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SURGICAL MANAGEMENT OF AGED COMPLEX SACRAL INJURIES BY LUMBOPELVIC STABILIZATION

MANEJO CIRÚRGICO DAS LESÕES COMPLEXAS ENVELHECIDAS DO SACRO POR ESTABILIZAÇÃO LOMBOPÉLVICA

MANEJO QUIRÚRGICO DE LESIONES COMPLEJAS ENVEJECIDAS DEL SACRO POR ESTABILIZACIÓN LUMBOPÉLVICA

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ABSTRACT

Objective: Evaluate the surgical indications, epidemiological data, radiographic outcomes, and postoperative complications of 16 cases of aged complex sacral fractures treated using bilateral spinopelvic fixation (PEF) or triangular osteosynthesis (OT) techniques in a case referral service. Traumatology and orthopedics complexes. Methods: A longitudinal study based on a retrospective review of patients' medical records with complex sacral fractures admitted between 2014 and 2020. All patients over 18 years of age whose time of evolution between the trauma and the surgical procedure was greater than or equal to three weeks were included. Results: The mean age was 39.8 years (18 to 71). Anterior pelvic ring injuries represented the most common association, present in 12 (75%) cases. In 8 (50%) cases, there was no neurological injury, 1 (6.2%) individual evolved with paresthesia, 2 (12.5%) with paresis in the lower limbs, and 5 (31.3%) with sphincter dysfunctions. Among the patients with neurological impairment, 4 (50%) evolved with complete improvement, 2 (25%) showed partial improvement, and 2 (25%) cases remained with the deficit. The mean surgical time was 3.6 hours for OT and 4.9 hours for FEP. Postoperative complications occurred in 4 (44.4%) patients who underwent PEF, and there were no postoperative complications in the OT group. Conclusions: The surgical management of these lesions using OT and FEP proved safe and effective. The minimum follow-up was 12 months, and all the individuals analyzed showed good evolution. ***Level of evidence IV; case series.***

Keywords: Sacrum; Wounds and Injuries; Spinal Fractures; Spinal Injuries.

RESUMO

Objetivo: Avaliar as indicações cirúrgicas, dados epidemiológicos, desfechos radiográficos e complicações pós operatórias de uma série de 16 casos de fraturas complexas envelhecidas do sacro tratadas através das técnicas de fixação espinopélvica bilateral (FEP) ou osteossíntese triangular (OT) em um serviço de referência de casos complexos de traumatologia e ortopedia. Métodos: estudo longitudinal, baseado na revisão retrospectiva de prontuários de pacientes com fraturas complexas do sacro, admitidos entre 2014 e 2020. Foram incluídos todos os pacientes acima de 18 anos cujo tempo de evolução entre o trauma e o procedimento cirúrgico foi maior ou igual a três semanas. Resultados: A média de idade foi de 39,8 anos (18 a 71 anos). As lesões do anel pélvico anterior representaram a associação mais comum, presentes em 12 (75%) casos. Em 8 (50%) casos não ocorreu lesão neurológica, 1 (6,2%) indivíduo evoluiu com parestesia, 2 (12,5%) com paresia nos membros inferiores e 5 (31,3%) com disfunções esfincterianas. Entre os pacientes com comprometimento neurológico, 4 (50%) evoluíram com melhora completa, 2 (25%) apresentaram melhora parcial e 2 (25%) casos permaneceram com o déficit. O tempo médio cirúrgico foi 3,6 horas para OT e 4,9 horas para FEP. Ocorreram complicações pós-operatórias em 4 (44,4%) pacientes que realizaram FEP e não houve complicações pós-operatórias no grupo submetido a OT. Conclusões: O manejo cirúrgico dessas lesões por meio da OT e FEP se mostrou seguro e eficaz. O seguimento mínimo foi de 12 meses e todos os indivíduos analisados apresentaram boa evolução. ***Nível de evidência IV; série de casos.***

Descritores: *Sacro; Ferimentos e Lesões; Fraturas da Coluna Vertebral; Traumatismos da Coluna Vertebral.*

RESUMEN

Objetivo: Evaluar las indicaciones quirúrgicas, datos epidemiológicos, resultados radiográficos y complicaciones postoperatorias de una serie de 16 casos de fracturas de sacro envejecidas y complejas tratadas mediante las técnicas de fijación espino pélvica bilateral (FEP) u osteosíntesis triangular (OT) en un servicio de referencia de traumatología y ortopedia. Métodos: estudio longitudinal, basado en una revisión retrospectiva de expedientes clínicos de los pacientes con fracturas sacras complejas ingresados entre 2014 y 2020. Se incluyeron en el estudio todos los pacientes mayores de 18 años cuyo tiempo de evolución entre el trauma y el procedimiento quirúrgico fue mayor o igual a tres semanas. Resultados: La edad promedio fue de 39,8 años (18 a 71 años). Las lesiones anteriores del anillo pélvico representaron la

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asociación más frecuente, presente en 12 (75%) casos. En 8 (50%) casos no hubo lesión neurológica, 1 (6,2%) evolucionó con parestesia, 2 (12,5%) con paresia en miembros inferiores y 5 (31,3%) con disfunción esfinteriana. Entre los pacientes con deterioro neurológico, 4 (50%) evolucionaron con mejoría completa, 2 (25%) mostraron mejoría parcial y 2 (25%) casos permanecieron con déficit. El tiempo quirúrgico promedio fue de 3,6 horas para OT y de 4,9 horas para FEP. Las complicaciones postoperatorias ocurrieron en 4 (44,4%) pacientes que se sometieron a FEP y no hubo complicaciones postoperatorias en el grupo OT. Conclusiones: El manejo quirúrgico de estas lesiones mediante OT y FEP demostró ser seguro y efectivo. El seguimiento mínimo fue de 12 meses y todos los individuos analizados mostraron una buena evolución. ***Nivel de evidencia IV; Series de casos.***

Descriptores: *Sacro; Heridas y Lesiones; Fracturas de la Columna Vertebral; Traumatismos Vertebrales.*

INTRODUCTION

The integrity of the sacrum is critical to the stability of the pelvic ring and the transmission of forces from the spine to the pelvis.[1] Most sacral fractures occur after high-energy trauma, corresponding to 1% of all spinal fractures.[1] Approximately 60% of these fractures go unnoticed in the initial evaluation,[2] due to several factors, such as low incidence, a wide variety of presentations in the patterns of these injuries, greater importance given to associated injuries, absence of neurological motor deficit, as well as the difficulty of identifying lesions on anteroposterior (AP) radiography of the pelvis at the first appointment.[3,4] The delay in identifying these injuries, associated with the clinical commitment of patients and the limitation of material and technical resources in some trauma centers, mean that some cases of complex sacral fractures are treated late.[4,5]

Old sacrum fractures, those with more than three weeks of evolution, still challenge orthopedic surgeons.[5,6] The surgical treatment of these lesions has a range of options. It must consider the anatomical particularities of the region, the biomechanical forces, the technical complexity of the fixation of the sacrum and pelvic ring, and the patient's clinical status.[7,8]

No studies published in the main databases (Pubmed, Scielo, and Bireme) evaluate a series of cases of complex sacral fractures treated late. Thus, this article aims to evaluate the surgical indications, epidemiological data, radiographic outcomes, and postoperative complications of a series of 16 cases of complex sacral fractures treated late using bilateral spinopelvic fixation or triangular osteosynthesis techniques in a reference service for complex traumatology and orthopedics cases in the public health system.

MATERIAL AND METHOD

Study population

A longitudinal study was carried out based on a retrospective review of medical records of patients diagnosed with complex fractures of the sacrum, admitted to a quaternary service of Orthopedics and Traumatology, in consecutive convenience sampling, between January 1, 2014, and July 1, 2014. 2020 All patients over 18 years of age undergoing surgical treatment were included, whose time of evolution between the trauma and the surgical procedure was equal to or greater than three weeks. Patients who suffered low-energy trauma, patients with fractures resulting from advanced neoplasia, patients with complex sacral fractures in which surgical techniques other than triangular sacral osteosynthesis (OT) or bilateral spinopelvic fixation (PEF) were excluded, and who had an outpatient follow-up of fewer than 12 months.

For the diagnosis of lesions as well as for surgical planning, radiographs were taken in anteroposterior (AP) and lateral (P) views of the sacrum, inlet, and outlet of the pelvis, in addition to computed tomography (CT) with three-dimensional reconstructions.

The Research Ethics Committee approved the present study (CAAE.39419620.9.0000.5273).

Procedures

Triangular osteosynthesis

A technique used for unilateral transforaminal fractures and sacroiliac dislocations with a vertical rise of the hemipelvis performed through a median approach with deep dissection and unilateral exposure of the L5 vertebral levels, sacrum, and posterosuperior iliac spine (PIPS). Polyaxial pedicle screws were inserted in the L5 and S1 vertebrae (when the fracture line allowed) and one or two polyaxial screws in the iliac, between the inner and outer boards associated with a percutaneous iliosacral screw.

In fractures with deviation greater than 1.0 cm, osteotomy of malunion was performed (when necessary), fracture reduction with the aid of reduction forceps, and unilateral skin traction with 4 to 7 kg. Cases with neurological deficit and nerve compression evidenced by imaging tests underwent removal of bone fragments from the canal and/or foraminoplasty, according to their particularities. After instrumentation, realignment, and nerve decompression, a pre-molded titanium rod was attached, and a distraction maneuver was performed to correct the vertical deviation, locking the system. The iliosacral screw was placed percutaneously after the fracture realignment.

Spinopelvic Fixation

A technique of choice for bilateral vertical or unilateral vertical sacral fractures associated with a transverse line. Longitudinal surgical access was performed in the posterior midline and bilateral exposure of the L5, sacral, and EIPS vertebral levels, followed by bilateral and symmetrical instrumentation with polyaxial pedicle screws in the L5 and S1 vertebrae (when the fracture line allowed) in addition to one or two polyaxial screws in the iliac.

When necessary, osteotomy of malunion was performed, in addition to fracture reduction with the aid of reduction and traction forceps. Cases with neurological deficit and nerve compression evidenced by imaging tests underwent decompressive laminectomy, remotion of bone fragments from the canal, and/or foraminoplasty, according to their particularities. After instrumentation, realignment, and nerve decompression, two pre-molded titanium rods were attached, one on each side, associated with a transverse traction device (DTT).

Patient follow-up

Regardless of the technique used, all patients were encouraged to mobilize the lower limbs early and to perform gait training with a walker, respecting the pain limitations and the particularities of the associated injuries. Outpatient follow-up was performed for a minimum period of 12 months.

Data analysis

After patient selection, factors such as age, gender, trauma mechanism, associated injuries, neurological *status*, fracture pattern - using existing classifications in the literature, clinical complications related to trauma, clinical complications related to the surgical procedure, surgical technique, interval between trauma and surgical treatment and time interval between surgical procedure and hospital discharge. The results of this study were compared to those published by other centers in different parts of the world.

The classification developed by Gibbons et al. was used for the stratification of neurological status. Thus, each patient was classified into one of the following groups: 1) without neurological alterations; 2) paresthesia in the lower limbs; 3) motor deficit in the lower limbs with intact bladder and bowel function; 4) bladder and bowel dysfunction.[19]

Data were tabulated in a spreadsheet using Excel version 14. Numerical variables were expressed as mean, minimum, and maximum. Categorical variables were expressed in the form of frequency.

RESULTS

We selected 16 cases of complex aged fractures of the sacrum surgically treated with OT or FEP techniques. Among them, 10 (62.5%) had a fall from high places as a trauma mechanism, 4 (25%) were victims of car accidents, 1 (6.2%) was crushed, and 1 (6.2%) threw herself from a moving car. The mean age was 39.8 years (range: 18 to 71 years old), 11 (68.7%) were male, and 5 (31.3%) were female (Table 1).

Of the total sample, 14 (87.5%) patients had associated lesions. Anterior pelvic ring injuries represented the most common association, present in 12 (75%) cases. The other orthopedic injuries diagnosed were: fractures of the acetabulum, lumbar and thoracic vertebrae, ribs, facial bones, and appendicular skeleton. Among the associated non-orthopedic injuries, 1 (6.2%) patient had a pulmonary contusion, 1 (6.2%) had bladder and urethral injuries, and 1 (6.2%) developed rhabdomyolysis after the trauma and before being submitted to the surgical procedure. All had good clinical evolution during follow-up.

The Gibbons scale was used to assess the neurological *status* of the individuals studied. The preservation of neurological integrity occurred in 8 (50%) cases; 1 (6.2%) individual evolved with paresthesia in the lower limbs, 2 (12.5%) with a motor deficit in the lower limbs, and 5 (31.3%) with sphincter dysfunctions. Among the patients with neurological impairment, 4 (50%) evolved with a complete improvement of the deficit, 2 (25%) showed partial improvement, and in 2 (25%) cases, there was no change in the condition (Table 2).

When evaluating fracture patterns, 9 (56.2%) were classified according to Denis' classification as located in zone II and 5 (31.3%) in zone III. In 2 (12.5%) cases, there were sacroiliac dislocations with the vertical ascension of the hemipelvis. Therefore, the Denis classification was not applied.

The most used treatment was FEP, 9 (56.2%) cases, followed by OT, 7 (43.3%). The mean time between trauma and definitive fixation of the sacral fracture was 50.6 days (range 21 to 120 days) for the OT group and 63.4 days (range 21 to 210) for those submitted to OT. EFF The interval between the surgical procedure and hospital discharge was 6 and 27 days for the groups undergoing OT and FEP, respectively (Table 3).

Table 1. Epidemiological profile of patients with complex sacral lesions undergoing late surgical treatment of complex sacral lesions.

Characterization of the study population	
n	16
Gender, n	
Male	11
Feminine	5
age, years	39.8
Mechanism of trauma, n	
Fall from height	10
Car accident	4
Others	2

Table 2. According to the Gibbons classification, the pre and postoperative distribution of patients with complex aged sacral lesions underwent surgical treatment and altered neurological status. The arrow pointing down indicates a change in the patient's stratification, representing an improvement in the neurological picture.

Id	Pre	Post	Variation
Patient 1	4	1	↓
Patient 2	4	1	↓
Patient 3	4	2	↓
Patient 4	3	3	=
Patient 5	2	1	↓
Patient 6	3	3	=
Patient 7	4	2	↓
Patient 8	4	1	↓

Table 3. Time intervals between trauma, hospitalization, hospital discharge, and the surgical procedure; mean surgery time and postoperative complications.

	Triangular osteosynthesis	**Lumbopelvic**
n	7	9
The time between injury and surgery, days	50.6 days (21 - 120)	63.4 days (21 - 210)
The time between hospitalization and surgery, days	11 days (1 - 22)	14 days (6 - 23)
The time between surgery and discharge, days	6 days (3 - 14)	27 days (2 - 106)
Surgery time, hours	3.6 h (2 - 8)	4.9 h (2 - 7.5)
Complications, n		
Infection	0	3
Bad positioning of screws	0	1

The mean surgical time was 3.6 hours for OT and 4.9 hours for FEP. During follow-up, which ranged from 12 to 84 months (mean, 46.9 months), postoperative complications occurred in 4 (44.4%) patients undergoing PEF, requiring at least one unplanned return into a surgery room. Among the complications, the most frequent was surgical site infection, which occurred in 3 (33.3%). In 1 (11.1%), there was a need to reposition the S1 screw due to radiculopathy. There were no postoperative complications in the group submitted to the OT procedure.

DISCUSSION

Due to the unstable nature of complex sacral lesions and the evolution of spinopelvic fixation techniques, surgical treatment has become the treatment of choice.[9] Conservative treatment remains reserved for patients with a clinical impairment who would not tolerate the invasive procedure.[10] However, it is not free of complications and is related to thromboembolic changes, skin lesions, deterioration of spinopelvic parameters, residual pain, and lower limb dysmetria.[1,5,11,12]

Initial attempts to fix sacral fractures with spinopelvic instability were performed with sublaminar wires.[8,13] However, the ineffectiveness of this technique concerning stabilization and resistance to deforming forces in the axial and sagittal planes led to limited outcomes.[8,13] It was after the emergence of the Galveston technique that spinopelvic fixation systems showed better postoperative results.[13] With advances in this technique, iliac screws appeared, positioned between the inner and outer boards of the iliac wing, coupled through a connecting rod to the pedicle screws of the lumbar and sacral vertebrae, significantly increasing the stability and rigidity of the system and decreasing the rates of pseudarthrosis[13,14] (Figure 1).

Schildhauer et al., in 1998, described the OT technique, a variation of the traditional bilateral spinopelvic fixation. It uses a pedicle screw at L4 or L5 and an iliac screw associated with one or two iliosacral screws, thus stabilizing the vertical and horizontal planes.[15,16] This technique is indicated for cases of sacroiliac dislocations, unilateral transforaminal fractures with a vertical rise that affect the L5-S1 facet joint, and fractures that require aggressive foraminal decompression with compromised bone stability, and in salvage procedures after the failure of the horizontal posterior pelvic stabilization techniques.[1,15,16] (Figure 2) Another advantage of this technique is that, like bilateral spinopelvic fixation, the triangular mount allows for early load bearing. [15,16]

The Denis classification for sacral fractures correlates the anatomical location of the fracture with the risk of neurological injury, differentiating injuries into three zones.[17] Zone I or alar is located laterally, zone II is located in the transforaminal region, and zone III is centrally located.[17] These zones have a 5.9%, 28.4%, and 56.7% incidence of neurological injury, respectively.[17] In our study, we analyzed patients with fractures of zones II and III of Denis, who presented 33.3% and 100% of neurological injuries.

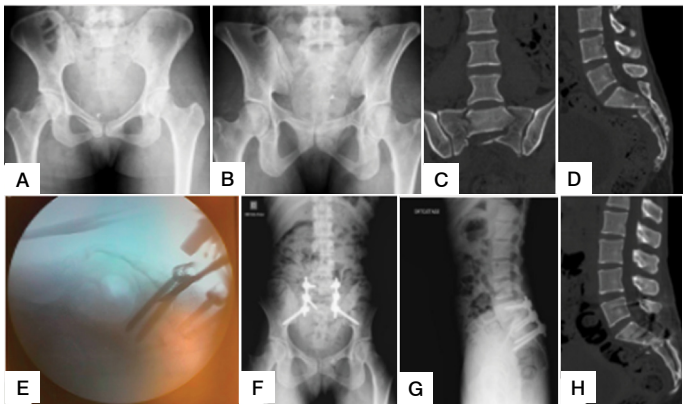

Figure 1. Female patient, 31 years old, a victim of a 3-meter fall. On neurological examination, Gibbons 4. Complementary imaging exams: a) Inlet radiography of the pelvis; b) radiography in the outlet view of the pelvis. Note the seemingly innocent radiographs; c) CT coronal reconstruction showing a "U" fracture pattern, with two vertical lines and one horizontal line, conceptually constituting a spinopelvic dissociation; d) Sagittal CT reconstruction showing flexion and posterior translation of the proximal fragment with bone compression of the central canal; e) intraoperative fluoroscopy with reduction maneuver by direct manipulation with an osteotome; f) postoperative radiograph in anteroposterior (AP) view; g) postoperative radiograph in the lateral view; h) Postoperative CT: sagittal reconstruction shows satisfactory reduction and decompression. A clinical segment of the patient showed considerable neurological recovery.

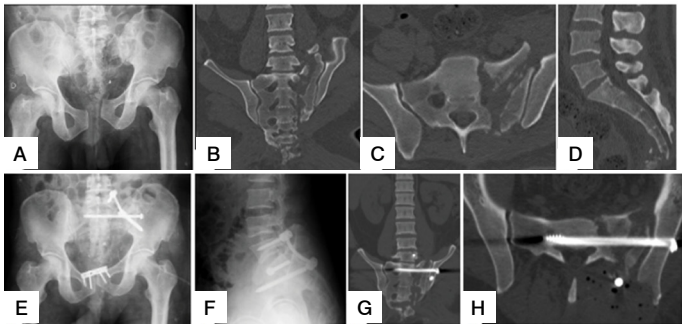

Figure 2. Male patient, 30 years old, a victim of a 9-meter fall with 30 days of evolution. On neurological examination, Gibbons 1. Imaging exams: a) Panoramic AP radiograph of the pelvis shows vertical ascension of the left hemipelvis; b) CT in the coronal reconstruction of the sacrum shows transforaminal fracture with displacement; cd) axial CT and sagittal sacral reconstruction; e) postoperative radiograph in the AP panoramic view of the pelvis: triangular assembly and osteosynthesis of the pubic symphysis were performed; f) postoperative radiography in lateral view; g) Postoperative CT: coronal reconstruction showing reduced vertical ascension of the left hemipelvis; h) Postoperative axial CT: positioning of the iliosacral screw.

In patients with cervical, thoracic, or lumbar spine injuries, the motor and sensory function of the extremities is classified according to the scale developed by the American Spinal Injury Association (ASIA). Still, in patients with sacral fractures, the assessment of the level of neurological injury by motor examination is caudally limited to the levels of L5 and S1.[18,19] In this context, Gibbons et al. classified patients diagnosed with sacral fractures according to their neurological status, assessing the presence of paresthesias, paresis and sphincter impairment.[19] In the present study, cases of complex lesions with spinopelvic instability were analyzed. Therefore, it was expected to find a high incidence of patients with neurological deficits.[20,21] In line with expectations, 50% (n=8) of the sample had a post-trauma neurological deficit, 1 (6.2%) was classified as Gibbons 2, 2 (12.5%) as Gibbons 3 and 5 (31.3%) as Gibbons 4.

Patients with preoperative neurological impairment underwent laminectomy, foraminoplasty, removal of bone fragments that compressed the canal (direct decompression), osteotomies of foci of malunion, and realignment of sacral fractures (indirect decompression). This made that 75% of the patients evolved with an improvement of the neurological picture, 50% with complete improvement, and 25% with partial improvement of the symptoms. Numbers similar to those described by König et al., 2012, presented a series of 43 cases of acute fractures in which 46.5% evolved with complete neurological improvement.[8]

Due to the lack of controlled studies with large sample size, it is not yet proven that surgical decompression is related to improving the neurological picture in the context of complex sacral fractures. To exemplify, neurological impairment can occur due to neuropraxia that often improves independently of surgical treatment, or it can occur due to root avulsion and, therefore, not improve despite decompressive surgery.[1] However, the present study analyzed only aged fractures, and the fact that 75% of patients with neurological alterations remained with a deficit for at least three weeks, only improving after surgical decompression, suggests that the performance of decompressive procedures is associated with patients benefits.

Sacral fractures have 96.4% of associated injuries, and the coexistence of anterior pelvic ring injuries is the most common association, representing 44.4%.[8] The indication for a surgical approach to the anterior lesion must be individualized. If surgical treatment is chosen, its reduction and stabilization must be performed before the subsequent time since the rigidity of the spinopelvic fixation prevents a good reduction of the anterior lesion.[1,21] In addition, initial fixation of the anterior pelvic ring has been shown to facilitate the reduction of posterior pelvic injury.[1,21] In this case series, an association of 75%, was found between complex sacral fractures and anterior pelvic ring injuries that were treated individually, taking into account their particularities. In one case, three surgical approaches were performed on the same day. In the first surgical stage, performed via the posterior approach in the prone position, osteotomy of the malunion focus was performed to realign the fracture, as well as procedures for decompression of the vertebral canal and release of nerve roots. Dorsal decubitus, to reduce and fix the lesion of the anterior pelvic ring and, finally, the third approach, again via the posterior approach, is used for bilateral spinopelvic fixation through the pedicle and iliac instrumentation.

As found in other studies, the main complication was surgical site infection (n=3).[22] In all complications, surgical re-approaches were necessary, a percentage considerably higher than the 42% described by Bellabarba et al.[23] All patients had a satisfactory clinical evolution until the last follow-up visit.

This study was conducted in a referral hospital for complex traumatology and orthopedics cases in the public health system; all cases were initially treated in other hospitals and later transferred to definitive treatment. Thus, the mean time elapsed between the fracture and the surgical treatment of the sacral lesion was 54.6 days (ranging from 21 to 210 days). This fact increased the procedures' complexity, duration, and bleeding. These factors may be related to the increase in postoperative complications.

The retrospective analysis and the small number of patients are limitations of this study. Due to the lack of studies evaluating the outcomes of surgical treatment of complex aged sacral lesions, our results were compared to case series that treated these lesions acutely. According to the literature, most complications related to the synthesis material occur in the first two years after the procedure.[2] Thus, late complications can still be expected, especially in cases where the postoperative follow-up was less than 24 months.

CONCLUSION

To our knowledge, this is the first published study that presents the results of a series of surgically treated aged, complex lesions of the sacrum. Late surgical treatment of complex sacral lesions by triangular osteosynthesis and bilateral spinopelvic fixation proved safe and effective, although the latter technique had higher complication rates.

All authors declare no potential conflict of interest related to this article.

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