



Minimally invasive surgical treatment using ‘iliac pillar’ screw for isolated iliac wing fractures in geriatric patients: a new challenge

Weon-Yoo Kim^{1,2} · Se-Won Lee^{1,3}  · Ki-Won Kim^{1,3} · Soon-Yong Kwon^{1,4} · Yeon-Ho Choi⁵

Received: 1 May 2018 / Accepted: 29 October 2018 / Published online: 1 November 2018
© Springer-Verlag GmbH Germany, part of Springer Nature 2018

Abstract

Purpose There have been no prior case series of isolated iliac wing fracture (IIWF) due to low-energy trauma in geriatric patients in the literature. The aim of this study was to describe the characteristics of IIWF in geriatric patients, and to present a case series of IIWF in geriatric patients who underwent our minimally invasive screw fixation technique named ‘iliac pillar screw fixation’.

Materials and methods We retrospectively reviewed six geriatric patients over 65 years old who had isolated iliac wing fracture treated with minimally invasive screw fixation technique between January 2006 and April 2016.

Results Six geriatric patients received iliac pillar screw fixation for acute IIWFs. The incidence of IIWFs was approximately 3.5% of geriatric patients with any pelvic bone fractures. The main fracture line exists in common; it extends from a point between the anterosuperior iliac spine and the anteroinferior iliac spine to a point located at the dorsal 1/3 of the iliac crest whether fracture was comminuted or not. Regarding the Koval walking ability, patients who underwent iliac pillar screw fixation technique tended to regain their pre-injury walking including one patient in a previously bedridden state. The visual analog scale score for pain at the last follow-up was quite satisfactory. Union was achieved in all patients at the last follow-up.

Conclusions Geriatric patients can have a form of IIWF caused by low-energy trauma that is a type of fragility fracture of the pelvis. Because subsequent deterioration of their walking status followed by a long period of non-weight bearing in geriatric patients could be as threatening as the fracture itself, the treatment paradigm for IIWF due to low-energy trauma in geriatric patients should differ from that due to high-energy trauma in most patients. In these types of fractures, minimally invasive surgical management that includes iliac pillar screw fixation can lead to good outcomes.

Keywords Fractures · Bone · Fixation · Fatigue · Crest bone · Iliac

✉ Se-Won Lee
ssewon@naver.com; ssewon@gmail.com

¹ Department of Orthopedic Surgery, College of Medicine, The Catholic University of Korea, Seoul 06591, Republic of Korea

² Department of Orthopedic Surgery, Daejeon St. Mary’s Hospital, College of Medicine, The Catholic University of Korea, Daejeon 34943, Republic of Korea

³ Department of Orthopedic Surgery, Yeouido St. Mary’s Hospital, College of Medicine, The Catholic University of Korea, 10, 63-Ro, Yeongdeungpo-Gu, Seoul 07345, Republic of Korea

⁴ Department of Orthopedic Surgery, College of Medicine, St. Paul’s Hospital, The Catholic University of Korea, Seoul 02559, Republic of Korea

⁵ Department of Orthopedic Surgery, College of Medicine, St. Vincent’s Hospital, The Catholic University of Korea, Suwon 16247, Republic of Korea

Introduction

In general, isolated iliac wing fractures (IIWFs) occur as a result of high-energy trauma, such as a direct blow to the side, in young patients [1]. IIWFs are uncommon, with a prevalence of 2.2% [2]. The mechanism of injury is usually high-energy trauma, such as a bicycle or lap seatbelt accident in pediatric patients or a motor vehicle accident or fall in adults [2]. However, in our experience, IIWFs can also result from low-energy trauma in geriatric patients. IIWFs due to low-energy trauma in the geriatric population have different characteristics from those due to high-energy trauma in young adults.

In general, these isolated fractures are considered stable fractures, as they do not compromise the stability of the pelvic ring and are considered amenable to conservative treatment. Analgesics and instructions for non-weight bearing

may be all that is necessary for treatment of IIWFs in most patients. However, when these fractures occur in geriatric patients, subsequent deterioration of their walking status, followed by a long period of non-weight bearing could be as threatening as the fracture itself. These patients may also have decreased bone healing ability, and their bone quality may become weak enough to cause another low-energy fracture in consequence of non-weight bearing. Furthermore, these fractures frequently cause excruciating pain, which significantly impairs quality of life. We believe that the treatment paradigm for IIWFs due to low-energy trauma in geriatric patients should differ from that of IIWFs due to high-energy trauma in most patients.

Thus, we have recommended surgical treatment in all geriatric patients with IIWFs, and performed minimally invasive screw fixation using the ‘iliac pillar,’ which is the thickest, column-like structure of the ilium [3], to treat geriatric patients with IIWFs due to low-energy trauma. To our knowledge, no previous case series have been published on IIWFs due to low-energy trauma in geriatric patients, nor has this group been described separately as a manifestation of fragility fracture of the pelvis. Thus, the aim of this study was to describe the characteristics of IIWFs in geriatric patients and to present a case series of geriatric patients with IIWFs who were treated with our minimally invasive screw fixation technique.

Materials and methods

Patients

We reviewed the medical records, radiographs, and computed tomography (CT) scans of 381 patients, who were admitted to our hospital for any pelvic bone fractures, with or without subsequent surgery, between January 2006 and

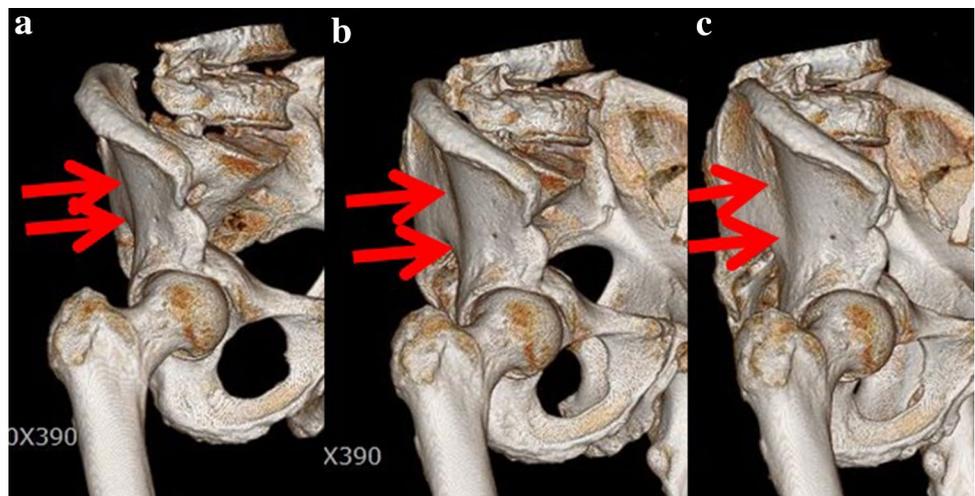
April 2016. The diagnosis of pelvic fracture was confirmed on anteroposterior, inlet, and outlet plain pelvic films, as well as a computed tomography (CT) scan. We identified 179 patients under 65 years and 202 patients over 65 years with pelvic bone fractures. After exclusion of cases associated with complete disruption of the pelvic ring or fractures extending to the acetabulum, seven patients were diagnosed with IIWFs. Since the distinction between high-energy and low-energy trauma can be ambiguous, we did not include the injury mechanism in our exclusion criteria. Among the seven patients, one refused surgical treatment due to terminal lung cancer and six consented to undergo surgical treatment. Finally, six patients were diagnosed with IIWFs and underwent the minimally invasive operation; all of these patients were over 65 years old.

All surgical treatments and decisions related to treatment plans were performed by the senior author. Patients who met the criteria for inclusion in the study were asked to return for a clinical and radiologic examination, at which time additional data were collected on pain, other symptoms, and outcome, specifically return to work and patient satisfaction. All patients were evaluated by a surgeon who was not responsible for any part of the patient’s treatment. Approval from the local institutional review board was obtained for this study.

Surgical technique

The iliac pillar is the bony thickening located vertically above the acetabulum on the lateral surface of the ilium and extending to the iliac tubercle, which is the thickening on the superior margin of the ilium [3] (Fig. 1). Our fixation technique used the iliac pillar as a corridor for a long-cannulated screw, taking advantage of the excellent bone stock around the posterior column of the acetabulum. Surgical intervention occurred after the patients’ general

Fig. 1 Red arrows indicate the ‘iliac pillar’ structure of the ilium on three-dimensional computed tomography



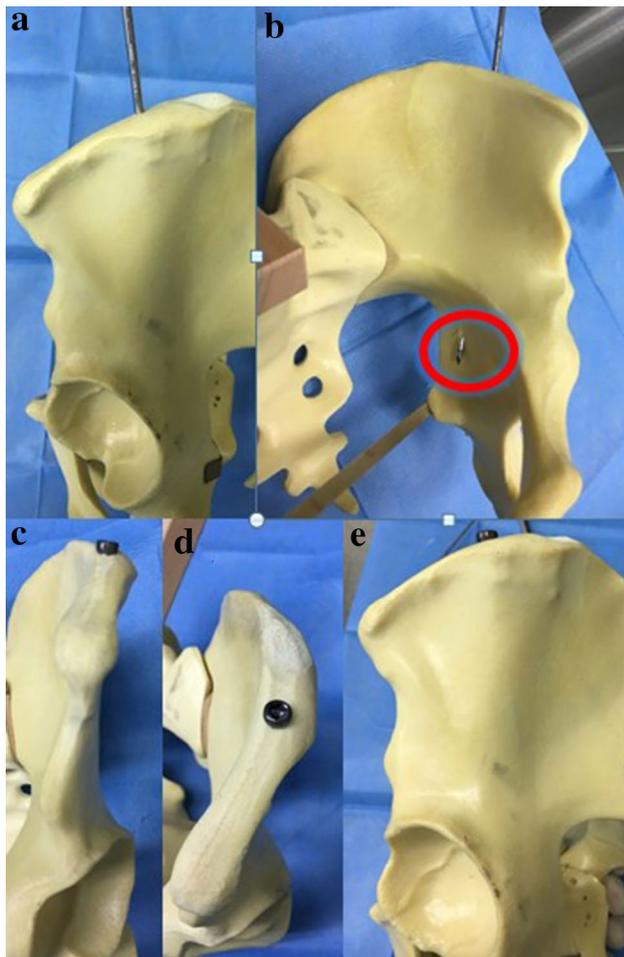


Fig. 2 Iliac pillar screw insertion in a saw-bone model. At the inner portion of the iliac tubercle, a guide pin was inserted along the iliac pillar toward the posterior part of the acetabulum until there was resistance to penetration (a, b). Then a reamer with a cannulated screw was tried along the guide pin with low velocity until it reached the fracture line. A long, 6.5-mm diameter cannulated screw (40 mm threaded) that was about 1 cm shorter than the measurement was inserted along the guide pin (c–e). Because the threaded portion of the screw was fixed without reaming into the posterior column of the acetabulum with good bone stock, this iliac pillar screw functioned like a post embedded in solid ground

medical condition had been stabilized and evaluated to assess the possibility of perioperative complications. All surgical treatments were performed 2–7 days after injury.

Usually, the patient is placed in a supine position on a radiolucent table. The image intensifier was placed contralateral to the injured side of the patient. The iliac tubercle was palpated, and a 5-cm skin incision was made to access the iliac crest, from the iliac tubercle to the intersection of the iliac crest and the posterior fracture line. The abdominal and iliacus muscles of the inner table of the ilium were elevated as Kern bone-hold forceps were applied on the iliac crest portion of the fractured ilium. Under an image intensifier, fracture reduction was

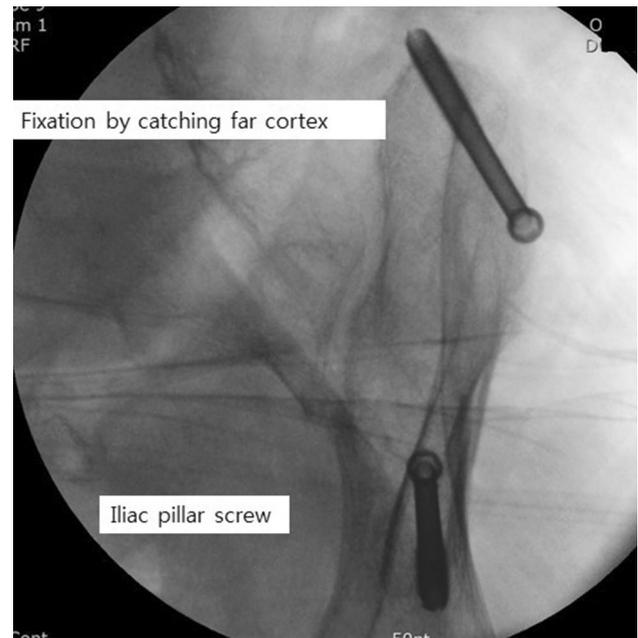


Fig. 3 Intraoperatively, the supraacetabular triangle with a 15° inlet view of the iliac oblique view is helpful in positioning the iliac pillar screw onto the supraacetabular area

Table 1 Koval walking ability index

| Walking ability | Score |
|---------------------------------|-------|
| Independent community ambulator | 1 |
| Community ambulator with cane | 2 |
| Community ambulator with walker | 3 |
| Independent household ambulator | 4 |
| Household ambulator with cane | 5 |
| Household ambulator with walker | 6 |
| Nonfunctional ambulator | 7 |

attempted while handling the Kern bone-hold forceps carefully and palpating with the surgeon's finger on the posterior fracture line. At the posterior part of the crest of the fractured ilium, a guide pin was inserted, penetrating as close as possible to the far cortex along the iliac crest. At the inner portion of the iliac tubercle, another guide pin was inserted along the iliac pillar toward the posterior part of the acetabulum until there was resistance to penetration, and the far cortex was not penetrated. Then a reamer with a cannulated screw was tried along the guide pin with low velocity until the fracture line was reached. A long-cannulated screw (6.5 mm diameter, 40 mm threaded) that was about 1 cm shorter than the measurement was inserted along the guide pin (Fig. 2.). Because the threaded portion of the screw was fixed without reaming into the posterior column of the acetabulum with its good bone stock,

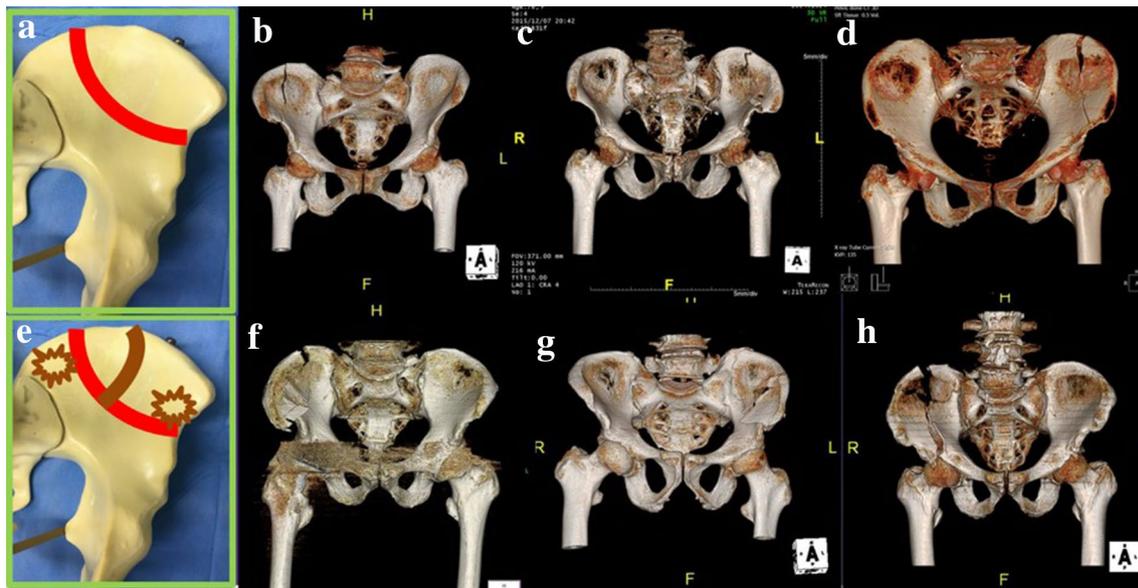


Fig. 4 Three patients (**b–d**) had IWFs without fracture comminution showed a characteristic main fracture line extending from a point between the anterosuperior iliac spine (ASIS) and the anteroinferior iliac spine (AIIS) to a point located at the dorsal 1/3 of the iliac crest

(**a**). Three patients who had IWFs with fracture comminution (**f–h**) also showed the main fracture line. However, they had one or two additional fracture lines and comminuted fracture pattern around the main fracture line (**e**)

this iliac pillar screw acted like a post embedded in solid ground. An additional cannulated screw was inserted along the guide pin to catch the far cortex of the intact iliac crest.

Fluoroscopy can be used to assess whether the placement of the iliac pillar screw has been accurately determined. This assessment involves a combination of anteroposterior, inlet, outlet, obturator oblique, and iliac oblique views. Among them, the supraacetabular triangle with a 15° inlet view of the iliac oblique view is helpful in positioning the iliac pillar screw onto the supraacetabular area (Fig. 3).

Weight bearing was permitted within 1 week after injury. Rehabilitation and return to a pre-injury walking level were guided by tolerance of pain-free activity. After discharge from the hospital, patients were instructed to return for evaluation at postoperative 1, 2, and 3 months and thereafter at 3-month intervals. At each follow-up visit, data were collected on complications, visual analog scale scores for pain, and the Koval walking ability, which grades ambulatory ability from independent community ambulatory (grade 1) to nonfunctional ambulatory ability (grade 7) (Table 1) [4]. In addition, at each follow-up visit, anteroposterior, inlet, and outlet radiographs of the pelvis were obtained.

Statistical methods

Since this was a case series, inferential statistical analysis was not appropriate. Simple summary statistics were used instead.

This study was approved by our hospital's institutional review board.

Results

Six geriatric patients received iliac pillar screw fixation for acute IWFs between January 2006 and April 2016. The incidence of IWFs was approximately 3.5% of geriatric patients with any pelvic bone fractures. Patients were followed up for a minimum of 6 months (range 6–24 months). There were two males and four females with a mean age of 77.5 years (range 66–91 years) and a mean time from injury to surgery of 3.4 days (range 2–7 days). The mean time between surgery and when the patient began walking with a walker was 7 days (range 3–14 days), except for one patient who was bedridden even before the fracture occurred.

Regarding the fracture pattern, three patients had IWFs without fracture comminution. Their main fracture line extended from a point between the anterosuperior iliac spine (ASIS) and AIIS to a point located at dorsal 1/3 of iliac crest. Three patients who had IWFs with fracture comminution also showed the main fracture line. However, they had one or two additional fracture lines and comminuted fracture pattern around the main fracture line (Fig. 4).

Satisfactory fracture reduction was achieved in all six patients. Postoperative infection was not observed in this cohort. However, one patient who complained of posterior

screw-induced irritation of the gluteal muscle area underwent implant removal for symptomatic implants (patient number 2). Regarding the Koval walking ability, patients who underwent iliac pillar screw fixation tended to regain their pre-injury walking ability, including one patient who was previously bedridden (patient number 5). The visual analog scale score for pain at the last follow-up was quite satisfactory (Table 2). In all patients, the reduced iliac wing fracture was well maintained through the last follow-up, as evaluated on radiographs (Fig. 5). Union was achieved in all patients at the last follow-up. Union time was not available in our data. None of the six cases had intrapelvic combined injuries, neurological symptoms, or hemodynamic instability, and none received a plate. In four cases, one iliac pillar screw and one additional screw were fixed, but in two cases one iliac pillar screw and two additional screws were fixed.

Discussion

In general, IIWFs are considered stable fractures, as they do not compromise the stability of the pelvic ring, and they are amenable to conservative treatment. Analgesics and instructions for non-weight bearing may be all that is necessary for treatment of IIWFs in most patients [2]. However, when these fractures occur in geriatric patients, subsequent deterioration of their walking status followed by a long non-weight-bearing period could be as threatening as the fracture itself. Above all, non-weight bearing for a long period can lead to secondary complications. Therefore, we suggest that the treatment paradigm for IIWFs due to low-energy trauma in geriatric patients should differ from that due to high-energy trauma in most patients. In these fractures, with minimally invasive surgical management that includes iliac pillar screw fixation, subsequent adverse effects can be avoided.

The iliac pillar is the bony thickening located vertically above the acetabulum on the lateral surface of the ilium and extending to the iliac tubercle, which is the thickening on the superior margin of the ilium (Fig. 1). This fixation technique uses the iliac pillar as a corridor for a long-cannulated screw, taking advantage of the excellent bone stock around the posterior column of the acetabulum. A long-cannulated screw (40 mm threaded) that is about 1 cm shorter than the measurement was inserted along the guide pin. Because the threaded portion of the screw was fixed without reaming into the posterior column of the acetabulum with its good bone stock, this iliac pillar screw functions like a post embedded in solid ground. An additional cannulated screw was inserted along the guide pin to catch the far cortex of the intact posterior iliac crest [5]. There could be a role for a less invasive application of this technique through a limited window.

Table 2 Data summary of patients undergone by iliac pillar screw technique

| Patient number | Age | Sex | Injury mechanism | Combined pelvis lesion | Time to surgery (day) | The day when patient started walking with walker (day) | Mean follow-up (months) | VAS of last follow-up | Pre-injury Koval walking ability | Last f/u Koval walking ability |
|----------------|-----|-----|---|------------------------|-----------------------|--|-------------------------|-----------------------|----------------------------------|--------------------------------|
| #1 | 77 | M | Pedestrian TA | None | 2 | 3 | 24 | 1 | 1 | 1 |
| #2 | 66 | F | Fall from standing position onto the ground | None | 2 | 7 | 18 | 1 | 1 | 1 |
| #3 | 74 | F | Fall from standing position onto the ground | None | 4 | 4 | 6 | 0 | 4 | 4 |
| #4 | 91 | F | Fall from standing position onto the ground | None | 5 | 14 | 15 | 2 | 5 | 5 |
| #5 | 81 | F | Fall from bedside | None | 2 | n/a | 6 | 3 | 7 | 7 |
| #6 | 76 | M | Fall from standing position onto the ground | None | 7 | 7 | 15 | 0 | 2 | 2 |

TA traffic accident. n/a not available, VAS visual analog scale, f/u follow-up



Fig. 5 A 74-year-old woman was admitted via the emergency department, complaining of pain in the right iliac crest area. She was injured by a fall from a standing position onto the ground and diag-

nosed with IIWF (a). Postoperatively, the fractured iliac wing was reduced, with the appearance of a symmetric pelvis in the pelvic anteroposterior (b), inlet (c) and outlet (d) views

Insufficiency fractures occur when normal stresses are applied to bone weakened by osteoporosis [6]. In the elderly, the pelvis is the most common location for these fractures. There are only a few reports of insufficiency fractures of the iliac wing in the English literature [6, 7]. Chary-Valckenaere et al. [7] documented 14 cases of iliac wing insufficiency fractures. They showed that initial radiographs in all patients were interpreted as negative, and that radionuclide testing and magnetic resonance imaging (MRI) led to a higher rate of fracture detection than standard X-ray and CT images. Clinically, iliac wing insufficiency fractures may be asymptomatic or present with mechanical pain and should be suspected in patients with osteoporosis risk factors [6, 7].

In 2013, Rommens et al. coined the term fragility fracture of the pelvis (FFP) to characterize pelvic insufficiency fracture with pelvic ring disruption in the geriatric population [8]. They also developed a classification system in which the fracture was graded from I to IV according to the degree of instability. The bony structures of the pelvis are not as strong as the surrounding ligaments in elderly patients with fragile bone, so FFPs are characterized by a disruption of bony structures only. The thick dorsal sacroiliac, sacrotuberous,

and sacrospinous ligaments remain intact and form anatomical borders [8]. In a previous report, the authors described a specific pattern of FFP in that the sacrotuberous and sacrospinous ligaments appeared to have been shortened [9]. This FFP might be a sort of avulsion fracture, in a very inclusive sense of the word, in which weakened bone is fractured despite thick, intact pelvic ligaments. The IIWFs in the current study were associated with an FFP pattern characterized by a fracture line that bypasses the iliolumbar ligament attached to the posterior ilium and includes a relatively strong pelvic brim (Fig. 4). We suggest that geriatric patients can have a form of IIWF as a manifestation of FFP, even though Rommens et al. did not IIWFs without pelvic ring disruption in their FFP classification.

The major strength of this study is that it is the first to present a case series of IIWF in geriatric patients as a manifestation of FFP and to introduce a specific technique for minimally invasive operative treatment. There were several limitations in our study. First, the study was based on retrospective review and contained a relatively small cohort of patients, because IIWFs in geriatric patients are relatively uncommon. Secondly, VAS scores and evaluation of walking ability are inevitably

subjective. Thirdly, all enrolled geriatric patients with IIWFs were recommended surgical treatment in a minimally invasive manner. Indeed, IIWFs are known to be treated conservatively, but considering the accompanying complications of prolonged non-weight bearing in elderly patients, we would like to shed light on minimally invasive screw fixation technique as a treatment option for IIWFs.

Conclusion

IIWFs are generated by high-energy trauma in young patients, and they are amenable to conservative treatment, such as analgesics and non-weight bearing. However, geriatric patients can have a form of IIWF caused by low-energy trauma that is a type of fragility fracture of the pelvis. Because subsequent deterioration of their walking status followed by a long period of non-weight bearing in geriatric patients could be as threatening as the fracture itself, the treatment paradigm for IIWF due to low-energy trauma in geriatric patients should differ from that due to high-energy trauma in most patients. In these types of fractures, minimally invasive surgical management that includes iliac pillar screw fixation can lead to good outcomes.

Acknowledgements We thank Yong-Woo Kim, Sang-Heon Lee and Kyong-Jun Kim for their help in correcting English grammar for this article.

Compliance with ethical standards

Ethical standards Ethical clearance has been taken from the institutional ethical committee.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Switzer JA, Nork SE, Routh ML Jr. Comminuted fractures of the iliac wing. *J Orthop Trauma*. 2000;14:270–6.
2. Abrassart S, Stern R, Peter R. Morbidity associated with isolated iliac wing fractures. *J Trauma*. 2009;66:200–3.
3. Tim D. White PAF. *The human bone manual*. Amsterdam: Elsevier Science; 2005.
4. Koval KJ, Skovron ML, Aharonoff GB, Meadows SE, Zuckerman JD. Ambulatory ability after hip fracture. A prospective study in geriatric patients. *Clin Orthop Relat Res*. 1995;310:150–9.
5. Cole PA, Jamil M, Jacobson AR, Hill BW. “The Skiver Screw”: a useful fixation technique for iliac wing fractures. *J Orthop Trauma*. 2015;29:e231–e234.
6. Ayalon O, Schwarzkopf R, Marwin SE, Zuckerman JD. Iliac wing insufficiency fractures as unusual postoperative complication following total hip arthroplasty—a case report. *Bull Hosp Jt Dis*. 2013;71:301–4.
7. Chary-Valckenaere I, Blum A, Pere P, Grigon B, Pourel J, Gauthier A. Insufficiency fractures of the ilium. *Rev Rhum Engl Ed*. 1997;64:542–8.
8. Rommens PM, Hofmann A. Comprehensive classification of fragility fractures of the pelvic ring: recommendations for surgical treatment. *Injury*. 2013;44:1733–44.
9. Lee SW, Kim WY, Koh SJ, Kim YY. Posterior locked lateral compression injury of the pelvis in geriatric patients: an infrequent and specific variant of the fragility fracture of pelvis. *Arch Orthop Trauma Surg*. 2017;137:1207–18.