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Complex lumbosacral fracture-dislocation with pelvic ring disruption and vertical shear sacral fracture: a case report of late presentation and review of the literature

Pelvik halka ayrılması ve vertikal sakral kırık ile birlikte kompleks lumbosakral kırık-dislokasyonu: Olgunun geç sunumu ve literatürün gözden geçirilmesi

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Combination of lumbosacral junction injury with closed vertical shear sacral fracture and disruption of the symphysis pubis is a very rare pattern of injury, particularly with a late presentation. To our knowledge, the complexity of such a lumbosacral injury with pelvic fractures, which was presented with a chronic condition, has never been addressed or identified in the previous literature. We aimed to demonstrate a case with a late presentation of a complex lumbosacral fracture-dislocation, pelvic ring disruption and a vertical shear sacral fracture with neurological deficits and to emphasize the difficulties in the management in this case and the operative technique used for the definitive treatment. The initial event had occurred three months earlier. Closed reduction by skeletal traction had failed; therefore, surgical correction was performed by means of indirect reduction via pedicle screws, iliac screws and rods system. Definitive stabilization with posterior lumbo-pelvic segmental fixation and posterolateral fusion were performed using a posterior approach. At one year after surgery, the clinical result was satisfactory with almost complete correction of a deformity and solid posterolateral fusion. The patient had partial recovery from the preoperative neurological deficit. We report herein a patient with a very unusual complex spondylopelvic injury pattern with late presentation, which required meticulous planning of management, imaging, and surgical technique before definitive treatment.

Key Words: Lumbosacral dislocation; pelvic ring disruption; spondylo-pelvic injury; traumatic spondylolisthesis; vertical shear injury.

Kapalı vertikal sakral kırık ve simfizis pubis ayrılması ile birlikte olan lumbosakral bileşke yaralanması, özellikle geç başvuran çok nadir bir yaralanma şeklidir. Bildiğimiz kadarıyla literatürde, pelvik kırıklarla birlikte olan ve kronik bir durumda başvuran böyle bir lumbosakral yaralanmanın karmaşıklığı ile ilgili hiçbir bilgi sunulmamış veya böyle bir olgu tanımlanmamıştır. Biz, nörolojik defisitlerle birlikte olan ve geç başvuran kompleks bir lumbosakral kırık-dislokasyonu, pelvik halka ayrılması ve bir vertikal sakral kırık olgusunu ortaya koymayı ve bu olgunun tedavisindeki güçlükler ile kesin tedavi için kullanılan ameliyat tekniğini vurgulamayı amaçladık. İlk olay üç ay önce olmuştu. İskelet traksiyonu ile kapalı redüksiyon başarısız olmuştu; bu nedenle, pedikül vidalar, iliyak vidalar ve çubuk (rods) sistemi yoluyla indirekt redüksiyon yöntemiyle cerrahi düzeltme gerçekleştirilmiştir. Posterior bir yaklaşımla, posterior lumbo-pelvik segmental fiksasyon ve posterolateral füzyon ile kesin stabilizasyon gerçekleştirilmiştir. Cerrahiden bir yıl sonra, neredeyse tam bir deformite düzeltmesi ve solid posterolateral füzyon ile birlikte, klinik yanıt tatmin edici olmuştur. Hasta, ameliyat öncesi nörolojik defisitten kısmen kurtulmuştur. Biz, burada, geç dönemde başvuran sıradışı ve kesin tedaviden önce titiz bir tedavi, görüntüleme ile cerrahi teknik planlaması gerektiren kompleks spondilo-pelvik yaralanma paternine sahip bir hasta bildirmekteyiz.

Anahtar Sözcükler: Lumbosakral dislokasyon; pelvik halka bozulması; spondilo-pelvik yaralanma; travmatik spondilolistezis; vertikal kayma yaralanması.

Fracture-dislocation of the fifth lumbar vertebra on the sacrum is an unusual injury. Injuries of the lumbosacral junction are always the result of high-energy trauma and are frequently associated with adjacent spinal fractures. The direction of the displacement may be anterior, posterior or lateral depending on the vector of the deforming force. The dislocation may be either unilateral or bilateral. A combined injury of the

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lumbosacral junction and the pelvic ring is a very rare situation.

We present a case study of a 26-year-old male who sustained a combination of lumbosacral fracture-dislocation and pelvic ring injury. The pelvic ring injury was a closed vertical shear sacral fracture and disruption of the symphysis pubis. Three months after the accident, the patient was referred to our institution with late combined injuries.

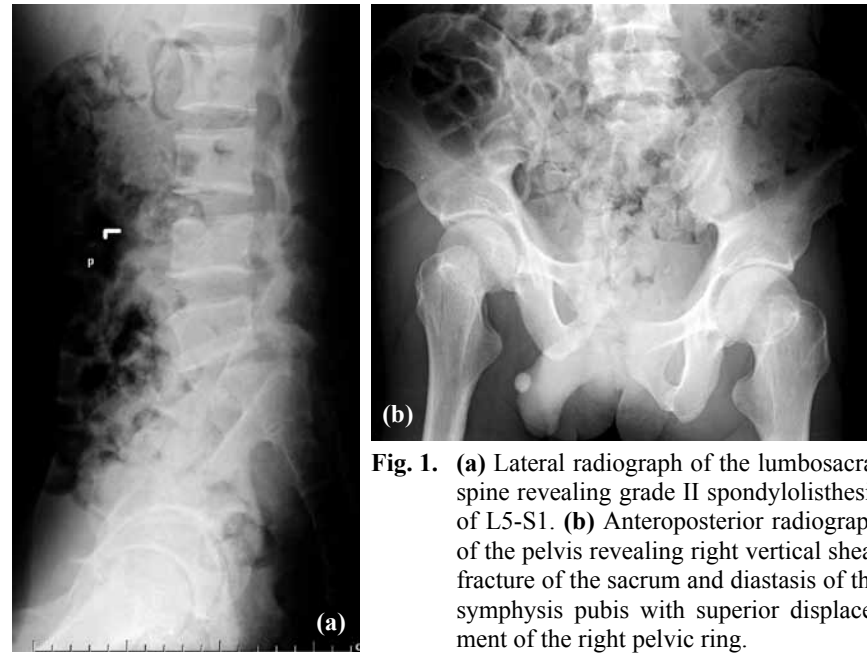

Fig. 1. **(a)** Lateral radiograph of the lumbosacral spine revealing grade II spondylolisthesis of L5-S1. **(b)** Anteroposterior radiograph of the pelvis revealing right vertical shear fracture of the sacrum and diastasis of the symphysis pubis with superior displacement of the right pelvic ring.

CASE REPORT

A 26-year-old male construction worker was crushed from behind with a loaded 3,000 kg metal bar while painting in a squatting position. He was transferred to the accident and emergency department at the local provincial hospital. On initial survey, the patient was alert, complaining of severe lower back pain, suprapubic pain and pain in both thighs. He also had weakness and numbness in both legs. The initial cervical spine and chest radiographs were unremarkable. The radiograph of the pelvis and lumbosacral spines revealed fracture-dislocation of the lumbo-sacrum with spondylolisthesis grade II of L5 on S1 and pelvic fracture on the right side. The patient was taken immediately to the emergency operating room, and he underwent a laparotomy. There was no evidence of intraperitoneal hemorrhage, but there was a urethral injury. Suprapubic cystostomy was performed because of incontinence and urethral injury. He was treated in the local provincial hospital with bed rest and skeletal traction for only one week; then, skeletal traction was removed for 10 weeks. Because of problems with transportation and the referral system, the patient was referred to the authors' center 12 weeks after the trauma. The neurologic examination revealed paralysis of bilateral tibialis anterior, extensor hallucis longus and gastrosoleus muscles. There was impaired sensibility of the skin of the L5-S1 dermatome. The rectal examination revealed an absent perianal sensation, loose sphincter tone and loss of voluntary contraction. There were pressure ulcers on the buttocks and adjacent area.

A new series of radiographs of the pelvis and lumbosacral spines was taken (Fig. 1a,b). Three-dimen-

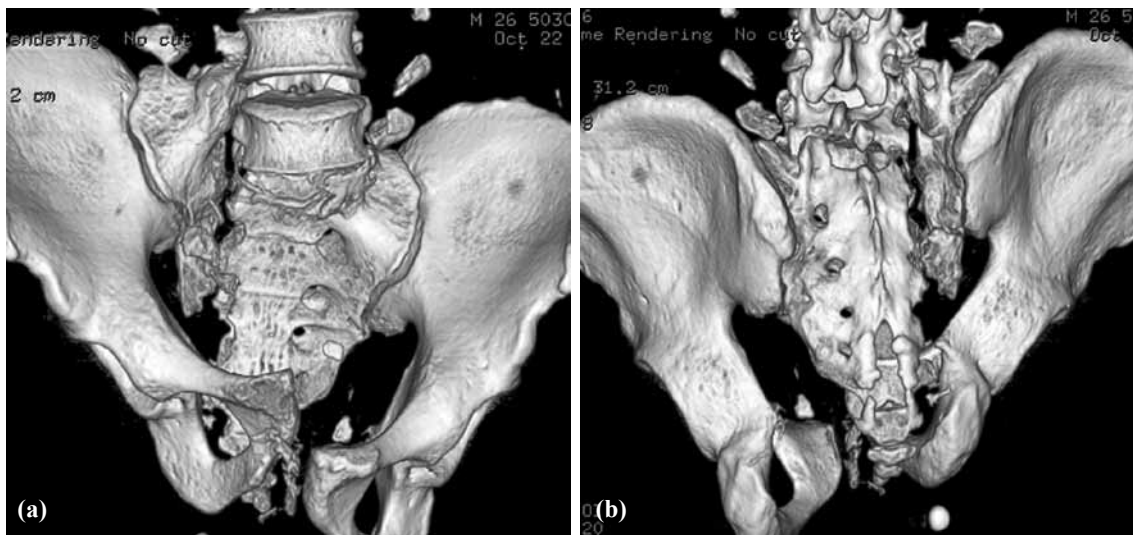

Fig. 2. **(a, b)** Three-dimensional CT of the pelvis showing fracture of the right transverse process and vertebral body fracture of L5 combined with right vertical shear fracture of sacrum and diastasis of the symphysis pubis, and superior displacement or right pelvic ring.

sional reconstruction computed tomography (CT) of the pelvis and lumbosacral spine showed the details of this complex musculoskeletal injury, comprising a fracture through the body and pars interarticularis of L5, fracture-dislocation of L5-S1 combined with transforaminal vertical shear sacral fracture at on the right side. There were also fractures of both transverse processes of L4-5, consistent with pubic symphysis disruption and right vertical shear trauma (Fig. 2a,b). Magnetic resonance imaging (MRI) depicted spondylolisthesis of L5 on S1, with narrowed disc space and posterior disc herniation at the central region of the L5-S1 level. Focus was on fractures of body ofthe L5 body, with bone fragments superimposed in the left lamina of L5, which compressed the left nerve root of L5-S1. Right L5, and S1-S4 nerve roots compression was shown due to right intervertebral foramen of L5-S1, and the right sacral foramina was destroyed. There was also a pressure effect at the dural sac of L5-S1 and inflammatory process at parts of marrows of L5 and S1 (Fig. 3a-c).

The electromyelography further revealed complete bilateral L4-S1 radiculopathy. There was also an ongoing process to a severe degree, with signs of reinnervation of the paraspinal and gluteal muscles and no sign of reinnervation to the tibialis anterior and gastrocnemius muscles.

In this patient, operation was indicated for stabilization of the pelvis and spine and for the decompression of nerve roots. First, we planned to reduce these upward pelvic deformities by distal femoral traction as much as the appropriate maximal weight could allow. After closed reduction, we predicted that partial reduction of these deformities might occur. The post-closed reduction alignment might provide us the opportunity to reduce via open anterior and posterior approach more easily. The traction weight was gradually increased up to 25 lbs. The patient complained of severe right hip pain, and widening of the right hip joint was shown on the pelvic radiograph. The traction weight was reduced to 10 lbs to maintain the deformity, which could not be reduced. In the steps of the operation, we initially planned to do the posterior decompression, reduction, stabilization, and fusion before the anterior approach due to a concern of surgical site infection caused by the suprapubic cystostomy, which was scheduled to terminate at one month after our posterior procedure. However, one month after posterior surgery, the suprapubic cystostomy still could not be terminated due to severe scarring and stricture after urethral injury. We discussed with the patient the risk of surgical site infection and the benefits of further anterior surgery for correction of some residual pelvic obliquity. The patient did not accept further operations due to substantial improvement in his overall condition, since he could move himself from bed to wheelchair with mild discomfort, and his pressure ulcers were healed. Therefore, we did not perform the anterior reduction and stabilization, which should ideally be done in this case.

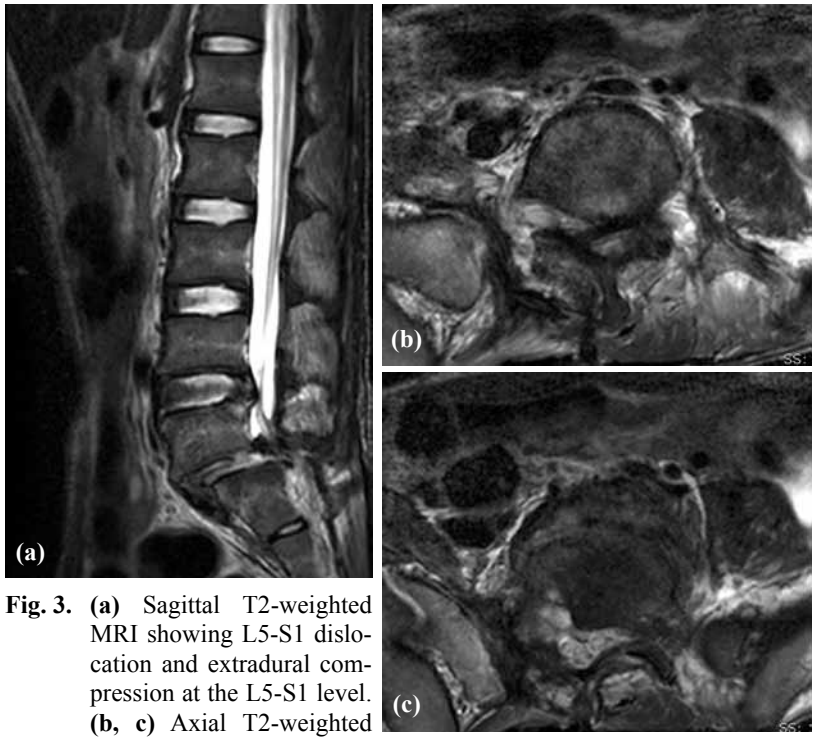

Fig. 3. **(a)** Sagittal T2-weighted MRI showing L5-S1 dislocation and extradural compression at the L5-S1 level. **(b, c)** Axial T2-weighted MRI demonstrates the L5-S1 extradural and bilateral nerve root compression.

For the above reasons, we performed posterior decompression, reduction, stabilization, and fusion. We do not consider the residual pelvic obliquity and anterior pelvic deformity acceptable, and had planned corrective surgery that was to take place after posterior surgery and termination of the suprapubic cystostomy.

Steps of the Operation

Because of severe spondylolisthesis of L5-S1, the insertion of a pedicle screw at L5 was quite difficult. We decided to insert a pedicle screw at L4 and an iliac screw on the right side, and temporary distraction was performed between right L4 and the iliac screw in order to reduce the spondylolisthesis of L5-S1, including upward displacement of the ilium. Decompressive laminectomy of L4-S1 and wide foraminotomy were performed before the reduction, thereby preventing stretching of nerve roots and related complications.

Fig. 4. Anteroposterior pelvic radiograph one year after surgery shows minimal upward displacement of right pubic symphysis.

Fig. 5. The patient could stand independently while holding on to a stretcher.

After the temporary distraction, we found that the insertion of a pedicle screw at L5 on the left side was easier due to the effect of an indirect reduction of the right side. Then we contoured and gently applied the left rod. Before tightening of the pedicle screws and rod system on the left side, the distraction between L5 and the ilium was performed for further reduction of spondylolisthesis. We could not insert the L5 and S1 pedicle screws on the right side due to the transverse process and vertebral body fracture of L5 and severe upward displacement of the ilium. After left rod distraction, the right contoured rod was coupled to the right L4 pedicle screw and iliac screw. We tried to perform more distraction between L4 and the ilium on the right side. Despite this, the upward displacement was only partially reduced due to the chronic condition of the injury. After tightening of the nuts onto the screws, a transverse crosslink bar was applied. The posterolateral fusion was performed with autologous corticocancellous graft from the lamina and spinous processes, which were decompressed. Fusion was additionally supplemented with hydroxyapatite substitutes.

Due to the residual pelvic obliquity, which was a consequence of the diastasis of the symphysis pubis, this patient required additional anterior pelvic ring stabilization with specific fixation after the previous posterior lumbo-pelvic ring reduction. However, we decided to avoid the anterior plating at the symphysis pubis due to a concern of postoperative infection from the suprapubic cystostomy, which was performed initially at the local provincial hospital before the patient's referral to us. Although we disagree regarding the suprapubic cystostomy as the initial treatment, we could not terminate this cystostomy at the time of the orthopedic procedures as mentioned previously because the patient had already developed urethral stricture.

One year after the injury, the patient had recovered uneventfully from the procedure. He had independent ambulation with wheelchair. The neurological deficits had resolved partially. The rectal examination revealed improvement in perianal sensation, fair sphincter tone and fair voluntary contraction. The electromyelography study revealed improvement in the right rectus femoris muscle and both sides of the gluteus maximus and gluteus medius muscles. However, the patient occasionally experienced problems during sitting activities due to some residual pelvic obliquity, including mild lumbar discomfort. The radiographs of the pelvis and spine showed preservation of good spinal alignment and minimal upward displacement of the pubic symphysis (Fig. 4).

At the most recent visit, 21 months after the operation, the physical examination revealed improvement in the tibialis anterior, extensor hallucis longus and gastrocnemius muscles as grade I muscle power, improved perianal sensation and fair sphincter tone. The electromyelography study showed improvement in reinnervation of the bilateral tibialis anterior and gastrocnemius muscles. The patient could stand by himself while holding a stretcher (Fig. 5). He could also walk with a walker independently using bilateral ankle-foot orthoses. However, the suprapubic cystostomy remained due to severe urethral scar and stricture. The pelvic radiographs showed acceptable spinopelvic alignment. Nevertheless, possible signs of early loosening around the iliac screws were noticed (Fig. 6a,b).

Hence, we discussed with the patient a possible revision of these screws. He still declined any further operations due to his experiencing only mild discomfort during ambulation.

DISCUSSION

Lumbosacral dislocation is usually the result of high-energy trauma,[1-5] and there are often associated lesions and fractures. Most of the cases reported in the literature had associated injuries. The lumbosacral dislocation is produced from a hyperextension mechanism according to the first description from Watson-Jones.[6] However, most authors consider a combination of hyperflexion with compression as the commonest mechanism of injury to produce bilateral L5-S1 dislocation.[7-9] Dewey and Browne[10] postulated that a severe force is applied to the lumbar spine and results in forward shifting on the fixed sacrum. Hyperflexion alone is not capable of producing either pure dislocation or fracture-dislocation in the lumbar spine. The combination of hyperflexion with vertical loading and rotation is necessary to create this injury.[11] Other investigators have assumed hyperflexion with various degrees of distraction and shear forces to be the most frequent mechanism of lumbar facet dislocation.[12-14] This case study represents an unusual combination of lumbosacral junction injury with closed vertical shear sacral fracture and disruption of the symphysis pubis. The patient had received a severe crush injury from a loaded 3,000 kg metal bar. We believe that severe crush of the pelvis with both lower extremities hyperflexed underneath the torso in a squatting position produced a combination of posteroanterior compression and vertical shear forces, which resulted in vertical shear sacral fracture on the right side and diastasis of the symphysis pubis. Combined open pelvic ring and lumbosacral junction injuries are always the result of high-energy trauma. Initial evaluation, stabilization of the patient, and treatment of life-threatening injuries, according to the Advanced Trauma Life Support Guidelines,[15] should take precedence over definitive treatment of this complex musculoskeletal injury. The principles of Damage Control Orthopedics (for instance as immediate temporary stabilization and secondary definitive treatment) is a well-established approach in this scenario. Particularly for pelvic ring injuries, early, even temporary, stabilization of the pelvic ring is of vital importance. Diagnosis of this lesion depends on an initial good quality radiologic study that demonstrates the abnormal relation of the lumbosacral facets. However, radiographs taken in the emergency room are often inadequate, and the lesion can occasionally be missed.[2] The presence of a transverse process fracture appears to be in obvious association with lumbosacral dislocation as in previous reports.[7-9,16-20] Early and extensive surgical intervention, particularly before physiologic stabilization of the patient, could lead to unacceptably high complication rates.[21] During this interim period and before any definitive surgery, thorough imaging studies (particularly CT and MRI of both spine and pelvis) are imperative because they will further delineate the details of the complex injury and facilitate definitive operative decisions. It must be emphasized that even severe lumbosacral junction trauma can be missed during the initial radiograph examination; delayed diagnosis may follow and be secondary to spondylolisthesis or neurological deterioration.[2-5] CT will confirm the diagnosis and further delineate the details of the injury. MRI will provide additional valuable information, particularly regarding the condition of the spinal canal and the integrity of the L5-S1 intervertebral disc. To our knowledge, this is the first report of a patient who had the unique combination of lumbosacral junction injury with closed vertical shear sacral fracture and disruption of the symphysis pubis that was initially inadequately treated. Reduction was attempted with traction for one week. The skeletal traction was not maintained for 10 weeks. Our patient underwent definitive treatment on the 12th week after trauma, after all the details of his complex injury had been thoroughly clarified by both CT and MRI of his spine and pelvis. The goal of definitive surgical interven-

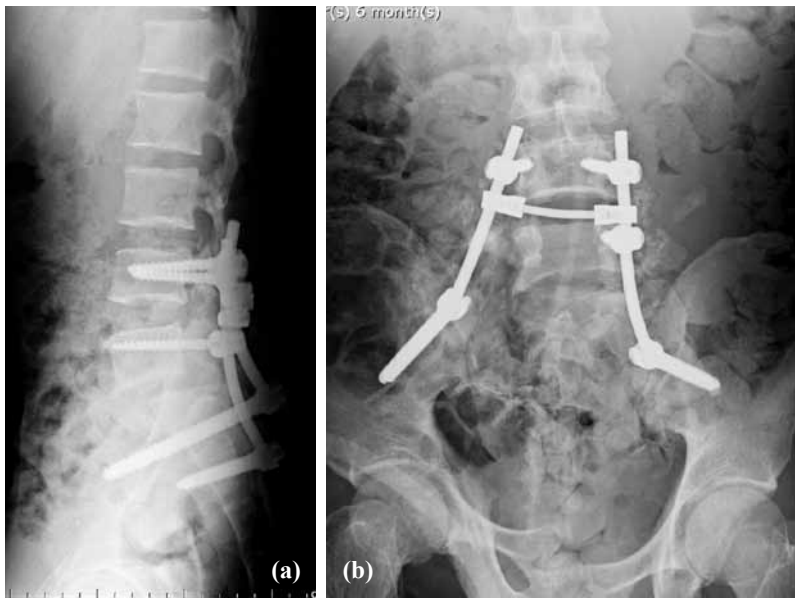

Fig. 6. **(a, b)** Anteroposterior and lateral radiograph of the lumbosacral spine including the pelvis 21 months after surgery. Note the preservation of good spinal alignment with almost complete reduction of the initial spondylolisthesis, some residual pelvic obliquity and some radiolucent area around the iliac screws.

tion in a case with such an unstable pattern of trauma should be adequate stabilization of all injuries in order to permit early mobilization of the patient. The logical way of reducing such a dislocation is by a posterior approach. To prevent late spinal instability, since posterior lumbar interbody fusion procedure could be difficult in these cases, an anterior lumbar interbody fusion may be recommended after posterior reduction with pedicle screw instrumentation.[1] From a biomechanical perspective, posterior lumbopelvic segmental fixation, involving a combination of pedicle and iliac screws connected to a system of longitudinal rods and transverse cross-links, constitutes the most stable construct of fixation of lumbosacral junction injuries.[2,22] In our case study, we proposed the correction of these injuries using indirect reduction technique. Nevertheless, only partial reduction was accomplished due to the chronic condition of these injuries. The same fixation as mentioned was performed with posterolateral fusion to provide stability for these injuries. However, we did not perform the anterior plating fixation at the symphysis pubis because we were concerned about the risk of postoperative infection from the suprapubic cystostomy that was done initially at the provincial hospital before referral to our hospital, and in view of the patient's decision after the posterior procedure. We did not agree with the decision to perform the suprapubic cystostomy, which should not have been an integral part of the initial treatment of closed pelvic ring injuries in this patient.

Finally, in view of our case study, we concluded that the combination of lumbosacral fracture-dislocation with closed vertical shear sacral fracture and disruption of the symphysis pubis was an unusual complex spondylo-pelvic injury pattern. These complex injuries demand immediate resuscitation and stabilization of the patient and a multidisciplinary approach. Cautious radiologic assessment by CT and MRI for accurate delineation of the complexity of the injury is necessary before definitive treatment, especially in the case of late presentation. After the patient's condition is stabilized and adequate information is retrieved from imaging studies, the definitive operative treatment should be performed as soon as possible in order to restore the proper alignment of these injuries.

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