Treatment of unstable sacral fractures with percutaneous reconstruction plate internal fixation[1]

Tratamento de fraturas sacrais instáveis com reconstrução percutânea com fixação de placa interna

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ABSTRACT

PURPOSE: To study the effects of percutaneous reconstruction plate internal fixation in the treatment of unstable sacral fractures.

METHODS: Percutaneous reconstruction plate internal fixation was applied on 21 cases of unstable sacral fracture (15 males and six females, at age range of 16-65 years, mean 38.3 years) including four cases of Denis Zone I, 14 cases of Zone II and three cases of Zone III. In operation, an arc incision (about 3-5 cm long) was made along the iliac crest on the outside border of posterior superior iliac spine (PSIS) on both sides, and then the plate was transported from the wounded side to the opposite one through the subcutaneous tunnel.

RESULTS: The mean incision length, operation time, intraoperative blood loss was 4.3cm, 45.2min, and 160.8ml respectively. All these patients were followed up for 12-33 months (average 16.3 months), which showed no incision infection, intraoperative neurovascular injury, internal fixation loose or breakage, disunion, or obvious lower limb length inequality. The function result was rated as excellent in six cases, good in 12 and fair in 3, with excellence rate of 85.7%, according to the Majeed scoring system.

CONCLUSION: Percutaneous reconstruction plate internal fixation is an ideal surgical approach to unstable sacral fractures, as it is easy, safe, causing less trauma and fewer complications, and conducive to quicker recovery.

Key words: Fracture Fixation, Internal. Reconstructive Surgical Procedures. Sacrum.

RESUMO

OBJETIVO: Estudar os efeitos da reconstrução percutânea com fixação de placa interna no tratamento de fraturas sacrais instáveis.

MÉTODOS: A reconstrução percutânea com fixação de placa interna foi aplicada em 21 casos de fratura sacral instável (15 homens e seis mulheres, com idade variando entre 16 e 65 anos, média de 38,3 anos) incluindo quatro casos de Zona I de Denis, 14 casos de Zona II e três casos de Zona III. No ato operatório, uma incisão arqueada (cerca de 3 a 5cm de comprimento) foi feita ao longo da crista ilíaca na borda externa da espinha ilíaca supero-posterior (PSIS) em ambos os lados, e então a placa foi transportada do lado da ferida para o lado oposto através do túnel subcutâneo.

RESULTADOS: O comprimento médio da incisão, tempo operatório e perda sanguínea intra-operatória foram, respectivamente, 4,3cm, 45,2min e 160,8ml. Todos estes pacientes foram acompanhados por 12 a 33 meses (média 16,3 meses), o que mostrou nenhuma infecção de ferida operatória, lesão neurovascular intraoperatória, perda da fixação interna ou quebra, desunião ou desigualdade nos comprimentos dos membros inferiores. O resultado funcional foi excelente em seis casos, bom em doze e falho em três, com taxa excelente de 85,7%, de acordo com o sistema de escore de Majeed.

CONCLUSÃO: Reconstrução percutânea com fixação de placa interna é uma abordagem cirúrgica ideal para fraturas sacrais instáveis, sendo fácil e segura, causando menos trauma e poucas complicações, conduzindo a uma recuperação mais rápida.

Descritores: Fixação Interna de Fraturas. Procedimentos Cirúrgicos Reconstrutivos. Sacro.

Introduction

The rapid development of transportation and construction industries has witnessed an increasing incidence of unstable sacral fractures. If improperly treated, they could be complicated with malunion or disunion at the late period, leading to lower back pain and lower limb function limitation and causing great inconveniences to the patients' work and life. The treatment of unstable sacral fractures has been a plaguing problem in clinics. Some researchers claimed that expectant treatment might achieve better functional, mental/emotional results[1]. Still the majority of scholars at home and abroad advocate surgical treatment to reduce complications at late period. Conventional operation approaches to unstable sacral fractures had such drawbacks as long incisions, long exposure time, much intraoperative blood loss, and large surgical trauma, which hinder the patients from recovery. The concern for the clinicians currently is how to diminish surgical wound, shorten operation time, and decrease perioperative complications, along with the popularity and development of minimal invasive surgery[2-5]. In this study, through percutaneous reconstruction plate internal fixation, satisfactory outcome have been achieved to treat unstable sacral fractures in 21 cases in our hospital from May 2003 through May 2009.

Clinical data

The study involved 21 patients with unstable sacral fractures (15 males and six females, at age range 16-65 years, mean 38.3 years). The injury causes included traffic accidents in 12 patients, fall from height in seven and crush in two. Previous to the operation, the anteroposterior, inlet and outlet radiographs of the pelvis were performed to identify the fracture-involving parts, fracture type and pelvis stability. Also pelvic CT scan and 3D reconstruction were conducted to further determine the displacements and the pelvic fracture stability. Their sacral fractures were all longitudinal: four cases in the ala sacralis zone (Denis Zone I), 14 cases in the sacral foramen zone (Zone II), and three cases in the sacral canal zone (Zone III)[6]. Seven cases were complicated by traumatic shock, 11 cases by multiple fractures, two cases by L_5 nerve injury and four cases by sacriplex injury. The time from injury to operation ranged from four days to 15 days (mean 6.8 days). All 21 patients had received traction reduction before percutaneous reconstruction plate internal fixation. The study has been performed in accordance with the ethical standards in the 1964 Declaration of Helsinki.

Treatment

After admission into our hospital, the patients had all received femoral traction with the traction weight of 1/6-1/4 of their body weight for 3-7 days. During the traction, the bed feet were elevated 30cm to counteract the skeletal traction. The operation was performed after complete or essential reduction of displaced fractures had been achieved. During anesthesia, general anesthesia or continuous epidural anesthesia, the patients were placed in the prone position. Then an arc incision, about 3-5 cm long, was made along the iliac crest on the outside border of posterior superior iliac spine (PSIS) on both sides. Then the skin, subcutaneous tissue and deep fascia were cut to expose the PSIS. And then gluteus was dissected from the outer plate of the ilium to expose the outer plate. Next a reconstruction plate with the length allowing three or more screws to be fixed was chosen. After the forward plate was fixed, the plate was transported from the wounded side to the opposite side through the subcutaneous tunnel (Figure 1a-e), placed on bilateral dorsal iliums. The screws were tightened till they penetrated the cortex. As nerve injuries were usually contused wounds, they generally don't need treatment. When CT identified a definite nerve entrapment by the bone flap, the incision could be extended to conduct a posterior surgical decompression simultaneously.

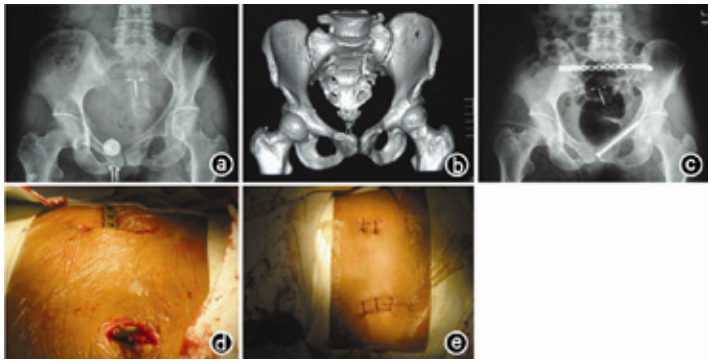

FIGURE1 - The plate implantation through the subcutaneous tunnel. **a**. Preoperative X-ray film; **b**. Preoperative CT film (sacral fracture); **c**. Postoperative X-ray film (satisfactory fracture reduction); **d**. Incisions during operation; **e**. Skin incisions after operation.

On postoperative day 1, the patients were allowed to do functional exercise in the semi-reclining position. Three weeks later, they were permitted to walk assisted by crutches without weight bearing or with partial weight-bearing. Three months later, they began to walk independently without crutches and resume physical labor gradually.

Results

In this group of patients, the incision length, operation time and intraoperative blood loss were (4.3±1) cm, (45.2±15.5) min, and (160.8±20.5) ml respectively. After the operation, they were all followed up for 12-33 months (average 16.3 months), which showed no incision infection, intraoperative neurovascular injury, internal fixation loosening or breakage, disunion or obvious lower limb length inequality. The two patients with L_5 nerve root injury had sensory disturbances and impaired motor functions in dominated areas. Three months later, their nerve functions were largely restored in the recheck. The three patients with sacral plexus injury also principally recovered from saddle hypesthesia and dysuria. Evaluation of the reduction were made using postoperative anteroposterior, inlet, and outlet radiographs of the pelvic ring, with the maximum fracture displacement distance on any film or rotation deformity angle on any plane as the basis for evaluation, according to the standard proposed by Mears *et al*.[7]. Anatomic reduction was achieved if there was no residual displacement in any film. The reduction was considered satisfactory when the postoperative displacement was less than 10mm in any direction on all the films and rotatory displacement was less than 15°in any plane. The reduction was dissatisfactory if the displacement in any direction was all more than 10 mm or rotational deformity on any plane all more than 15°. In this group of patients, anatomic reduction was attained in 15 cases, and satisfactory reduction in six cases. Function results were assessed in terms of pain, standing and sitting, sexual function, and the need of assistance when walking, walking distance, and gait according to scoring system proposed by Majeed[8]. Five factors were assessed and scored: pain (30 points), standing (36 points), sitting (10 points), sexual intercourse (4 points) and work performance (20 points). The total score then gave a clinical grade as excellent (≥85 points), good (70-84 points), fair (55-69 points) or poor (<55 points). Altogether, six cases were evaluated as excellent, 12 cases as good, three as fair (excellent and good rate of 85.7%).

Discussion

Among various classifications of sacral fractures, Denis's classification, combining the fracture types with fracture shape and clinical manifestation, is simple and practical, therefore has been widely acknowledged. Denis *et al*.[6] classified sacral fractures into three types based on different fracture anatomical locations: alar (Zone I: the fracture was passed through alar but without injuries in the sacral foramina or sacral canal), foraminal (Zone II: the fracture was passed through one or several sacral foramens. The ala might be involved but the central sacral canal was not injured) and central sacral canal (Zone III: the fracture was passed through the sacral canal. Ala and sacral foramens might be involved). This system was designed to assist predicting nerve injury risks. The Zone I fracture could easily result in L_5 nerve root injury, ended up with nerve damage in about 6% cases. The Zone II fracture, including the neural foramen, might lead to anesthesia in the sacral region, while the central sacral canal is not involved. The Zone III fracture, is highly associated with nerve damage (about 56%) and might cause cauda equina syndrome.

Unstable sacral fractures, often accompanied by shock and other life-threatening injuries, are easily neglected and untreated in clinics. Routine anteroposterior pelvic roentgenograms cannot demonstrate the sacrum clearly due to the overlap of soft tissue shadows and intestinal gases, therefore has a higher rate of missed diagnosis and might delay treatment. Pelvic inlet radiographs, however, displaying anteroposterior and body of sacrum clearly, could better demonstrate the pelvic anteroposterior displacement. Pelvic outlet radiographs exhibit the central sacral canal better and help to demonstrate upward or downward sacral displacement. Therefore patients of pelvic fractures should undergo pelvic anteroposterior, inlet, and outlet radiographs to avoid missed diagnosis. With the development of CT technology, CT scan can evaluate the nature and stability of pelvic injuries accurately by revealing the details, identifying the damage to the sacral foramina and the central sacral canal, therefore has largely enhanced the sacral fracture diagnosis accuracy. In our hospital, CT scanning has been performed on all suspected cases of sacral fractures in recent years. CT 3D reconstruction, moreover, with a higher resolution and illustrating the sacral relative position more accurately, is more effective in identifying the sacral fracture classifications and thus has become one of the important imaging methods in sacral fracture diagnosis[9,10]. Some authors advocate reconstruction of CT images of the sacrum in the sagittal plane in trauma to prevent failure of identification[11].

Currently, different opinions still remain on the treatment of sacral fractures. We believe that expectant treatment of sacral fractures, which are frequently accompanied by unstable fractures, could lead to such sequelae as malunion and sacral nerve injury. To correct and prevent the pelvic ring deformity, and to avoid further nerve injuries or to deal with the existing nerve injuries, surgeries are required to reconstruct the stability of the pelvic ring. Established techniques included iliosacral screw fixation, transiliac rod fixation or plating, local (transsacral) plate osteosynthesis or a combination of triangular osteosynthesis using a vertical

lumbopelvic fixation and a transverse fixation of the sacrum[2-5]. Sacroiliac screw fixation is the best choice by biomechanics[12]. Yet its screw placement was quite technically demanding: improper practice in the process is easy to impair the sacral nerve, coccygeal nerve or the adjacent blood vessels. Meanwhile, repeated X-ray needed during the operation forced the medical staff and the patients to receive a large amount of X-ray. It also cannot be applied to sacral fracture III, limiting its application. Sacral rod internal fixation, although easy, secure, and less invasive[13], can only be applied to patients with integrated ligament structure in front of the sacrum, otherwise an open anterior part would easily be caused after compression. Meanwhile, over compression could lead to sacral fracture compression and sacral nerve injury. Sagi HC *et al*.[14] reported use of triangular osteosynthesis in 58 patients with vertically unstable transforaminal sacral fractures, when the patients were allowed full weight bearing at six weeks and had malunion rate of only 5%. The authors noted a high rate of prominent and painful hardware(95%). Bellabarba *et al*.[15] employed triangular osteosynthesis for 19 patients. Triangular osteosynthesis involved internal fixator, fracture end and iliac waist and formed a stable complex structure, with high shearing force. The technique of rigid segmental lumbopelvic stabilization achieved excellent structural restoration of the lumbosacral spine and posterior pelvic ring, permitting early mobilization without external immobilization, while maintaining a stable platform for neurologic recovery. The major complications in our series included infection (three out of 19, 16%), wound healing complications (three out of 19, 16%), rod breakage (six out of 19, 31%) and iliac screw prominence (three out of 19, 16%). A total of eight patients (42%) required an unplanned secondary visit to the operating room[15]. In fact, this technique limited the movement of the lumbosacral joint, reduced the rotation of L5 and the ilium and may cause a great number of complications[16]. It also cannot be exercised on patients with bilateral sacroiliac joint dislocation or fracture. Posterior strain belt with plate internal fixation then provides with adequate mechanical strength to meet the clinical need of stabilization. With this approach, there were no cases of internal fixation loosening or breakage or nonunion in this group of patients. This method, namely, reconstruction plate internal fixation, has the merits of easy practice, small trauma, and firm stabilization. The plate, easy to mould to fit the ilium, does not produce compression on the sacral foramen and central sacral canal, therefore is applicable to all types of sacral longitudinal fracture. Also it avoids X-ray in fixation during surgery, and prevents injury to sacral nerve and major pelvic blood vessels. With all these virtues, it has been increasingly applied in clinics.

How to diminish surgical trauma, shorten operation time, and reduce perioperative complications has been a major concern of clinicians. Traditional posterior reconstruction plate internal fixation adopts the lumbosacral midline incision to dissect sacrospinalis which reaches bilateral posterior superior iliac spine. Therefore, the longer incision, longer exposure time, more blood loss, and larger operation wound by this approach would impede patients' recovery. Previously, adopting this method, we had an operation time of 60.5 min and a surgical blood loss of 310.6 ml on average. Recently, by percutaneous reconstruction plate internal fixation, we have shortened the operation time to 45.2 min and reduced blood loss to 160.8 ml averagely. The incision-exposed time and bleeding volume were greatly decreased. In this group of cases, the mean incision was 4.3 cm long, while that in traditional fixation operation is 10.5 cm. Meanwhile, smaller incisions are conducive to rehabilitation exercises as they produce less soft tissue injuries, reduce risks of postoperative infection, and decrease postoperative pain. Moreover, there wouldn't be repeated X-ray check, compression on the sacral foramen and central sacral canal, paratherapeutic nerve injuries, or much interference with blood-supply in the fracture sites. Consisting with the BO concept, this approach is an ideal minimally invasive surgery in treatment of unstable sacral fractures. In its application, a large-weight traction should be administered before operation to completely or essentially reduce the vertical relocation, otherwise difficulty in intraoperative reduction or postoperative lower limb length inequality might be caused. When treating thin patients, who have thin subcutaneous fat and would feel uncomfortable as the plate presses the skin in prostration, this method should be applied with caution. On patients of severe osteoporosis, it also requires much caution.

Conclusion

Percutaneous reconstruction plate internal fixation is an ideal surgical approach to unstable sacral fractures, as it is easy, safe, causing less trauma and fewer complications, conducive to quicker recovery, and meeting the aesthetic requirements.

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