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LUMBOPELVIC FIXATION AND SACRAL DECOMPRESSION FOR A U-SHAPED SACRAL FRACTURE

Case report

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ABSTRACT - *Background:* U-shaped sacral fractures are highly unstable, can cause significant neurological deficits, lead to progressive deformity and chronic pain if not treated appropriately. *Objective:* To report a case of a U-shaped sacral fracture treated with lumbopelvic fixation and decompression of sacral roots in a 23-years-old man. *Method:* Decompression of the sacral roots combined with internal reduction and lumbopelvic fixation using iliac screws. *Results:* Restitution of lumbosacropelvic stability and recovery of sphincter function. *Conclusion:* Lumbopelvic fixation is effective in restoring lumbosacralpelvic stability and allows full mobilization in the postoperative period. Good neurological recovery can be expected in the absence of discontinuity of the sacral roots.

KEY WORDS: u-shaped, sacral fracture, lumbopelvic fixation, sacral roots.

Fixação lombopélvica e descompressão sacral para fratura em U do sacro: relato de caso

RESUMO - *Introdução:* As fraturas sacrais em U são instáveis e podem causar significativa lesão neurológica, deformidade progressiva e dor crônica se não tratadas apropriadamente. *Objetivo:* Relatar caso de um homem de 23 anos com fratura em U do sacro tratada com fixação lombopélvica e descompressão das raízes sacrais. *Método:* Descompressão da cauda equina associada a redução interna e fixação lombopélvica usando parafusos ilíacos. *Resultados:* Reconstituição da estabilidade lombosacropélvica e recuperação da continência esfincteriana *Conclusão:* A fixação lombopélvica é eficaz em restaurar a estabilidade lombo-sacro-pélvica e permite mobilização imediata no pós-operatório. Recuperação neurológica pode ser esperada na ausência de neurotmese das raízes sacrais.

PALAVRAS-CHAVE: fratura em U do sacro, fixação lombopélvica, raízes sacrais.

Sacral fractures have been classified by Denis[1] into three types (Fig 1A), depending on the sacral zone involved. U-shaped sacral fractures[2] result from bilateral longitudinal sacral fractures associated with a transverse component (Fig 1B). Roy-Camille classified U-shaped fractures into three subtypes, based on the mechanism and degree of displacement[2] (Fig 1C). These fractures are usually caused by falls, suicidal jumps, crushing injuries or motor vehicle accidents[1-5]. In the setting of a U-shaped sacral fracture, the longitudinal components disconnect the central sacrum from the alae and sacroiliac joints while the transverse component disconnects the upper sacrum from the lower sacral segments (Fig 1, B and C). The end result is spinopelvic dissociation, where the rostral sacral segments remain attached to the lumbar spine while the caudal sacral segments remain connected to the pelvis[5]. They are highly unstable, have a high incidence of neurological injuries and lead to progressive deformity and chronic pain if not treated properly[1,2,6]. Lumbosacral joint injuries are common whenever there is a vertical shear component along zone II, and their presence can add further instability to the lumbosacropelvic junction[7,8].

Transiliac plates or rods, lumbopelvic bars or plates, trans-iliac-sacral-iliac bars and percutaneous iliosacral screws have been used in the treatment of vertically unstable and U-shaped sacral fractures[2,4,9-12]. The technique of triangular osteosynthesis with lumbopelvic fixation has been described more recently for high-

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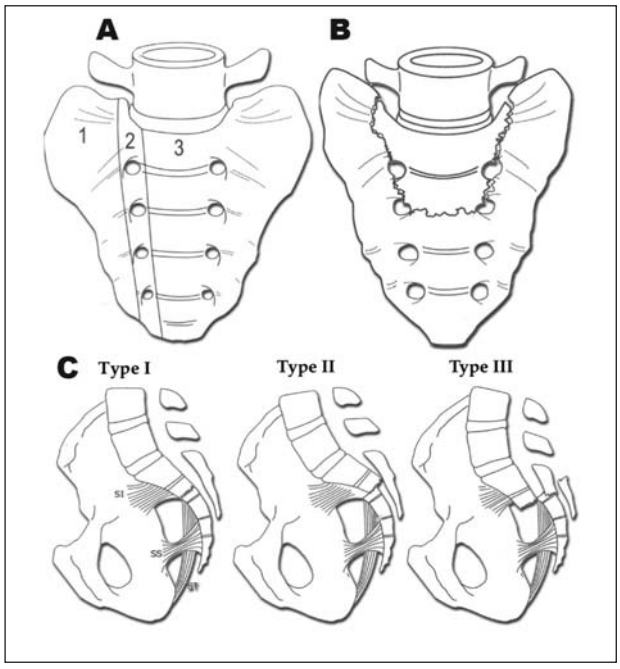

Fig 1. Schematic drawings of the sacrum. (A) The three sacral zones according to Denis' classification. Zone I: the fracture is lateral to the foramina. Zone II: the fracture goes through the foramina. Zone III: the fracture goes through the central canal. (B) A typical U-shaped sacral fracture with bilateral longitudinal components coursing through zone II and the transverse component along zone III. (C) Roy Camille's classification of U-shaped fractures. Type I: minimal or no displacement. Type II: Displaced in flexion. Type III: Displaced in extension; upper segments anterior to lower sacral segments.

Fig 2. Preoperative images. (A) Plain X-ray showing rotation at the lumbosacral junction with fractured right L5 pedicle and bilateral zone II sacral fractures. (B) Coronal reformats showing fractures of the right L5 pedicle and upper sacral segments disconnecting the central sacrum form the sacral alae. (C) Axial CT scan showing fractured right L5 pedicle and right L5-S1 joint widening. (D) Axial CT scan showing bilateral zone II fractures, displacement of the rostral segments and stenosis of the central canal and foraminae. (E) CT scan sagital reformation demonstrating displaced upper segments posteriorly, in flexion.

grade (Roy-Camille subtypes II or III) fractures and allows immediate mobilization and full weight bearing[5,13,14].

We present a case of a patient with a Roy-Camille type II U-shaped sacral fracture combined with a L5-S1 unilateral facet dislocation that was treated with sacral decompression plus bilateral lumbopelvic stabilization using long iliac screws. His outcome was excellent, with recovery of sphincter function, no chronic pain and a stable lumbosacral spine and pelvis on follow-up.

METHOD

Case description – A 23 year-old man was involved in a high-speed motor vehicle accident and sustained multiple trauma, including a mild head injury (Glasgow Coma Scale), severe abdominal and pulmonary injuries, bilateral ankle fractures and pelvic injuries. Neurological examination disclosed a complete right foot drop, weakness of the extensor hallucis longus and ankle plantar flexion on the right side, plus saddle anaesthesia combined with urinary retention.

Lumbosacral imaging studies showed a fracture of the right L5 pedicle and unilateral right L5-S1 dislocation (Fig 2A and C). Pelvic imaging demonstrated a symphisis pubis disruption, a Roy-Camille type II U-shaped sacral fracture with severe compression of the sacral nerve roots (Fig 2B, D and E). The vertical component on the right side extended through the lower sacral segments, making this a Y variant of a U-shaped fracture.

Surgical technique – A midline incision from L3 to S4 was made and the paraspinal musculature was subperiosteally dissected off the posterior elements of L4 through S4 and both posterior iliac crests. Under fluoroscopy guidance, screws were placed through both L4 pedicles and the left L5 pedicle. After recessing down both posterior iliac crests, entry points on the posterior superior iliac spines were made and a 5 mm cannulating probe was advanced into both iliac buttresses, under fluoroscopy, aiming towards the anterior inferior iliac spine. Two screws were placed in the right Ilium and one in the left Ilium. Two screws measured 100 mm and one measured 120 mm in length. A laminectomy from L5 through S4 was performed with full decompression of all sacral roots. All roots were found to be intact. A traumatic dural tear at the S2-S3 level was treated using 6-0 Prolene

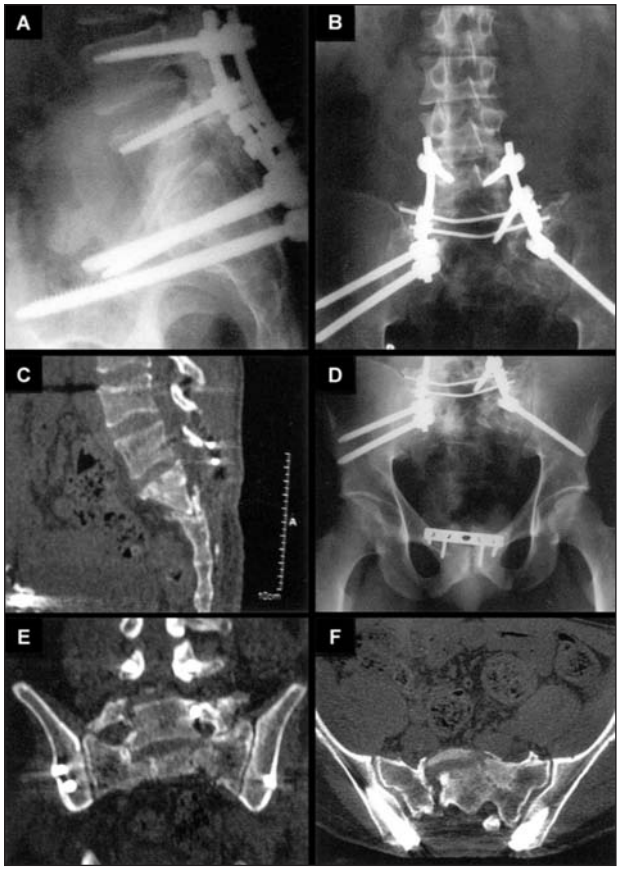

Fig 3. Postoperative images at 12 months. (A) Lateral lumbosacral images showing L4-ilium fixation, with normal sagittal alignment. (B) AP image demonstrating good coronal alignment and L4-Ilium fixation. (C) Sagittal reformations of the lumbosacral spine showing good alignment and full decompression of the central canal. (D) AP image of the pelvis showing anatomical alignment and the long iliac screws. (E) Coronal reformation showing healed upper sacral segments. Note iliac screws coursing along iliac buttresses. (F) Axial CT scan showing the decompression of the central canal and S1 foraminae and the entry point for the iliac screws.

sutures and a dural substitute (Duragen®, Integra Neurosciences, Plainsboro, NJ, USA). Distraction was applied on the right side so as to reduce the deformity. Cross-links added transverse fixation so as to provide rotational stability and prevent splaying of the posterior pelvic ring (Fig 3). Autograft was laid along the transverse processes of L4 and L5 and the sacral alae.

Results – The patient was allowed to be mobilized as tolerated without any orthosis in the immediate postoperative period. On the third postoperative day, some sensation to pinprick on the left perianal region (S2 and S3) could be detected on the neurological examination. A minor wound breakdown was treated with frequent dressing changes and healed uneventfully without a need to return to the operating room. Continuous improvement in the neurological function was seen during hospitalization and as an outpatient. At the one year follow-up visit, the patient was ambulatory with a splint on the right foot for a persistent foot drop. There was no lumbar or pelvic pain during ambulation or in the resting position. Sexual dysfunction was still present, even though the patient had bowel continence and was able to fully empty his bladder under voluntary control. No post-void residuals could be seen on the bladder ultrasound. The patient has returned to work full time.

Follow-up imaging studies at 12 months showed no evidence of loss of correction or pelvic instability, with good consolidation of the sacrum (Fig 3 A-F).

DISCUSSION

Sacral fractures can be associated with neurological injuries. Unilateral vertical shear sacral injuries may affect the L5 and S1 roots but rarely compromise bowel/bladder function unless a transverse component is present[1,12,15-17]. U-shaped sacral fractures, on the other hand, are distinct. A longitudinal injury along zone I or II on both sides plus a zone III (transverse component) fracture is the hallmark. The incidence of neurological injuries and bladder dysfunction is elevated in high-grade fractures[1,2,4,9,14-18]. Variations include severe comminuted fractures of the upper sacrum[19] or extension of one or both longitudinal component through the lower sacral segments, resulting in a Y or H variant[14]. Lumbosacral junction injuries are relatively common in the presence of a vertical shear component along zone II[8,20].

In the past, techniques for stabilization of U-shaped sacral fractures have included lumboiliac plates[2], transiliac plates[4], transiliac rods[20] and percutaneous iliosacral screws[9,10,12]. Percutaneous iliosacral screws are particularly valuable for non-displaced Roy-Camille type I injuries[9]. Absence of rigid fixation in all planes is the major drawback of these techniques and full weight bearing is not permitted postoperatively. The triangular osteosynthesis was a technique developed for the treatment of vertical shear unstable sacral fractures, and proved to be biomechanically superior to the other techniques[13,21,22]. It consists of a unilateral lumboiliac fixation combined with an iliosacral screw as the horizontal component.

The use of bilateral lumbopelvic fixation and sacral decompression evolved from the triangular osteosynthesis as an option in the treatment of high grade U-shaped sacral fractures, with excellent results[3,5,14]. The use of a cross-link or a iliosacral screw in these constructs provides horizontal stabilization[3,14,15]. In a series of 18 patients[14], improvement of neurological function was demonstrated in 83% of cases, with recovery of bowel/bladder function seen in

10 out of 18 patients and a healed sacral fracture in all patients. The presence of continuity of the sacral roots correlated directly with the chance of full neurological recovery[14].

Only fixation techniques that provide an anchor point anterior to the pivot point of the lumbosacral junction significantly increase the maximum moment at failure in flexion when crossing the sacroiliac joint[23]. The suprasciatic notch can provide a passage for long iliac screws[24], with a point of fixation well anterior to the pivot point[23,25]. These long screws protect against the flexion forces related to the long lever arm linked to the spine component in U-shaped fractures[26]. Besides, using a screw with the maximum diameter allowed provides a stronger bicortical purchase when compared to Galveston rods, which are smoother and thinner[26].

In our patient, we decided to perform a lumbopelvic fixation due to several reasons: there was a L5-S1 unilateral facet dislocation with lumbosacral instability and also spinopelvic instability due to the U-shaped sacral fracture. Severe compression of the sacral nerve roots with neurological deficits was present, and a decompression was definitely justified. Additionally, early mobilization has been shown to decrease the rate of complications in patients with pelvic ring fractures[27] and this type of construct would allow early weight bearing with full mobilization.

We used long iliac screws to overcome the long moment arm related to the spinal component of the fracture-dislocation, as described previously[14,22]. Cross-links were added to provide horizontal and rotational stability and prevent splaying of the posterior pelvic ring. An excellent result was accomplished, with return of the ability to empty the bladder spontaneously with no post-void residuals, no pain in the upright position, full consolidation of the fracture and return to work.

In conclusion, high grade U-shaped sacral fractures can be effectively treated with lumbopelvic fixation, which provides immediate restoration of lumbo-sacral-pelvic stabilization. It allows early mobilization without the need for bracing or weight bearing restrictions postoperatively, a crucial factor in polytrauma patients. Recovery of sphincter function can be expected when the sacral roots are decompressed and found to be in continuity.

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