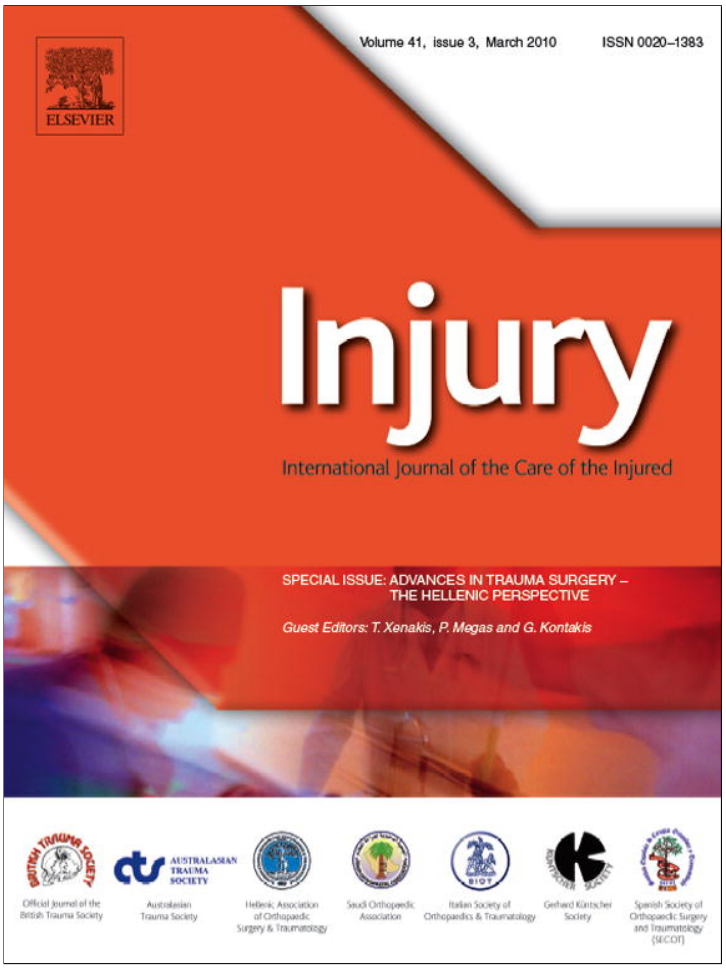

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Management of traumatic sacral fractures: A retrospective case-series study and review of the literature

Vassilis A. Lykomitros, Kyriakos A. Papavasiliou *, Ziyad M. Alzeer, Fares E. Sayegh, John M. Kirkos, George A. Kapetanos

3rd Orthopaedic Department, Aristotle University of Thessaloniki, Medical School, Greece

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ABSTRACT

Background: Being the result of high-energy trauma in most cases, traumatic sacral fractures are rare, difficult to recognise and frequently misdiagnosed. Furthermore they may lead to vascular injuries, mechanical instability, neurological impairment and increased morbidity. As a result, patients with traumatic sacral fractures may suffer major socio-economic consequences.
Objective: This retrospective case-series study evaluated the functional, neurological, mental and emotional status of patients who had suffered traumatic sacral fractures and either followed conservative or underwent operative treatment at our department.
Patients and methods: We evaluated the clinical and radiographic results of all patients who had suffered traumatic sacral fractures between December 2003 and June 2007. The case-notes of all patients were reviewed, all co-existing injuries were registered and an ISS was calculated for each patient. At the latest follow-up visit, all patients completed the Short Form-36 questionnaire as well.
Results: Sixteen patients (eleven male, five female) were included in this study. At the time of initial admission, the mean age of the patients was 30 years (range: 14–53) and the mean ISS was 33.2 points (range: 21–59). The mean follow-up period was 24.1 months (range: 13–40). Six patients were treated operatively (four patients diagnosed with some type of neurological impairment at their initial physical examination and two patients due to pelvic instability). The mean ISS of the patients who were treated operatively was 41.1 points (range: 21–59), whereas of those who were treated conservatively was 28.5 points (range: 21–45). No patient had any neurological deficit at his/her latest re-evaluation. Patients who were treated conservatively achieved the best scores in every domain of the SF-36 questionnaire, when compared with those who were treated operatively.
Conclusion: The diagnosis and management of sacral fractures may pose several dilemmas in everyday's clinical praxis. Patients suffering from traumatic sacral fractures who were treated conservatively seem to have better functional and mental/emotional outcomes, probably because their injuries were less severe than those of the patients who were treated conservatively.

Introduction

Traumatic sacral fractures are rare, nevertheless they still constitute a major cause of death and disability in patients involved in high-energy blunt trauma.[12] Furthermore, they are frequently overlooked upon initial consultation and this may consequently lead to pelvic instability and increased morbidity and mortality rates.[2,16,21,34] As a result, patients with sacral fractures are usually suffering major consequences.[18]

Aim of this retrospective case-series study was the evaluation of the functional, neurological, mental and emotional status of all patients who had suffered traumatic sacral fractures and either followed conservative or underwent operative treatment at our department.

Patients and methods

This study was approved by our Institution's Scientific Research Board and it was conducted in accordance with the World Medical Association Declaration of Helsinki of 1975 as revised in 1983 and

* Corresponding author at: 3 Natalias Mela Str., 546 46 Thessaloniki, Greece. Tel.: +30 6944531188; fax: +30 2310693154.
E-mail address: kyrpap2005@yahoo.com (K.A. Papavasiliou).

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2000. All patients were informed about their participation at the study and consented before their enrollment.

Patients suffering from traumatic sacral fractures who had been treated at our department (one of the four regional tertiary trauma centres which cover a population of approximately 2,5 million inhabitants) were included in the study. Their case-notes were reviewed, all co-existing injuries were registered and the ISS[19] was calculated. Vertical traumatic fractures were classified according to Denis et al.[5] (as modified by Roy-Camille et al.[23] and Strange-Vognsen and Lebech[30]) classification scheme; transverse according to the Schmidek et al.[27] classification scheme.

All displaced and unstable posterior pelvic ring injuries with fracture of the sacrum, dislocation or fracture-dislocation of the sacroiliac joint, or fracture of the ilium were regarded as indications for open reduction and internal fixation.[17] Displaced (>10 mm) fractures of the pubic rami or total disruption of the symphysis pubis, or both, were also treated with internal fixation. A concomitant displaced acetabular fracture was also an indication for open reduction and internal fixation. Case-sensitive, gradual weight-bearing on crutches was allowed 3 weeks after the operation, under the condition that no neurological impairment was present. Full weight-bearing was allowed after the sixth postoperative week. Patients were allowed to return to work at a minimum period of 3 months after their injury.

Patients were examined at 1, 2, 3, 6, 9 and 12 months following their discharge from the hospital and every 6 months thereafter. The minimum follow-up period was 12 months. At their latest follow-up visit, all patients had a physical and neurological examination and plain radiographs. Patients were also asked to answer the Short Form-36 (SF-36) Health Related Quality of Life Questionnaire.[1,35] Their neurological status was evaluated on the basis of the Gibbons et al.[9] classification scheme.

Results

During a period of 43 months (between December 2003 and June 2007), sixteen in total patients suffering from traumatic sacral fractures were transferred or referred to our department for evaluation and treatment. The mean age of the patients at the time of initial admission was 30 years (range: 14–53). The mean follow-up period was 24.1 months (range: 13–40) (Table 1).

Ten patients sustained their injuries at motor vehicle collisions, four as pedestrians at road-traffic accidents and two after falling from height. Their mean ISS[19] was 33.2 points (range: 21–59). Six patients were operated on at a mean period of 4.8 days (range: 0–7 days) following their injury (Tables 1 and 2). The operative method used in each case, was individualised according to the type of the fracture (classification and stability), the co-existing injuries and the patient's general health status (Table 2). Only patient #8 (Figs. 1–4) was operated on 93 days after his injury, due to his delayed referral to our department. Four patients were diagnosed with some type of neurological impairment at their initial evaluation (Gibbons et al.[9] Stage 4: one, Stage 3: two and Stage 2: one); all of them were treated operatively. No patient had any neurological deficit at the final follow-up visit (Table 2).

The average SF-36[1,35] score was 87.4 points (range: 59.7–96.2). The best scores were achieved at the 'role limitations due to physical health' domain (average: 94.7, range: 25–100 points) and the worse at the 'General Health' domain (average: 74.3, range:

Table 1
The patients' demographics together with their concomitant injuries, the method of treatment followed in each case and the classification of their (vertical) fractures according to the Denis et al.[5] (as modified by Roy-Camille et al.[23] and Strange-Vognsen and Lebech[30]) scheme. Patient #8 was suffering from a low transverse fracture[27]. N/A = not applicable.

Patient	Sex	Classification		Age at initial evaluation (years)	Duration of follow-up (months)	Severe co-existing injuries	ISS[19]	Method of treatment
		Denis et al.[5]	Roy-Camille et al.[23]					
1	F	I	N/A	14	40	Bilateral pubic rami	21	Non-operative
2	M	I	N/A	20	38	Bilateral pubic rami, left radius fracture	26	Non-operative
3	M	II	N/A	32	33	Stable T12 fracture, unstable L5 fracture, right pubic ramus fracture, partial urethra rupture	30	Operative
4	M	I	N/A	25	32	L5 fracture	21	Non-operative
5	M	IIIC	Type 3	26	31	Pelvic ring fracture type C, right acetabulum fracture, bilateral pubic rami fractures, peri-hepatic and splenic haematoma, bladder rupture, mandible fracture, pulmonary contusions	50	Operative
6	F	I	N/A	35	28	Concussion, right femoral shaft fracture, patellar fracture	41	Non-operative
7	M	I	N/A	53	25	Bilateral kidney contusions, spleen haematoma	21	Non-operative
8	M	NA	N/A	22	24	None	21	Operative
9	M	I	N/A	44	24	Pubic symphysis diastasis, right sacroiliac joint fracture-dislocation (Isler[13] Type A), left ulna fracture, splenic haematoma, skin degloving injury at the low-back and buttocks	59	Operative
10	F	II	N/A	26	20	Pulmonary contusions, pneumothorax	45	Non-operative
11	M	II	N/A	31	18	Pubic symphysis diastasis, left femoral shaft fracture	45	Operative
12	F	IIIA	Type 2	28	16	Unstable L5 fracture right femoral shaft fracture, right bimalleolar fracture, right talus fracture-dislocation	42	Operative
13	M	I	N/A	16	15	None	21	Non-operative
14	F	I	N/A	19	15	Pulmonary contusions	36	Non-operative
15	M	I	N/A	39	13	Right humeral fracture, left bimalleolar fracture	29	Non-operative
16	M	I	N/A	50	13	Scalp injury	24	Non-operative

Table 2
The results of the neurological examination (classified according to the Gibbons et al.[9] scheme) of all operatively treated patients upon their initial and their latest follow-up evaluation together with the actual operative method implemented in each case.

Patient	Neurological examination upon initial evaluation	Operative method implemented	Neurological evaluation upon follow-up	Comments
3	Gibbons et al.[9], Grade 3	T12 balloon kyphoplasty	Full recovery	Full neurological recovery at 2 months postoperatively
	Decreased muscle strength of the right lower limb: long toe extensors, toes extensors, ankle dorsiflexors, toes flexors, ankle plantar flexors, knee extensor, abductors, adductors	Decompression and posterior fusion of L4-S1	Gibbons et al.[9], Grade 1	Full weight-bearing walking capability at 3 months postoperatively
	Achilles tendon reflex: absent right	Posterior approach ORIF with iliosacral cannulated screws		*Trans-operative complication*: Laceration of the internal iliac artery and the internal iliac vein that necessitated their ligation through anterior approach
	Partial sensory impairment: lateral tibia right, lateral foot right, semi-scrotum right, buttock right			
5	Gibbons et al.[9], Grade 3	Posterior approach ORIF with transiliac bars	Full recovery	Full weight-bearing walking capability at 5 months postoperatively
	Right sciatic nerve paresis		Gibbons et al.[9], Grade 1	Capable of dancing at 24 months postoperatively
8	Gibbons et al.[9], Grade 2	Posterior approach	Full recovery	The patient (preoperatively) was suffering from painful defecation due to the distal part of the fractured sacrum and the subsequently developed orthosigmoid haematoma
	Partial sensory impairment: S3, S4, S5	ORIF with 2 LC-DCP plates	Gibbons et al.[9], Grade 1	Full neurological recovery at 6 months postoperatively
	Partially reduced anal sphincter contraction	Instillation of heterologous bone grafts		
9	Gibbons et al.[9], Grade 1	Initially external fixation	Gibbons et al.[9], Grade 1	Full weight-bearing walking capability at 6 months postoperatively
	No neurological deficit	Anterior approach ORIF of the pubic symphysis diastasis Posterior approach ORIF of the sacral fracture with transiliac bars		The patient has returned to his previous work (truck driver) at 24 months postoperatively *Postoperative complication*: The transiliac bars were prematurely removed at 3 months postoperatively due to infection
11	Gibbons et al.[9], Grade 1	Anterior approach ORIF of the pubic symphysis diastasis	Full recovery	Full neurological recovery at 2 months postoperatively
	No neurological deficit	Posterior approach ORIF of the sacral fracture with transiliac reconstruction plates	Gibbons et al.[9], Grade 1	Full weight-bearing walking capability at 6 months postoperatively
12	Gibbons et al.[9], Grade 4	Decompression L5-S3	Full recovery	Full neurological recovery at 2 months postoperatively
	Partial cauda equina syndrome	Posterior fusion L4-S1 ORIF with iliosacral cannulated screws	Gibbons et al.[9], Grade 1	Full weight-bearing walking capability at 6 months postoperatively

55–90 points). Patients who were treated conservatively achieved better scores in every domain of the questionnaire when compared with those who were treated operatively (Table 3).

Discussion

Being the result of high-energy trauma,[15,22] traumatic sacral fractures may be accompanied by progressive loss of neurological function and increased morbidity and/or mortality rates. Unfortunately, in 24–70% of cases, this type of fracture is overlooked during the patient's initial evaluation.[21] This may be the result of the fact that proper physical and neurological examination is difficult for up to 20% of these patients who usually arrive at a trauma centre either unconscious, or intubated.[33] Almost every patient who suffered a traumatic sacral fracture has additional injuries as well which pose diagnostic and therapeutic dilemmas.[13,21,33] All our patients had other injuries as well at their initial evaluation (Table 1). An additional crucial issue is the fact that plain radiographs may often 'conceal' sacral fractures; hence their definitive diagnosis usually requires special views, CT or MRI scans.[4] A sacral injury should always be suspected in patients reporting peri-pelvic pain or altered sensorium. As a standard practice at our A&E department, patients who sustained injuries following high-energy trauma or fall from height who suffer from blood loss of unknown aetiology, are presumed to suffer from sacral fractures until further examination has excluded that possibility and/or another cause of bleeding is found.

The primary goal when treating a sacral fracture in a polytrauma patient is to control and eventually stop the potentially lethal concurrent internal bleeding.[17] Definite surgical treatment can be scheduled and performed later. Only one patient (#3) was operated on a few hours after his injury; in the remaining 4 cases (#5, #9, #11, #12), operative treatment was

Fig. 1. Photograph showing patient's #8 lower back at the OR. Notice the osseous prominence developed due to the transverse sacral fracture the patient sustained after falling from height.

Fig. 3. Patient #8. Trans-operative view. Notice the gap between the distal and the proximal sacral fragments. The patient underwent ORIF (posterior approach) with two LC-DCP plates.

postponed. Patient's #8 case was not treated as urgent due to his delayed referral.

The decision to operate on a patient suffering from a sacral fracture is mainly based on the co-existence of neurological deficit and/or deformity. Several additional criteria are also taken into account (life-threatening bleeding, prevention of pelvic malunion or nonunion, patient's needs). Traditionally, non-operative treatment has been first choice, mainly because operative treatment offered only limited capability for fracture reduction and stabilisation. However, surgical intervention facilitates early mobilisation, reduces early mortality and improves long-term outcome in the poly-traumatised patients.[10] The role of surgery on neurological recovery following a sacral fracture remains controversial[9,33,36] (Table 4). Four of our patients were diagnosed with some type of

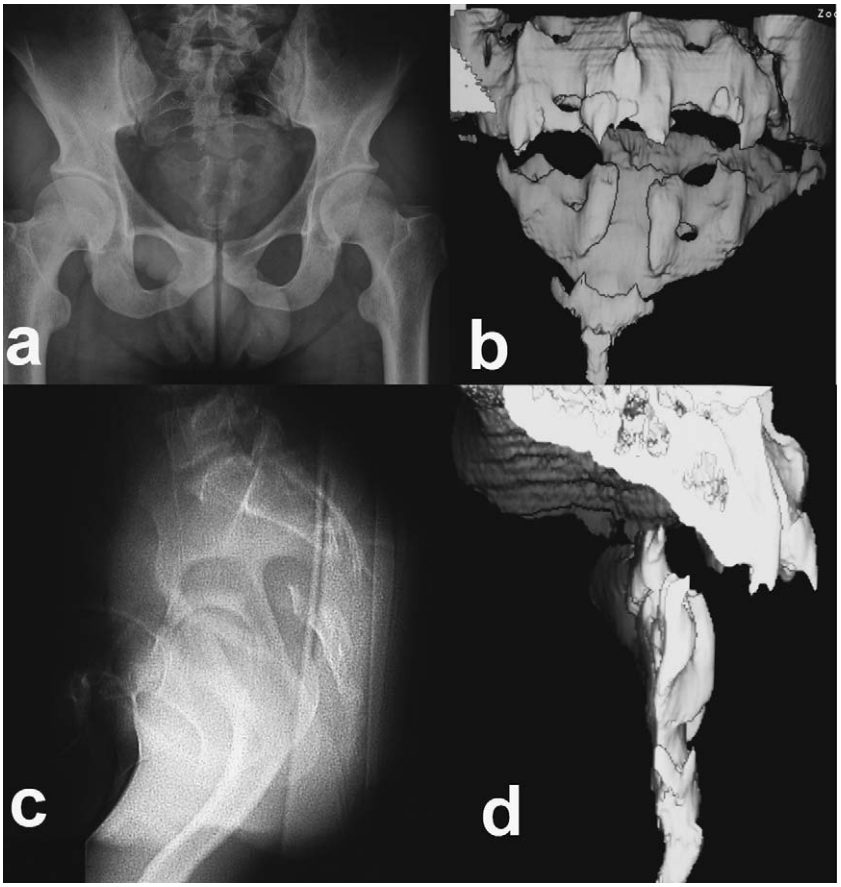

Fig. 2. Patient #8. Standard anteroposterior radiograph of the pelvis (a) and latero-lateral radiograph of the sacrum and coccyx (c), showing the patient's transverse sacral fracture. 3D CT reconstruction (b = coronal plane, d = sagittal plane) of the patient's fractured sacrum.

Table 3
The results of the SF-36[1,35] questionnaire.

Patient	Domains								
	SF-36 general score	Physical functioning	Role limitations due to physical health	Role limitations due to emotional problems	Energy/ fatigue	Emotional well being	Social functioning	Pain	General health
1	91.9	95	100	100	85	88	100	90	80
2	94.5	100	100	100	85	92	100	90	90
3	76.9	85	100	100	62.5	68	50	77.5	55
4	91.9	95	100	100	85	88	100	90	80
5	87.5	95	100	100	100	84	50	90	60
6	91.9	95	100	100	85	88	100	90	80
7	89.1	95	100	100	85	88	100	90	60
8	96.2	100	100	100	95	92	100	100	85
9	77.6	85	100	100	62.5	68	50	77.5	60
10	87	80	100	100	85	88	100	90	75
11	77.6	85	100	100	62.5	68	50	77.5	60
12	59.7	80	25	0	62.5	68	62.5	67.5	60
13	94.5	100	100	100	85	92	100	90	90
14	94.5	100	100	100	85	92	100	90	90
15	92.6	100	100	100	85	88	100	90	75
16	94.5	100	100	100	85	92	100	90	90
Average 'trauma' values	87.4	93.1	95.3	93.7	80.9	84	85.1	86.8	74.3
Average 'trauma' conservatively treated	92.2	96	100	100	85	89.6	100	90	81
Average 'trauma' operatively treated	79.2	88.3	87.5	83.3	74.1	74.6	60.4	81.6	63.3

neurological impairment at their initial examination. However, none of them had any neurological deficit at their latest evaluation.

Standard conventional techniques of ORIF remain the standard of care for the definitive treatment of pelvic ring fractures[32]. The role of percutaneous pelvic reconstruction is still unlear[8,29] and is considered by many as a complementary possibility for distinct fracture patterns and almost never a first choice procedure.[22] Nevertheless, patients suffering from fractures with minimal displacement and no neurological deficit may well benefit from this technique in terms of immediate mobilisation. Regardless of

Table 4
Outcome of treatment of patients suffering from sacral fractures accompanied by neurological deficit.

Study	Patients with neurological deficit	Method(s) of treatment	Summary of outcomes at final follow-up evaluation
Ayoub[2]	32	Operative	Complete neurological recovery: 21/32 Partial neurological recovery: 8/32 No neurological recovery: 3/32
Blanco et al.[3]	2	Operative	Neurological deficit remained in 2/2
Bodkin and Choksey[4]	1	Operative	Partial neurological recovery
Denis et al.[5]	51	Operative and conservative	Conservative treatment was successful in patients with S1 or S2 sciatica Laminectomy was effective in patients with zone III fractures The results of late decompression were not very favourable
Ebraheim et al.[6]	7	Operative	4/7 improved 3/7 remained unchanged
Epstein et al.[7]	1	Operative	Power improved, pain was resolved
Gibbons et al.[9]	15	Operative and conservative	7/8 operatively treated improved 4/7 conservatively treated improved
Gribnau et al.[10]	8	Operative and conservative	No patient was confined to bed All were able to care for themselves
Harma et al.[11]	2	Operative	Complete neurological recovery
Kim et al.[14]	6	Operative and conservative	Neurological deficit remained in 2/6 patients (operatively treated:1)
Lindahl and Hirvensalo[17]	40	Operative	Complete neurological recovery: 14 Sensory defects: 8
Phelan et al.[20]	4	Conservative	Complete neurological recovery
Sabiston et al.[24]	9	Conservative	Gradual improvement following a slight deterioration
Sapkas et al.[25]	6	Operative	Neurological deficit remained: 5/6
Schmidek et al.[27]	9	Operative and conservative	Partial neurological recovery: 1
Schweitzer et al.[28]	15	Operative	Neurological deficit remained: 2/15
Taguchi et al.[31]	7	Operative	5/7 Motor, sensory, bladder and bowel improvement
Tötterman et al.[33]	17/32 initially evaluated	Operative	Complete neurological recovery: 2/17 Sensory impairments: 29/32
Zelle et al.[36]	13	Operative and conservative	Patients undergoing surgical decompression had a significantly better neurological improvement and physical function
Current study	4	Operative	Complete neurological recovery

Fig. 4. Patient #8. Standard anteroposterior radiograph of the pelvis, at 24 months postoperatively, showing consolidation of the fracture. Notice the bone graft that was used to promote fracture healing.

method, the pelvic ring should always be considered as one unit and be treated as such[26,32]; hence in two patients (#9, #11) we had to implement both posterior and anterior approaches.

Patients suffering from traumatic sacral fractures who were treated conservatively achieved better scores at all the domains of the SF-36 questionnaire,[1,35] when compared with those who were treated operatively (Table 3). This might be explained by the fact that patients treated conservatively had no neurological deficits and less concomitant injuries at their initial evaluation. This is the reason why these patients' average ISS[19] was considerably lower (28.5 points) than that of the patients who were treated operatively (41.1 points). As a result, less morbidity and better functional status were expected at their latest follow-up visit. Compared with our series, the SF-36 values reported by Tötterman et al.[34] (for 31 patients suffering from operatively treated sacral fractures) were lower for all but two domains ('social functioning', 'general health'). Our better results may be related to the relatively longer follow-up period of our study (2 years vs. 1.4 years).

This study has several limitations. Given the scarcity of this type of injury, additional traumatic sacral fractures might have been misdiagnosed or overlooked at our A&E department.[21] The follow-up period was relatively short and the study's population was small and heterogeneous. Consequently, we cannot comment on the advantages and (potential) disadvantages of each operative technique and we cannot favour the operative against the conservative treatment of patients suffering from sacral fractures and vice versa. Another limitation was the fact that we used the SF-36[1,35] score which is characterised by the lack of discriminating ability when assessing patients with multiple injuries.[34] Unfortunately this was the only available general health survey that has been translated and validated into our language.[1] Furthermore, patients completed the SF-36[1,35] questionnaire at their latest follow-up only and not during their initial evaluation as well. Therefore the scores achieved may not reflect the exact status of the patients and may also have been influenced (in favour of the patients with longer follow-up[34]) by the time-interval between the initial diagnosis and their latest follow-up visit.

Conclusions

- Sacral fractures are rare and frequently misdiagnosed.
- Patients suffering from traumatic sacral fractures who were treated conservatively, seem to have better functional and mental/emotional outcome, probably because their injuries were less severe than those of the ones who were treated conservatively.

Conflict of interest

None of the authors had or has any financial and personal relationships (including but not limited to: employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding) with other people or organisations that could inappropriately influence (bias) this work.

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