

Cannulated iliac screw fixation combined with reconstruction plate fixation for Day type II crescent pelvic fractures

Ming Li¹, Dichao Huang¹, Hailin Yan¹, Haiyang Li¹, Liping Wang^{2,3} and Jianghui Dong^{2,3} 

Abstract

Objective: This study was performed to evaluate the safety and efficacy of a single cannulated iliac screw combined with reconstruction plate fixation for crescent pelvic fractures (Day type II).

Method: Thirty adult patients (23 men, 7 women) with a mean age of 42.3 years (range, 22–81 years) were retrospectively reviewed. The time interval between the injury and the operation ranged from 3 to 14 days. The duration of screw insertion, the frequency of C-arm X-ray examination, and the intraoperative blood loss volume were recorded. The minimum follow-up was 12 months (mean, 29 months; range, 12–36 months). Radiographic evaluation was performed using the Matta and Tornetta criteria.

Results: According to the Matta and Tornetta radiological criteria, the reduction was rated as excellent in 20 patients and good in 10 patients. Based on the Majeed functional evaluation at the follow-up appointment, the outcome was rated as excellent in 28 patients and good in 2 patients.

Conclusion: This technique can restrict damage to the surrounding soft tissues, decrease complications, and promote good clinical results.

Keywords

Bone screws, hip fractures, internal fixators, mandibular reconstruction, pelvis, reduction

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Introduction

A crescent fracture is a type of posterior iliac wing fracture that extends into the sacroiliac joint and is always associated with a pubic ramus fracture. This injury pattern is a well-recognized subset of pelvic ring injuries that can result from a lateral force, and it can be classified as Young–Burgess lateral compression type IIB and Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) type 61-B2.2 and 61-B2.3.^{1,2} Moreover, according to the fracture line position at S1 on a pelvic axial computed tomography (CT) scan, Day et al.³ classified crescent pelvic fractures into three distinct types and fixation methods: Day type I, Day type II, and Day type III.

Surgical treatments have been implemented for displaced crescent fractures with or without concomitant sacroiliac joint disruption and crescent fractures associated with pelvic instability and/or deformity and open pelvic fractures. For example, Calafi et al.⁴ used closed reduction with percutaneous iliosacral screw fixation, open reduction with internal fixation (ORIF), and pelvic external fixation for posterior iliac crescent fracture with associated sacroiliac joint disruption (PICFSID). Shui et al.⁵ summarized the surgical treatments for different Day type fractures. Generally, double-plate fixation was used for type I crescent fractures, and internal fixation by means of an interfragmentary screw and neutralization plate was adopted for type II crescent fractures.^{1,6} In addition, Scherer et al.⁷ introduced the LC2 screw fixation technique to treat crescent fractures, in which the screw was implanted from the posterior inferior iliac spine (PIIS) to the anterior inferior iliac spine (AIIS). The supra-acetabular iliac screw and pelvic external fixation screw were placed from the AIIS to the PIIS.^{8,9} Berry et al.¹⁰ found that the suprasciatic intrailiac path passing from the posterior superior

iliac spine (PSIS) toward the AIIS provided a longer and potentially safer anchor site. Sacral fracture with spinopelvic disassociation is an additional indication for iliac screw fixation.¹¹

The iliac screw placement technique from the PSIS can be applied in the lumbopelvic reconstruction technique.¹² The spinopelvic fixation technique¹³ is also suitable for both adult and paediatric patients with spinal deformity. The PSIS is an obvious landmark of the pelvis and is easily recognized during the operation. In this study, a method involving a single cannulated iliac screw combined with reconstruction plate fixation was used in the treatment of Day type II crescent pelvic fractures. The objectives of this study were to summarize the major operation procedures of this technique and evaluate the postoperative clinical effects and prevention of complications.

Materials and methods

This study involved patients who underwent surgical fixation of crescent pelvic fractures using ORIF from January 2014 to December 2017 (Table 1).

The inclusion criteria were a Day type II crescent pelvic fracture in the S2 plane on a CT scan with or without a combined craniocerebral injury, abdominal or chest injury, or limb fracture as well as a stable condition with the ability to tolerate surgery. For patients with diabetes, heart disease, hypertension, cerebral infarction, Parkinson's syndrome, or mental disorders requiring treatment by internal medicine or psychiatry specialists, surgery was performed when the risk of surgery and anaesthesia was reduced. The exclusion criteria were an age of <18 years, follow-up of <1 year, type A pelvic fracture or Day type I or III crescent pelvic fracture, and the presence of acetabular fractures and Duverney fractures of the ilium.

Table 1. Patient demographics and characteristics.

Patient number	Sex/Age (years)	Mechanism of injury	Concomitant injuries	Fracture pattern (Day type/OTA type)	Time to operation (days)	Duration of screw insertion (minutes)/		Intraoperative blood loss (mL)	Outcome	
						Frequency of C-arm use (n)	Matta and Tornetta radiological evaluation		Majeed functional evaluation	
1	M/22	MVA	IULF	Type II/61-B2.1	4	9/3	120	Excellent	Excellent	
2	M/32	Fall	ILLF	Type II/61-B2.1	5	10/3	190	Excellent	Excellent	
3	M/49	MVA	BLLF	Type II/61-B2.3	6	11/3	210	Good	Excellent	
4	M/51	MVA	-	Type II/61-B2.2	6	10/2	210	Excellent	Excellent	
5	M/41	MVA	-	Type II/61-B2.2	3	7/1	120	Excellent	Excellent	
6	M/35	Fall	BLLF	Type II/61-B2.1	10	21/3	260	Good	Excellent	
7	M/40	HWC	-	Type II/61-B2.2	3	15/3	220	Excellent	Excellent	
8	M/33	MVA	-	Type II/61-B2.1	3	7/2	140	Excellent	Excellent	
9	M/70	MVA	TI	Type II/61-B2.1	7	16/4	220	Excellent	Excellent	
10	F/81	Fall	IULF/ILLF	Type II/61-B2.1	7	18/3	240	Good	Excellent	
11	F/38	MVA	-	Type II/61-B2.1	3	8/2	140	Excellent	Excellent	
12	F/34	Fall	HLLF	Type II/61-B2.1	7	7/2	130	Excellent	Excellent	
13	M/62	MVA	IULF	Type II/61-B2.1	6	9/2	230	Excellent	Excellent	
14	M/23	HWC	-	Type II/61-B2.1	3	7/2	120	Excellent	Excellent	
15	M/42	MVA	-	Type II/61-B2.2	3	9/3	130	Excellent	Excellent	
16	M/29	Fall	BLLF	Type II/61-B2.1	8	11/3	210	Good	Excellent	
17	M/33	HWC	-	Type II/61-B2.1	3	8/2	150	Excellent	Excellent	
18	M/39	MVA	HULLF	Type II/61-B2.2	6	12/3	230	Excellent	Excellent	
19	F/25	HWC	-	Type II/61-B2.2	3	8/1	140	Good	Excellent	
20	M/53	HWC	LFNI/UR/AF	Type II/61-B2.1	13	22/6	380	Good	Good	
21	M/49	MVA	IULF	Type II/61-B2.1	6	9/2	130	Excellent	Excellent	
22	M/34	HWC	-	Type II/61-B2.1	3	8/1	120	Good	Excellent	
23	M/29	MVA	AI	Type II/61-B2.2	12	16/2	230	Excellent	Excellent	
24	M/38	Fall	LFNI/CI	Type II/61-C2.1	7	10/2	170	Excellent	Excellent	
25	F/71	Fall	HLLF/IULF	Type II/61-B2.1	6	11/2	210	Good	Excellent	
26	M/41	MVA	LF/BULF	Type II/61-B2.1	8	16/3	210	Excellent	Excellent	
27	F/65	Fall	ILLF	Type II/61-B2.3	9	17/2	250	Excellent	Excellent	
28	F/49	MVA	HULLF/LF	Type II/61-C1.2	13	17/4	300	Good	Good	
29	M/35	HWC	ILLF	Type II/61-B2.1	7	11/3	200	Excellent	Excellent	
30	M/72	Fall	HLLF	Type II/61-B2.3	7	15/3	250	Good	Excellent	

M: male, F: female, MVA: motor vehicle accident, HWC: heavy weight collision, IULF: ipsilateral upper limb fractures, HULLF: heterolateral upper limb fractures, ILLF: ipsilateral lower limb fractures, HLLF: heterolateral lower limb fractures, BLLF: bilateral lower limb fractures, BULF: bilateral upper limb fractures, LF: lumbar fracture, LFNI: lumbar fracture combined with nerve injury, CI: craniocerebral injury, TI: thoracic injury, AI: abdominal injury, AF: acetabular fracture, UR: urethral rupture.

All operations were performed by one senior orthopaedic surgeon (first author). All operations were performed with the patient under general anaesthesia. We initially performed reduction and internal fixation of ipsilateral femoral or tibial fractures; thus, rendering traction was more convenient during surgery. The lateral position was used, and the side of the operation

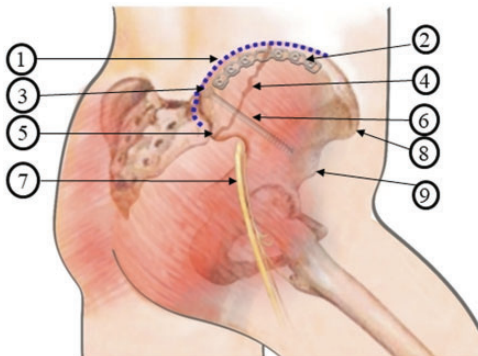


Figure 1. Schematic drawing indicating a pelvic fracture with cannulated screw fixation and reconstruction plate fixation (the patient was placed in the left lateral decubitus position). ① Dotted line represents skin incision. ② Reconstruction plate fixation. ③ Posterior superior iliac spine. ④ Fracture line. ⑤ Posterior inferior iliac spine. ⑥ Cannulated iliac screw. ⑦ Sciatic nerve. ⑧ Anterior superior iliac spine. ⑨ Anterior inferior iliac spine.

was on the top, which was convenient for placing the screw from the PSIS. The PSIS is a palpable key landmark that can be imaged with sufficient quality to ensure safe screw placement. After the operation area was exposed, the displaced and unstable fractures of the superior ramus of the pubis were first fixed with reconstruction plates. The iliac spine fracture was then stabilized using a reconstruction plate. Finally, the cannulated iliac screw was inserted. A schematic drawing of the operation in this study is shown in Figure 1.

The cannulated iliac screw entry position is the highest point of the PSIS (Figures 1 and 2). The process of placing the cannulated iliac screw is presented in Figure 2. The bone over the PSIS was removed with a rongeur to accommodate the screw cap and minimize hardware prominence. Using a surgical incision at the iliac crest, the operator was able to touch the outer table or the inner table of the iliac fracture with a finger to guide the Kirschner wire (Figure 2). The typical trajectory was a $45^\circ \pm 5^\circ$ angle of medial angulation from the sagittal plane and a $15^\circ \pm 5^\circ$ angle of cephalad angulation from the coronal plane. The Kirschner wire was not placed too close to the sciatic notch to avoid its invasion of the superior gluteal vessels and nerves.

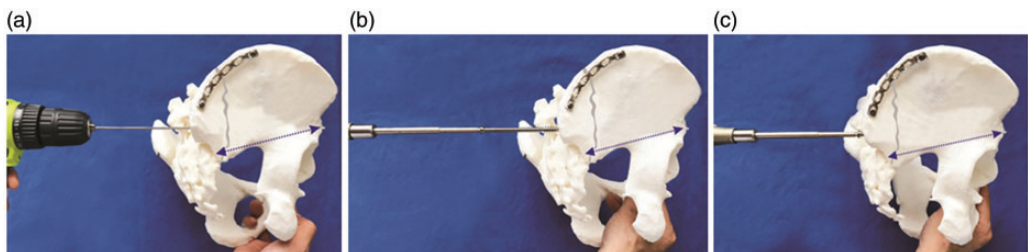


Figure 2. Three-dimensional model showing the surgical technique with cannulated iliac screw for a pelvic fracture. The screw trajectory is between the posterior superior iliac spine (PSIS) and Anterior inferior iliac spine (AIIS). (a) A guide wire (Kirschner wire) was placed from the PSIS toward the AIIS. (b) A cannulated iliac screw was placed from the PSIS toward the AIIS along the guide wire, and (c) the cannulated iliac screw was completed. The blue arrow demonstrates the projected tract of an LC2 screw (from the posterior inferior iliac spine to the AIIS).

A Kirschner wire with a leaning angle of more than 50° in the sagittal plane will invade the pelvic cavity and damage the pelvic organs and branch vessels of the internal iliac artery and vein.

Postoperative images, including radiographs and CT scans, were obtained to assess the fracture pattern, position of the reduction, and screw trajectory. Postoperative CT scans were performed to analyse the accuracy of screw placement via reconstruction of CT images in the axial, coronal, and sagittal planes. The postoperative rehabilitation protocol included restriction of toe-touch weight-bearing activity for 8 weeks. Patients with lower limb fractures could not safely ambulate, and bed-to-chair transfers with assistance were provided until the patients had advanced to full weight-bearing activity. Patients with a single crescent pelvic fracture were also recommended to walk with crutches under partial weight bearing at 8 weeks postoperatively. Full weight bearing was achieved 10 weeks postoperatively. We also advised patients to attend follow-up every 3 months for the first year postoperatively.

Results

The patients' details are presented in Table 1. Thirty adult patients (23 men, 7 women) with a mean age of 42.3 years (range, 22–81 years) who underwent surgical fixation for crescent pelvic fractures and had a minimum follow-up of 12 months (mean, 29 months; range, 12–36 months) were retrospectively reviewed. These patients were part of a cohort of 287 patients who underwent surgical fixation from January 2014 to December 2017. The average duration of screw insertion was 11.8 minutes (range, 7–22 minutes). The intraoperative blood loss volume was 195 mL (range, 120–380 mL). The frequency of C-arm use in the process of screw insertion was 2.6 times (range, 1–6 times). The red blood cell transfusion volume during the

operation was 0.8 U (range, 0–3 U), and autologous blood transfusion was performed in 19 patients (63.3%). According to the AO/OTA classification, 17 (56.7%) patients had 61-B2.1 fractures, 8 (26.7%) had 61-B2.2 fractures, 3 (10.0%) had 61-B2.3 fractures, 1 (3.3%) had a 61-C1.2 fracture, and 1 (3.3%) had a 61-C2.1 fracture.

The obturator oblique view showed that the screw position was located in the cancellous bone corridor between the inner and outer tables of the ilium superior to the acetabular dome from the PSIS to the AIIS (Figures 3(h) and 4(f)). The images in Figures 3 to 5 show that the Kirschner wire near the arch line did not invade the pelvic cavity. Percutaneous sacroiliac screw fixation was conducted if the fracture was also combined with sacroiliac joint dislocation (Figure 5).

One patient (Patient 24 in Table 1) had a right lumbosacral plexus injury before the operation. The patient's muscle strength and sensation had basically returned to normal at 26 months after surgery, and only numbness of the skin remained in the anterior region of the patella. In one 81-year-old woman (Patient 10 in Table 1), the postoperative CT scan showed that the tip of the screw had penetrated the external table of the ilium approximately 5.0 mm into the hip muscles; however, it did not cause any uncomfortable symptoms. The fractures healed, and the patient resumed self-care after 1 year of follow-up. For the other patients, the cannulated iliac screws were in the expected location as confirmed by postoperative radiographs and CT scans, and no screws had intruded into the hip joint or sacroiliac joint (Figures 3–5). According to the Matta and Tornetta radiological evaluation criteria,^{14,15} the reduction was rated excellent in 20 patients and good in 10 patients. In addition, according to the Majeed¹⁶ functional evaluation at the final follow-up, the outcome was rated excellent in 28 patients and good

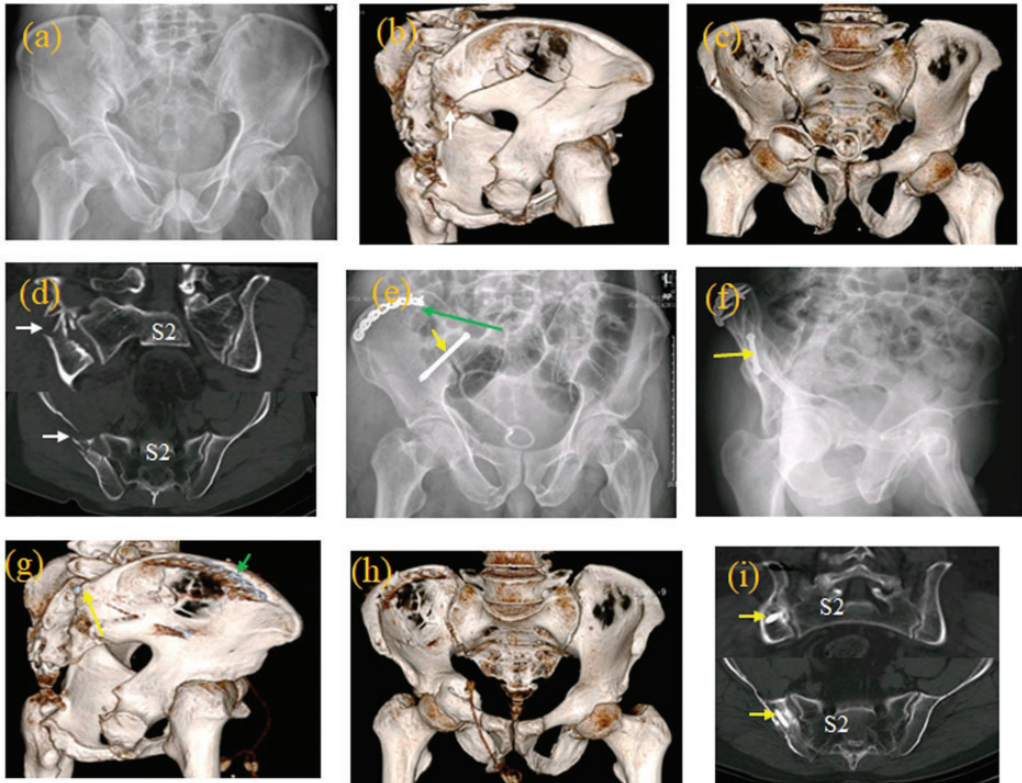


Figure 3. A 40-year-old man with an Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association type 61-B2.2 crescent pelvic fracture (Day type II) resulting from heavy weight collision (Patient 7 in Table I). (a) Anteroposterior view of preoperative pelvic three-dimensional computed tomography (3D-CT) scan. (b) Right view of preoperative 3D-CT scan on the outside of the ilium showing the ilial crescent fracture. (c) Preoperative CT scan in the transverse plane. (d) Anteroposterior view of postoperative pelvic 3D-CT scan. (e) Postoperative 3D-CT scan on the outside of the right ilium. (f) Postoperative CT scan at S1/2 in the transverse plane showing that the cannulated iliac screw is located in the cancellous bone channel between the inner and outer tables of the ilium. (g) Oblique view of radiographic image at 14 months after surgery showing fracture healing. (h) Obturator oblique view of radiographic image showing that the cannulated iliac screw is between the inner and outer tables of the ilium. (i) Anteroposterior view of radiographic image at 15 months after surgery showing fracture healing with removal of the cannulated iliac screw. The yellow arrows indicate the cannulated iliac screw, and the green arrows indicate the iliac crest reconstruction plates.

in 2 patients, and the good-to-excellent rate was 100%. No mortality, wound infection, sciatic nerve or superior gluteal nerve injury, or deep venous thrombosis of the lower extremity occurred in any patients. Additionally, no nonunion, malunion, loss of reduction, or breakage of the internal

fixation devices occurred during follow-up (Table 1).

Discussion

The Day classification is defined by CT images in the transverse plane parallel to

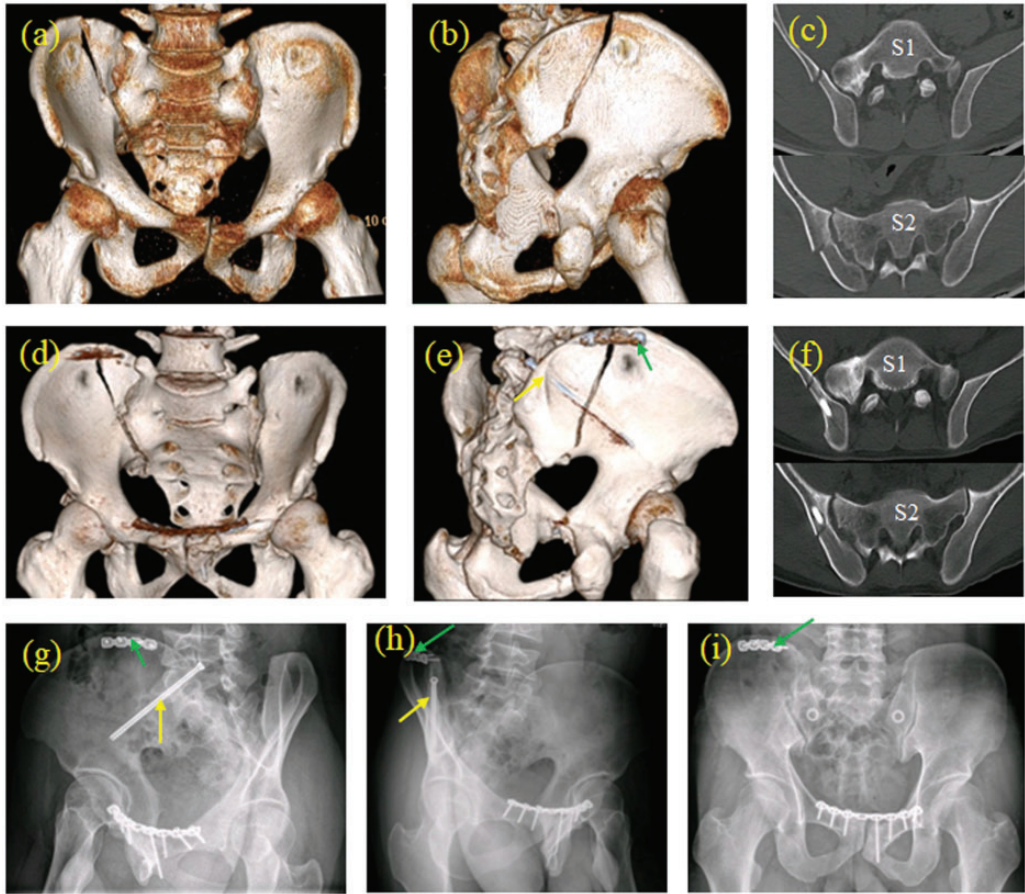


Figure 4. A 53-year-old man with an Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association type 61-B2.1 crescent pelvic fracture (Day type II) caused by a fall (Patient 20 in Table 1). (a) Anteroposterior view of preoperative pelvic radiographic image. (b) Right view of preoperative three-dimensional computed tomography (3D-CT) scan on the outside of the ilium. (c) Anterior view of preoperative pelvic 3D-CT scan. (d) Preoperative CT scan at S2 in the coronal and transverse planes. (e) Anteroposterior view of postoperative pelvic radiographic image. (f) Obturator oblique view of postoperative radiographic image. (g) Postoperative 3D-CT on the outside of the right ilium at the 22-month follow-up. (h) Anteroposterior view of postoperative pelvic 3D-CT scan. (i) Postoperative CT scan at S2 in the coronal and transverse planes. The white arrows indicate the fractures, the yellow arrows indicate the cannulated iliac screw, and the green arrows indicate the iliac crest reconstruction plates.

the sacroiliac superior endplate; that is, the position of the fracture line is on the one-third plane of the S1 vertebral body.³ The projection of the sacroiliac joint on the outer table of the ilium is not a straight line but a curve. Therefore, the fracture line extends from the one-third to

one-fourth area of the posterior iliac crest to the crescent fracture in the PIIS. The fracture line in the S1 plane enters the anterior one-third of the sacroiliac joint, while the fracture line in the S2 plane enters the middle one-third of the sacroiliac joint. In this study, the crescent pelvic fractures were

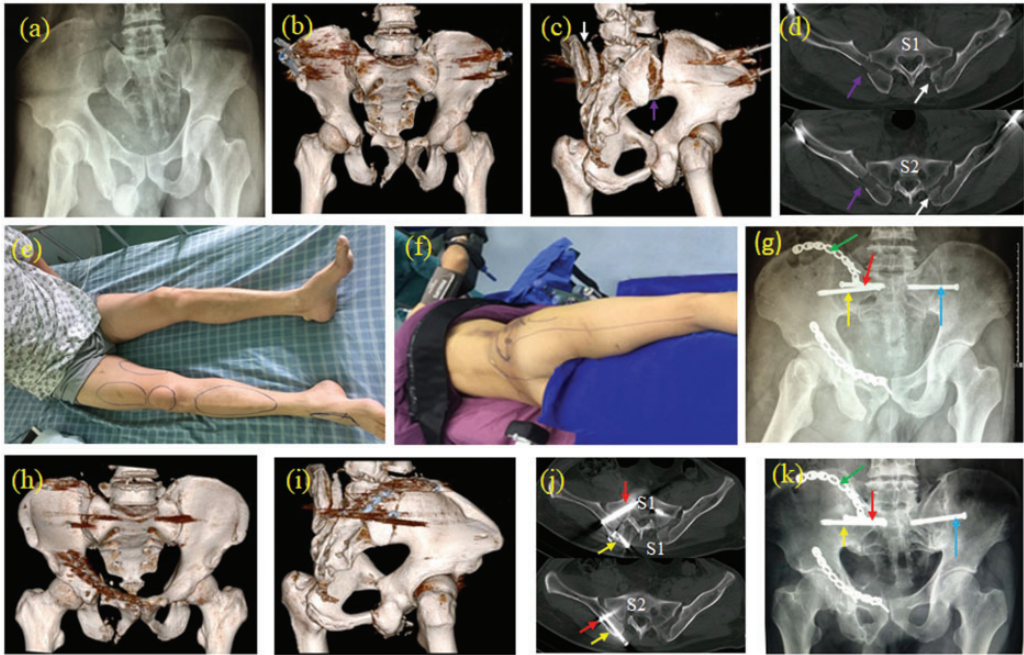


Figure 5. A 38-year-old male construction worker with an Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association type 61-C2.1 crescent pelvic fracture (Day type II) after a fall from a high building (Patient 24 in Table I). (a) Anteroposterior view of a radiographic image of the pelvis. (b) Preoperative pelvic three-dimensional computed tomography (3D-CT) scan showing that the pelvis was fixed by external fixation. (c) Preoperative 3D-CT scan on the outside of the right ilium. (d) Preoperative CT scan in the transverse plane showing a Day type II fracture. (e) The area marked on the skin of the right lower limb was the area of skin numbness, and the muscle force of the quadriceps was level 3. (f) Intraoperative left lateral position (floating position). (g) Anteroposterior view of postoperative radiographic image of pelvis. The yellow arrow indicates the cannulated iliac screw, the green arrow indicates the iliac crest reconstruction plate, the red arrow shows the right-side sacroiliac screw, and the blue arrow shows the left-side sacroiliac screw. (h, i) Postoperative 3D-CT scan of the anterior pelvis and right ilium. (j) Postoperative CT scan in the transverse plane. (k) Anteroposterior view of a radiographic image at 26 months after surgery.

classified according to the position of the fracture line in the S2 plane of the axial CT scan (Figures 3–5). The S2 plane in the axial CT scan more realistically reflects the damage of the sacroiliac joint. Based on a report regarding PICFSID,⁴ 12% of the PICFSIDs were not easily grouped according to the Day type classification system. The posterior iliac fracture obliquity did not correspond to the position of the principal fracture line as defined by the Day type criteria. In these variants, the principal

fracture line was essentially parallel to the sacroiliac joint on the axial CT images, and the posterolateral cortex of the unstable iliac segment remained intact. ORIF with either an anterior or posterior surgical approach was adopted when accurate closed reduction and percutaneous screw fixation for the injuries were not possible. Anterior pelvic ring reduction and stabilization were injury-specific and consisted of pubic symphysis plating, superior pubic ramus medullary screw fixation, anterior

pelvic external fixation, or a combination of these constructs.

Berry et al.¹⁰ reported that the suprasciatic intrailiac path passing from the PSIS toward the AIIS was significantly longer than the path from the PSIS to the superior rim of the acetabulum in adults and teenagers. The screw trajectory was from the PSIS to the AIIS, allowing for screws of up to 100 mm in most adult patients. The minimum thickness of the paths directly above the sciatic notch was 20.2 ± 2.4 mm. The anchor passage running from the PSIS to the AIIS achieved the optimum intra iliac anchor stiffness and strength. Zheng et al.¹⁷ found that the length of the line between the PSIS and the AIIS was 140.6 ± 1.1 mm, and the distance between this line and the greater sciatic notch was 18.3 ± 0.8 mm. The bone mass is very rich in the area superior to the linea arcuata, which is the connecting line between the PSIS and the AIIS. In general, two internal fixation methods are available for inserting screws from the posterior aspect of the ilium. The first method is insertion of LC2 screws, and the screw trajectory is from the PIIS to the AIIS² (Figure 2). The second method is insertion of iliac screws, and the screw trajectory is from the PSIS to the AIIS¹³ (Figure 2). Both screw trajectories are located superior to the iliosciatic notch.

Iliac screw fixation is commonly used as part of a spinal instrumentation construct to provide stability across the lumbosacral junction. Iliac screw fixation techniques can be applied to spinopelvic fixation and sacral fractures with spinopelvic disassociation, and the starting point of insertion of the iliac screws is from the PSIS.¹³ Iliac screw fixation has been used to prevent premature loosening of sacral fixation and to provide more rigid fixation of the sacropelvic unit.¹⁸

Intraoperative anteroposterior fluoroscopy accurately reflects the distance from the iliac screw to the sciatic notch.¹⁹ Paediatric spinal deformity correction

surgery using the lumbopelvic reconstruction technique relies on identification of the PSIS and high-quality anteroposterior fluoroscopic imaging to view the pelvic inlet for iliac screw placement.¹²

Crescent pelvic fracture dislocation is considered rotationally unstable and vertically stable and is usually classified as AO/OTA type 61-B2.2 or 61-B2.3.² AO/OTA type 61-C with iliac crescent fracture dislocation has also been reported.²⁰ In the present study, two patients had AO/OTA type 61-C fractures; one fracture was type 61-C1.2 and the other was 61-C2.1. The injury mechanism in these two cases was heavy weight collision. The possible mechanism of vertically unstable posterior iliac crescent fracture dislocation is both lateral compression and vertical shear trauma, resulting in both vertical and rotational instability. When the initial surgery is not possible because of severe associated organ injuries in patients with vertically unstable iliac crescent fracture dislocation, transcondylar traction allows reduction of the sacroiliac joint and ORIF at a later stage.

Despite the protrusion of the PSIS from the skin being useful for intraoperative localization, it is still difficult to locate the surface of the PIIS during surgery by manual touching. In addition, the bone mass in the PIIS area is smaller than that in the PSIS area; thus, the holding force of screws is weaker and the risk of screws penetrating the bone cortex is relatively higher.

The line that links the PSIS with the AIIS runs transversely through two acetabular columns with an adequate cancellous bone mass. The area surrounded by the inner and outer tables of the ilium forms a relatively safe cancellous bone tunnel, where anatomical variations and sex-related differences are small. Important structures adjacent to the screw path include the sciatic nerve, the superior gluteal vessels, and the superior gluteal nerve.

If the screw penetrates the bone cortex, it might also invade these structures.

Compared with internal plate fixation, cannulated screw fixation can reduce surgical trauma and protect the soft tissues and residual blood circulation. Busuttil et al.²¹ compared the biomechanical stability of the screw-only fixation technique with that of the standard anatomical buttress plate fixation technique in an anterior column posterior hemitransverse fracture model. In this *in vitro* biomechanical study, screw-only fixation had construct survival at least as good as that provided by standard anatomical buttress plate fixation. In addition, for fixation of anteroposterior compression type 2 pelvic ring injuries, Avilucea et al.²² suggested that use of an anterior plate with a supplemental posterior screw significantly decreases the rate of anterior plate failure and malunion compared with the use of an anterior plate alone. Cannulated screw internal fixation requires only a reduction incision, and the incision length is one-half to one-third the length of the plate fixation incision. During the operation in their study, this technique caused much less damage to the soft tissues and bones adjacent to the fracture compared with plate fixation, which reduced the disturbances to the important nerves, vessels, and blood supply in the region.²² The complications related to the operation also decreased. The screw path was in the safe cancellous tunnel between the inner and outer tables of the ilium, which was equivalent to intramedullary fixation. This technique achieved better resistance to lateral displacement and lateral shearing stress compared with plate fixation. Additionally, compared with pelvic reconstructive plate fixation, intraoperative shaping was avoided and the operation time, blood loss, anaesthetic dosage, and intraoperative C-arm fluoroscopy time were reduced.²²

Iliac screw fixation also has disadvantages. For example, the screw cap protrudes

from the subcutaneous tissue of the PSIS and is uncomfortable for patients. In our early cases, we removed the screws after fracture healing. In later cases, we removed an approximately 5- × 5-mm bone mass in the bulge region of the PSIS, and the screw cap was buried in the iliac bone to avoid postoperative discomfort. The present study provided an alternative method to treat these injuries.

Surgery-related complications occurred in only one patient because the screw cap protruded subcutaneously, causing discomfort. According to the Matta and Tornetta radiological evaluation criteria, the reduction was rated excellent in 20 patients and good in 10 patients. The surgical indications in our study group were strictly selected, and the excellent-to-good rate of postoperative reduction and function reached 100%. However, because of the lack of well-designed reduction instruments, a reduction incision was still necessary at the iliac fracture site. Therefore, a minimally invasive operation could not be achieved. Additionally, the sample size was small and could not fully reflect the advantages and disadvantages of the technology. Long-term follow-up of more than 6 years is lacking, and the long-term complications of this technique cannot be determined. The number of patients in whom this technique has been applied is not very large; in particular, it has been applied in very few children and older individuals. Therefore, further data collection is needed to perform high-quality randomized controlled studies with reconstruction plate fixation and to prove the advantages of the technique.

Conclusion

A single cannulated iliac screw combined with reconstruction plate fixation was implemented in patients with Day type II pelvic fractures. This technique can reduce the risks of surgery, and the learning curve

is relatively short. It also provides a clinical treatment method for pelvic fractures with higher safety and practicability, fewer complications, and an easier operation.

Author contributions statement

Conceived and designed the study: Ming Li, Liping Wang, Jianghui Dong. Implemented the surgery: Ming Li. Patient follow-up: Dichao Huang, Hailin Yan. Analysed and interpreted the data: Haiyang Li. Wrote the manuscript: Ming Li, Liping Wang, Jianghui Dong.

Consent for publication

Written consent was received from the patients for the use of their data.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Ethical approval

All procedures involving human participants were performed in accordance with the recommendations of the institutional review board of Ningbo No. 6 Hospital and with those of the 1964 Helsinki Declaration. The institutional review board of Ningbo No. 6 Hospital approved the study, and informed consent was obtained from all patients involved in the study.

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