



Prolonged pain in patients with fragility fractures of the pelvis may be due to fracture progression

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Abstract

Purpose Most fragility fractures of the pelvis (FFPs) are conservatively treated in the early phase. However, the definition of conservative treatment failure and the subsequent treatment protocol is controversial. Fracture progression (FP) sometimes occurs during conservative treatment of FFPs. This study aimed to assess the association between FP and prolonged pain in patients with FFPs receiving conservative treatment.

Methods Retrospective case series in a single institution in Japan. A total of 192 consecutive FFP patients were identified during study period. Seventy-nine patients met the inclusion and exclusion criteria. FFPs were diagnosed using both CT and MRI and FP was diagnosed with CT. Patients met criteria for prolonged pain if they had persisting pain after 2 weeks of conservative treatment and had lack of improvement in mobility. The relationship between FP and prolonged pain was analyzed using Fisher's exact test.

Results Of the 79 patients, 18 developed FP. Four of the 18 patients with FP met criteria for prolonged pain. Two of 61 patients without FP had prolonged pain ($p=0.022$; odds ratio 8.12). In the entire study cohort, six patients (7.6%) met criteria prolonged pain and underwent elective surgery.

Conclusion In patients with FFPs, prolonged pain was associated with FP ($p=0.022$, OR 8.12). The presence of prolonged pain might help identify FP. If FP is identified, surgical treatment may be required with cautious follow-up particularly in cases, where FFP progresses to type III or IV fracture.

Keywords Fragility fractures of the pelvis · Fracture progression · Prolonged pain · Conservative treatment · Surgical indication

Introduction

Fragility fractures of the pelvis (FFPs) are low-energy injuries caused by osteoporosis. The incidence of FFPs is an increasing social and economic problem [1, 2]. Furthermore, high mortality and morbidity have been reported previously [1, 3]. In terms of life expectancy and functional restoration, appropriate treatment strategy including conservative and operative treatment should be established. In contrast with high-energy pelvic ring fractures, most FFPs

are conservatively treated in the early phase. Rommens and Hofmann have developed a comprehensive classification for FFPs (Fig. 1) with suggestions for the management of each fracture type [2]. FFP Type I injuries can be treated conservatively. For FFP type II fractures, they have recommended initial conservative treatment with adequate pain management and rehabilitation as tolerated. If conservative treatment fails, percutaneous fracture fixation is recommended. For type III and IV fractures, surgical treatment may be preferable [2, 4, 5]. Approximately half of the cohort in the study conducted by Rommens and Hofmann presented with type II fractures. Consequently, half of the patients with FFPs received conservative treatment in the early phase followed by reassessment of surgical treatment.

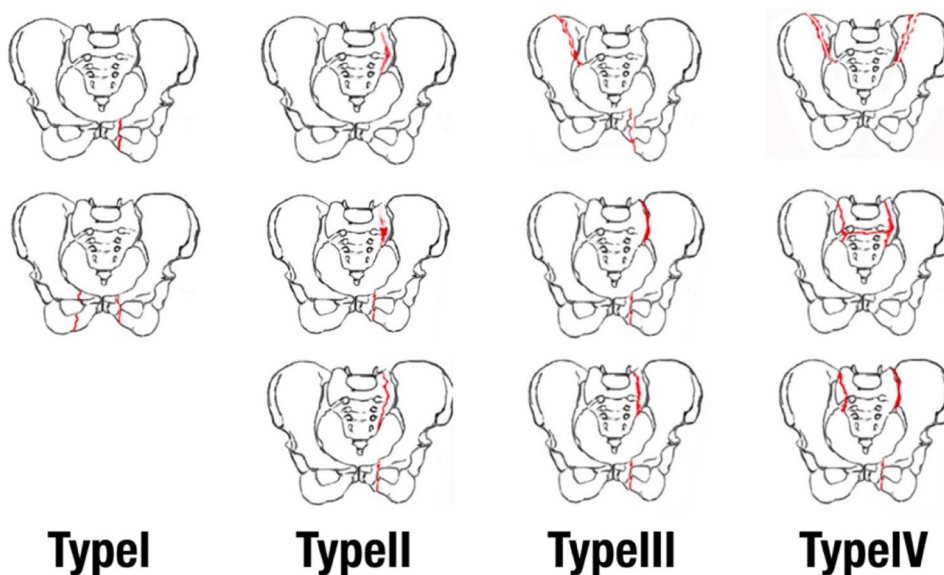
Currently, the indications for surgical treatment after failure of conservative treatment remain controversial. There are multiple reports regarding shift from conservative to surgical management of FFPs; however, the rationale underlying

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Fig. 1 Comprehensive classification of fragility fractures of the pelvis according to Rommens and Hofmann. FFP type I: anterior injury only. FFP type II: non-displaced posterior injury. FFP type III: displaced unilateral posterior injury. FFP type IV: displaced bilateral posterior injury. These figures are cited from the article by Rommens [2]



such shifts widely varies among authors. Hopf et al. reported good results with percutaneous surgical stabilization of FFPs of the posterior pelvic ring. Furthermore, they have indicated that decision regarding surgical management should be made within 6 days after the injury. However, the fracture types were not specified in this study [8]. Other authors have also reported pain as an indication for surgery; however, there is no consensus on how long the pain should persist before considering surgery [9–11]. In our recent experience, most FFPs of type II or lower can be conservatively treated, and a decline in activities of daily living (ADLs) is less likely to be observed in these cases. When conservative treatment fails, patients present with long-term pain. Even if union is finally achieved, the decline in their functional status remains a concern. In addition, conservative treatment alone has been associated with loss of social and physical independence and autonomy and with high mortality [12]. If the risk factors associated with the failure of conservative treatment are recognized, we can identify patients who can benefit from surgery at an earlier time. As a result, patients could start rehabilitation early, hospital stay is shortened, and the risk of significant functional decline is decreased.

Some individuals with FFPs develop fracture progression (FP) during the course of the treatment [5]. Figures 2 and 3 show two examples of contrasting FP: the first case showed progression from type IIc to IIIc, thereby requiring surgical treatment due to prolonged pain (Fig. 2). The second case involved fractures that had progressed, but eventually obtained union with conservative therapy, and patients with such fracture were able to walk without pain (Fig. 3). FP is probably caused by increased instability. Moreover, prolonged pain may be a surgical indication in the late phase. No studies regarding the relationship between FP and prolonged pain have been conducted. Thus, this study aimed to

describe the association between prolonged pain and FP in patients with FFPs who were conservatively treated in the early phase.

Setting

Retrospective case series in a regional orthopaedic trauma center.

Materials and methods

The current study was approved by the local institutional review board (KGE01024-010). Between August 2013 and July 2017, we identified 192 consecutive patients who presented with an FFP defined as pelvic ring (excluding acetabular fractures) and/or isolated iliac wing fractures after low-energy trauma such as falling from standing height. Patients were included if they had both CT and MRI at admission, received conservative treatment, and had documented bony union in the follow-up CT. MRI is performed frequently along with CT in low-energy pelvic trauma patients. Patients with both CT and MRI were included in an attempt to ensure that there was no pre-existing bone bruise in the area, where the FP developed and, therefore, increasing the accuracy of the diagnosis of FP. Patients were included regardless of their age. Exclusion criteria included facing being diagnosed only by CT if the patient underwent surgical treatment in the early phase (three patients, two type IIIa, and one type IVb). We included 79 patients in the final analysis. Of these patients, 7 were men and 72 were women. The average age was 85 (46–103) years. 77 patients were > 65 years. The author, an orthopaedic trauma consultant specialized

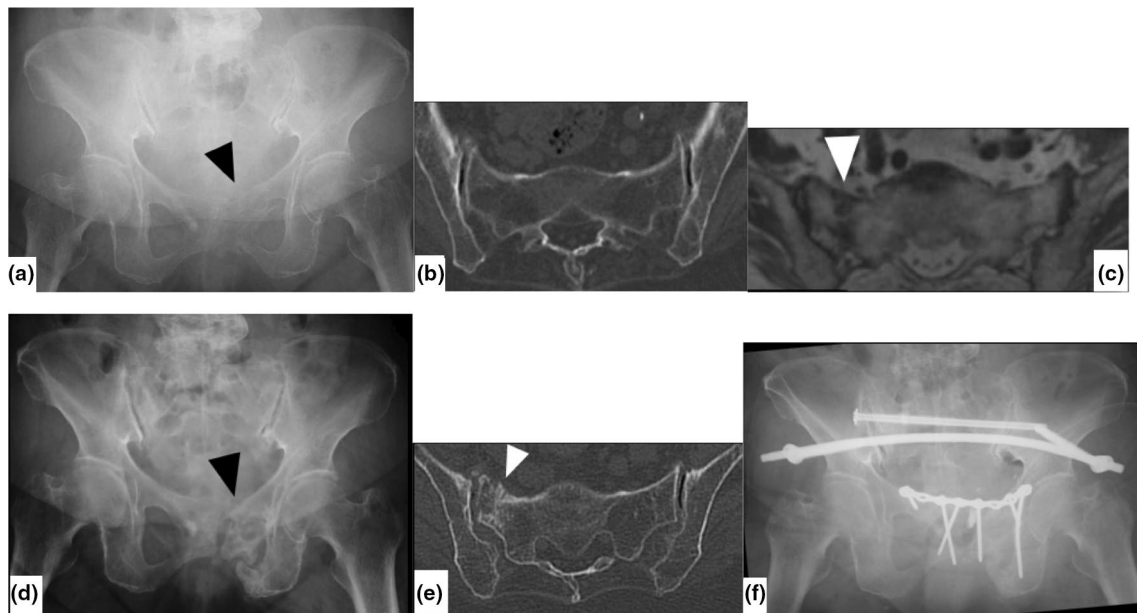


Fig. 2 Images of an 84-year-old woman who fell and presented with prolonged pain due to fracture progression. **a** Initial pelvis antero-posterior (AP) plain radiography. Radiography shows displaced left pubic rami fracture (black arrow). **b** Axial computed tomography (CT) scan upon admission shows the absence of any fracture in the posterior pelvic ring. **c** Magnetic resonance imaging shows right sacral ala non-displaced complete fracture (white arrow). The frac-

ture was first classified as FFP type IIc. **d** Pelvis AP plain radiography 6 months after the injury. Displacement of the left pubic rami was increasing (black arrow). **e** Axial CT scan after 6 months. Sacral fracture progressed to complete displaced fracture (IIc–IIIc, white arrow). **f** Patient complained of prolonged pain due to fracture. Finally, surgery was conducted after 6 months

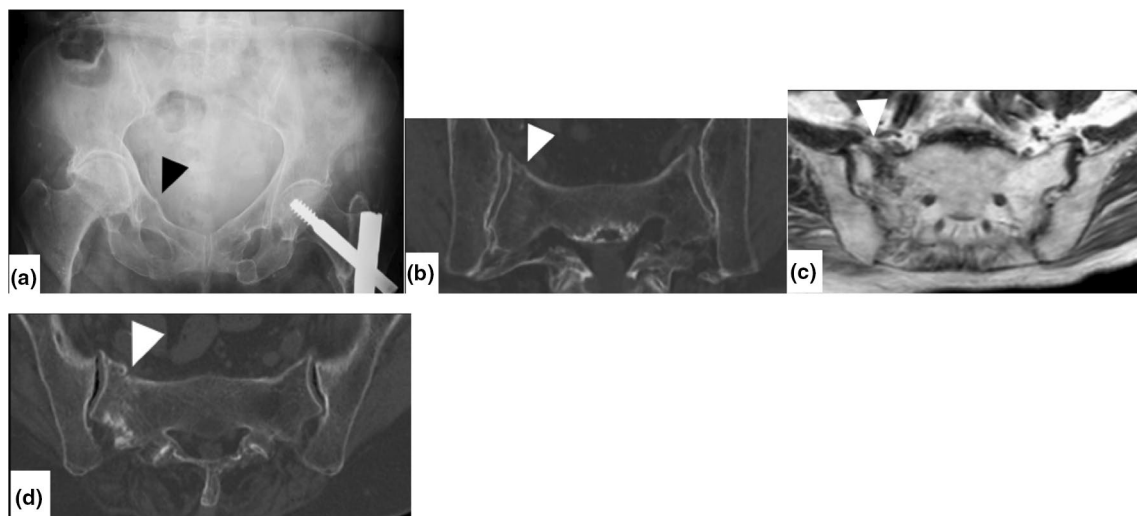


Fig. 3 Images of an 85-year-old woman who fell and presented with fracture progression without prolonged pain. **a** Initial pelvis antero-posterior plain radiography. Radiography shows right pubic rami fracture (black arrow). **b** Axial computed tomography scan upon admission shows a small crush lesion in the right sacral ala. **c** Mag-

netic resonance imaging shows right sacral ala non-displaced incomplete fracture (white arrow). The fracture was first classified as FFP type IIb. **d** Axial CT scan after 5 months. Fracture progressed from incomplete to complete fracture (white arrow). However, fracture united uneventfully without pain

in pelvic and lower extremity trauma, classified all fractures according to Rommens and Hofmann fracture classification [2]. The distribution of the fracture types at the time of admission is 11 as type I, 57 as type II, 4 as

type III, 5 as type IV, and 2 as iliac wing fractures. Bone bruises identified in the initial MRI were classified as fractures.

Treatment strategy in our institution

In our institution, the surgical decision-making for patients with FFPs is based not only on the fracture type according to Rommens and Hofmann, but also on the degree of pain and mobility of the patient. Thus, even in the early phase, if patients cannot change positions in bed owing to pain, an urgent surgical stabilization of the fracture is usually performed, which is the same as in proximal femur fractures. In contrast, if patients can change positions or sit in bed, we recommend conservative therapy.

In our study cohort, we prefer elective fracture stabilization when the severity of pain progresses or if pain persists after 2 weeks of conservative treatment. Prolonged pain is a problem when getting out of bed and during physical rehabilitation. When delayed- or non-union is identified, a surgical stabilization was scheduled as soon as the diagnosis was made (Fig. 4).

Definitions

Non-union

Non-union was defined as a fracture without visible progressive signs of healing for 3 months minimum and at least 6 months has elapsed since injury [6].

Delayed union

Delayed union was defined as an ununited fracture that continues to show progress towards healing or has not been

present long enough to satisfy an arbitrary time criterion for non-union [7].

Fracture progression

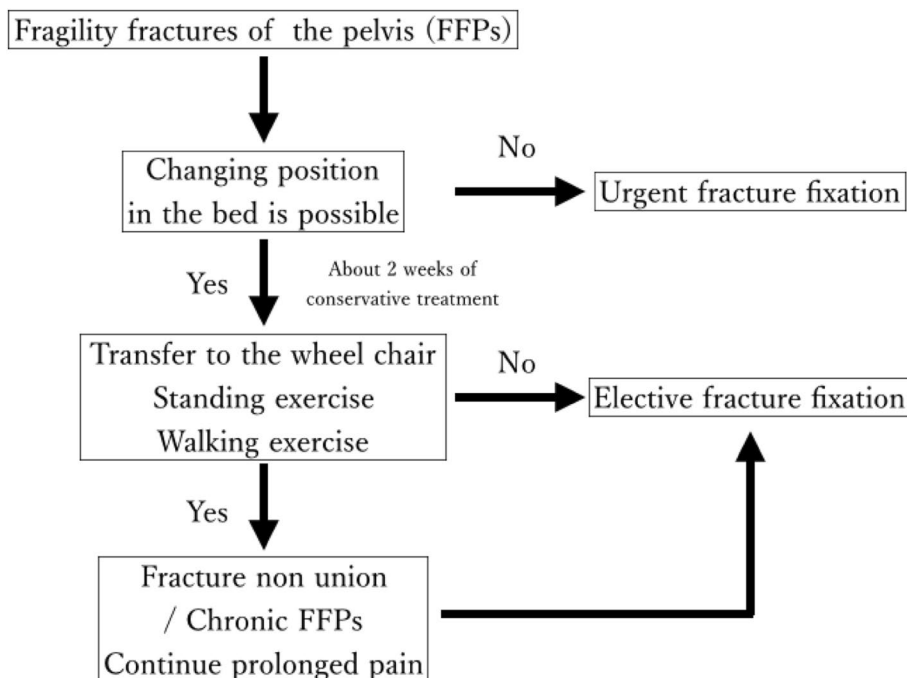
We defined FP as a fracture that progressed one or more levels according to Rommens and Hofmann's FFP classification or a pubic ramus or sacral fracture that progressed from unilateral to bilateral or to additional iliac fractures. FP was diagnosed by CT. In our institution, follow-up CT after low-energy pelvic fractures is not performed routinely to confirm bony union; however, they are encouraged especially in patients with posterior lesions or persisting pain. The timing of the follow-up CT is patient-specific.

Prolonged pain

We defined prolonged pain as pain that persisted after 2 weeks of conservative treatment and that is severe enough to cause at least one of the following (depending on the patient's pre-trauma degree of mobility): inability to transfer to a wheel chair, to start standing training, to start walking training, or able to start walking training but lack of progress in walking distance due to pain. To assess the patient's mobility progress (or lack thereof), the authors relied on the expertise of the physical therapy team of our institution.

We investigated the number and proportion of cases in which fractures progressed, the number and proportion of cases with prolonged pain, and the details of the FP. Statistical analysis was performed using the Fischer's exact test. All statistical analyses were performed with EZR (Saitama

Fig. 4 Treatment strategy for FFPs in the author's institute based on pain experienced by patients



Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of R commander that is designed to add statistical functions frequently used in biostatistics [14].

Results

In 24 out of 79 patients with FFP (30.4%), the MRI revealed additional lesions not previously identified in the CT. In 19 out of these 24 patients, a fracture was clearly evident in the follow-up CT. Table 1 describes the number of cases according to Rommens and Hofmann criteria and imaging modality. Out of 79 patients, 18 (22.8%) developed FP. The average age was 85.2 years and 17 were women. The most common progression according to Rommens and Hofmann’s was from type IIb to IIc. Of these 18 patients, 4 (22.2%) met criteria for prolonged pain. Sixty-one of 79 patients did not develop FP, and in this group, only two patients met criteria for prolonged pain. These results were statistically significant [$p = 0.022$, odds ratio (OR) 8.12, Table 2]. All the patients meeting criteria for prolonged pain (6, 7.6%) underwent elective surgery. The distribution of patients according to FP and prolonged pain can be observed in Table 3. Among the patients with FP, the progression to an undisplaced fracture (FFP types I and II–II) occurred in 11 cases and 1 of 11 case underwent elective surgery. On the other hand, the progression to a displaced fracture (FFP types I, II–III, and IV) occurred in seven cases and three of seven cases under went elective surgery. Three-fourth of the patients experienced progression from type I or II to type III or IV according to the FFP classification. Although statistical analysis was not conducted owing to a small sample size, prolonged pain is more likely to develop in patients with FFP that progressed to type III or higher. In our study cohort, 2 of 11 type I

Table 1 Fracture type according to imaging modality

CT diagnosis	MRI diagnosis	Number of patients
Ia	IIb	7
Ib	IIb	1
Ia	IIc	1
Ib	IIc	1
IIb	IIc	11
No fracture	IIa	1
No fracture	IIb	1

Table 2 Contingency table of prolonged pain and fracture progression

	Pro-longed pain		Total	Percentage (%)	<i>p</i> value*
	Yes	No			
Fracture progres-sion +	4	14	18	22.2	0.022 (odds ratio 8.12)
Fracture progression –	2	59	61	3.4	
Total	6	73	79		

* $p < 0.05$ was considered statistically significant

cases (18.2%) and 16 of 57 type II cases (28.1%) occurred fracture progression.

Discussion

The incidence of FFPs has been increasing in recent years; its treatment is a social concern, as it mostly affects the elderly group [15, 16]. In this study, fracture progression occurred in 30.4% of cohort. Patients with fracture progression were eight times more likely to also have prolonged pain compared with patients without fracture progression.

Rommens and Hofmann developed a comprehensive classification for FFPs and suggested corresponding treatment: conservative treatment for FFP types I and II, with conversion to surgical management when conservative treatment fails, and surgical treatment for FFPs’ types III and IV. However, they did not clearly define conservative treatment failure [2, 4, 5]. Oberkircher stated that surgical treatment is indicated if conservative treatment fails. However, he did not suggest specific timeframes for conservative therapy

Table 3 Prolonged pain according to degree of fracture progression

Degree of progression	Prolonged pain		Total	
	Yes	No		
I→II	0	1	1	
I→III	1	0	1	
II→II	1	8	9	
II→III	3	0	3	
II→IV	0	3	3	
II→II plus iliac fracture	0	1	1	18

FP “II→II” involves IIb→IIc (seven patients), IIb→IIc with unilateral pubic rami fracture to bilateral fracture (one patient), IIb with unilateral pubic rami fracture to bilateral fracture (one patient)

FP “II→II plus iliac fracture”: Iliac incomplete but slightly displaced fracture. That was diagnosed in follow-up CT scan. Still callus formation was seen and patient did not complain any pain, conservative treatment continued, and fracture healed uneventfully

[17]. The previous studies reported a change of management towards surgical treatment if pain is prolonged. However, there is no definite opinion regarding the time period [8–11]. Therefore, the criteria for surgical repair of FFP after failure of conservative treatment in FFPs are not well established. Our study results suggest that prolonged pain might be a sign of fracture progression and, therefore, conservative treatment failure.

Fracture type and mechanical instability might be useful elements in deciding whether surgery should be conducted; however, neither has been strongly associated with patient's pain. Prolonged pain inhibits improvement in ADLs, and therefore, its presence in the late phase might help surgeons and patients decide whether surgery must be performed. According to our study, FP may be associated with prolonged pain. Four (22.2%) out of 18 patients with FP had prolonged pain, and we found a statistically significant difference compared with the group without FP in which only two of 61 patients had prolonged pain. In other words, patients with FFP and FP were eight times more likely to have prolonged pain than those without; therefore, FP may be a risk factor of prolonged pain. Although statistical analysis was not conducted owing to a small sample size, three of four patients who presented with progression from type II (or lower) to type III (or higher) exhibited prolonged pain. This suggests that patients with a higher fracture type are more likely to develop prolonged pain. In other words, if an FFP progresses to type III or higher, considering the higher risk of prolonged pain, cautious follow-up, and early conversion to surgical treatment should be considered.

This study has several limitations. First, this study was retrospective in nature, and our inclusion criteria were strict (CT and MRI at admission and confirmation of union on CT) to isolate cases in which fracture progression could be clearly proven. A large number of patients with FFPs did not meet these criteria (110/192, 57.3%) and were excluded; therefore, information about these patients is lacking. In our institution, CT and MRI are encouraged in patients with FFPs with posterior lesions, since MRI is more sensitive than CT to identify these kinds of lesions [13]. However, in our protocol, the use of MRI is still a decision of the primary doctors. There is no study evaluating that MRI-based diagnosis for FFP changes initial treatment strategy. Furthermore, if the patients do not complain of pain, it is sometimes difficult to justify a follow-up CT. During the study period, 79 patients achieved bony union as confirmed on CT scan, and among them, a low number (18/79) developed FP, and even a lower number (6/79) developed prolonged pain. Although Fischer's exact test was used as a statistical tool, the small sample size decreased the validity of our results. In addition, prolonged pain could not be measured with validated instruments, such as the Visual Analog Scale, because of the large number of patients with dementia. Finally, the

definition of prolonged pain used in this study was developed by the authors, as a consensus definition has not been obtained in this field. Currently, no studies have described the relationship between FFPs and FP and prolonged pain. We hope that the results of our study contribute in improving the outcomes of patients with FFPs.

Conclusion

In patients with FFPs, prolonged pain was associated with FP ($p=0.022$, OR 8.12). If FP is identified, surgical treatment may be required with cautious follow-up particularly in cases where FFP progresses to type III or IV fracture.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

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