facing medial and the trajectory being 45° caudal and 35° lateral as measured on preoperative CT scan, the probe was tunneled down an intraosseous pathway into the distal ilium. The target point of the screw was just cephalad to the superior gluteal notch, the thickest part of the ilium. 70 mm-length, 20°-angled self-tapping screw (CD Horizon Legacy, Medtronic Sofamor Danek, TN, USA) was advanced through the trajectory under the fluoroscopic guidance (Fig. 2C). The screw head

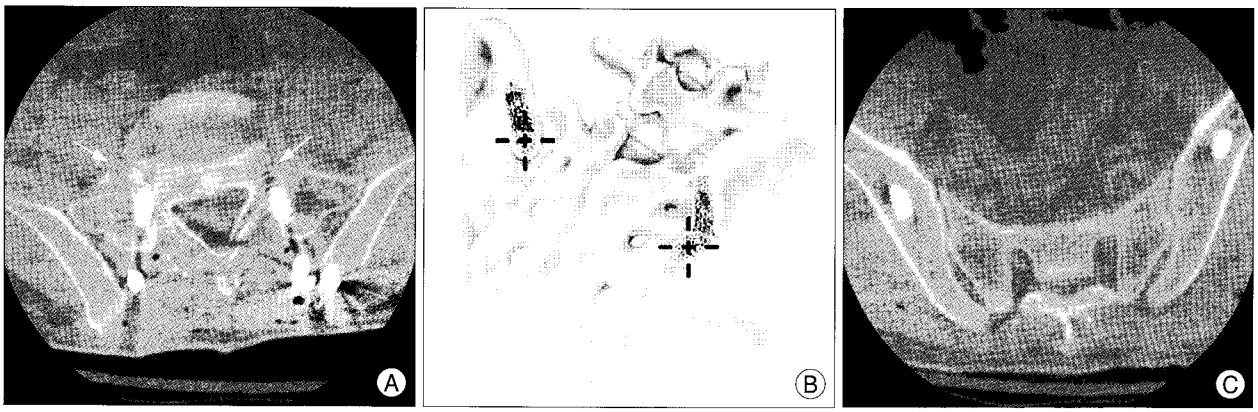

Fig. 2. Postoperative computed tomography. A : Postoperative computed tomography shows bilateral sacral ala fractures (arrows) and appropriately placed sacral screws. B : Illustration showing starting points for the iliac screw (From Medtronic : Iliac fixation surgical technique). C : Postoperative computed tomography showing tips of iliac screws located in the bilateral iliac bones.

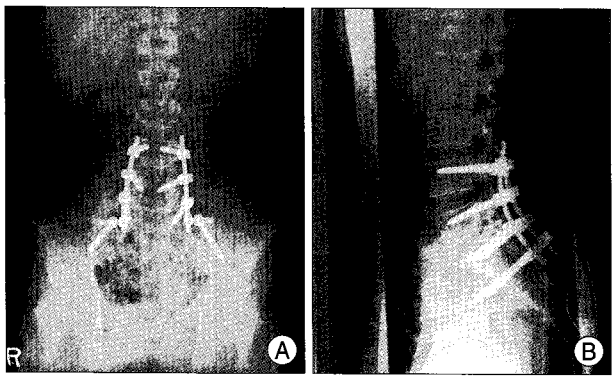

Fig. 3. Postoperative plain radiograph. A : Anteroposterior radiograph B : lateral radiograph showing final appearances of instrumentation.

was positioned in the pit and facing directly medial to allow the lateral connector to engage and thus keep the rod vertical in its orientation. First, lateral connector was engaged on vertical rod and the whole rod complex was applied on the lumbo-sacral screws. Finally, lateral conncetor was connected to the iliac screw (Fig. 3). The postoperative course was uneventful. The patient was able to sit after removal of hemovac from the wound on the postoperative day 3 and was referred to the rehabilitation programs.

DISCUSSION

Sacral fractures are relatively common injury but the U-shaped sacral fractures are rare[7]. If the fractures are isolated in the sacrum and the patient is neurologically stable, conservative treatment could be recommended. However, stabilization surgery is required if the sacral fractures are combined with unstable lumbo-sacral fractures. In such a case, U-shaped sacral fractures make the solid fixation very difficult.

The posterior lumbosacral fixation is easy to neurosurgeons. However, solitary fixation by S1 pedicle screw has often proven to be insufficient for patients with comminuted sacral fractures like the U-shaped fractures[4,8,11]. For such cases, various augmentation techniques to protect sacral pedicle screws have been reported. These techniques include divergent sacral ala screws[5], S2 pedicle screws[1], foraminal hooks[10] and Galveston technique[2]. Leong et al.[5] have shown that two divergent sacral screws improve compression, tension, and torsion stiffness by 20-26% over single sacral screw. The divergent screw fixation or S2 pedicle screw was not suitable for our patient with bilateral ala fractures. Therefore, we thought that the sacro-pelvic fixation would be an excellent approach.

The Galveston technique was originally described for cases of pelvic obliquity associated with neuromuscular scoliosis and use of ilium for distal fixation[2]. This technique was technically demanding and bending rods into the appropriate alignment was time consuming[6,11]. This necessitates accurate operative planning to determine the angle to which the rods must be shaped and the length of rod required.

Iliac screws have advantages that the screws are relatively easy and rapid to insert. According to Peelle's analysis, iliac screws are equivalent to the Galveston rod technique for pelvic fixation in neuromuscular scoliosis correction[8]. As they are connected to the rods, via modular connectors, minimal rod bending is required and this allows for a low-profile construct. Also, the iliac screws provide an improved pelvic purchase in comparison to the smooth Galveston rods and has reduced intra-operative blood loss and operative time[6]. There are frequent loosening signs on postoperative radiograph evaluation, However, the finding did not correlate with ultimate screw failure or pseudarthrosis. Ninety-five percent of patients with sacropelvic fixation using iliac screws coupled with S1 screws had excellent distal fixation and fusion rate[4].

The entry point of iliac screw at posterior superior iliac spine should be rongered off as much as the mass of the screw head to avoid screw prominence that makes a patient discomfort while sitting on chairs. Screw prominence is one of main causes of iliac screw removal[4,11].

Accurate screw placement depends on carefully preoperative evaluation about radiographic appearance of sacrum and ilium. Axial sections of computed tomography helps to define the orientation and thickness of the ilium. Vertical angle of the screw direction is intraoperatively determined under the fluoroscopic guidance. However, it is better to evaluate the lateral angle preoperatively on CT scan. According to our experience, it is safe to have initially iliac probe face medially until it touches the inner table of iliac cortex at the sacroiliac joint and then rotate the probe facing laterally to avoid damage to SI joint. The screw should be inserted to the maximum possible depth and be entirely intraosseous throughout their length.

Regarding the iliac crest bone graft harvesting, we placed the iliac screws before harvesting the bone graft. It is recommended to stay at least 1 cm from the trajectory of the iliac screw at all times while harvesting the crest and previous iliac crest harvesting does not necessarily prevent ipsilateral screw placement[4].

CONCLUSION

Sacro-pelvic fixation using iliac screws has been shown to improve biomechanical strength and seems to provide acceptable clinical result. Further follow-up studies on sacroiliac joint problems and long-term clinical outcomes will be recommended.

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