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ORIGINAL ARTICLE

Evaluation of a treatment protocol based on conservative therapy for fragility fractures of the pelvis

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Abstract

Purpose In an aging society, fragility fractures of the pelvis (FFP) have increased significantly. However, there is no clear consensus on the timing and criteria for transitioning from conservative treatment to surgery for these fractures. Thus, we aimed to investigate the effects of our treatment protocol for FFP based on conservative treatment.

Methods We conducted a retrospective study including 74 patients with FFP at our institution between 2015 and 2021. All patients were treated conservatively for the first two weeks. During this period, only wheelchair transfer was allowed. If the patient could not walk after this period, surgery was performed. Fracture type (Rommens classification), walking ability, presence of complications after admission, presence of fracture union, and surgical treatment was investigated. Patients were divided into two groups: a stable group (type I/II) and an unstable group (type III/IV).

Results Fracture union was achieved in all patients. Thirteen patients developed complications after being admitted to our hospital; seven showed decreased walking ability, and six required surgeries. The stable and unstable groups comprised 47 and 27 patients, respectively. There were no statistically significant differences between the groups regarding the percentage of patients who developed complications or experienced decrease in walking ability. The percentage of patients who required surgery was significantly higher in the unstable group ($p < 0.05$).

Conclusion Our FFP management protocol was effective regardless of fracture type. It is important to provide a period for careful assessment of instability, and to try to prevent fracture progression.

Keywords Fragility fractures of the pelvis · Conservative treatment · Rommens classification · Computed tomography

Introduction

Fragility fractures of the pelvis (FFP) are a type of fracture caused by low energy trauma in the elderly and are known to have a high mortality rate [1, 2]. With the aging of the society in recent years, the number of patients who experience FFP has significantly increased [3, 4]. Therefore, it is important to accurately assess fracture type to ensure appropriate treatment.

There have been many reports on the treatment options and outcomes of FFP based on the Rommens classification [5–8]. The Rommens classification, developed by Rommens and Hofmann in 2013, is generally used to evaluate FFP fracture types [9]. Based on computed tomography (CT) images, the type of fracture is evaluated in detail and classified as type I-IV in order of instability. Type I FFP is defined as an anterior disruption alone and can be treated conservatively. Conservative treatment is also recommended for type II FFP, which is defined as non-displaced posterior disruption; however, surgery is performed percutaneously in cases in which conservative treatment cannot be continued due to pain. Type III-IV FFPs are unstable fractures with displaced posterior disruption, for which surgical treatment is recommended (Fig. 1).

In recent years, the mainstream treatment strategy for FFP has been conservative, and if difficult, surgery is performed [10–12]. Moreover, high rates of surgery-related complications have been reported after operative treatment [13].

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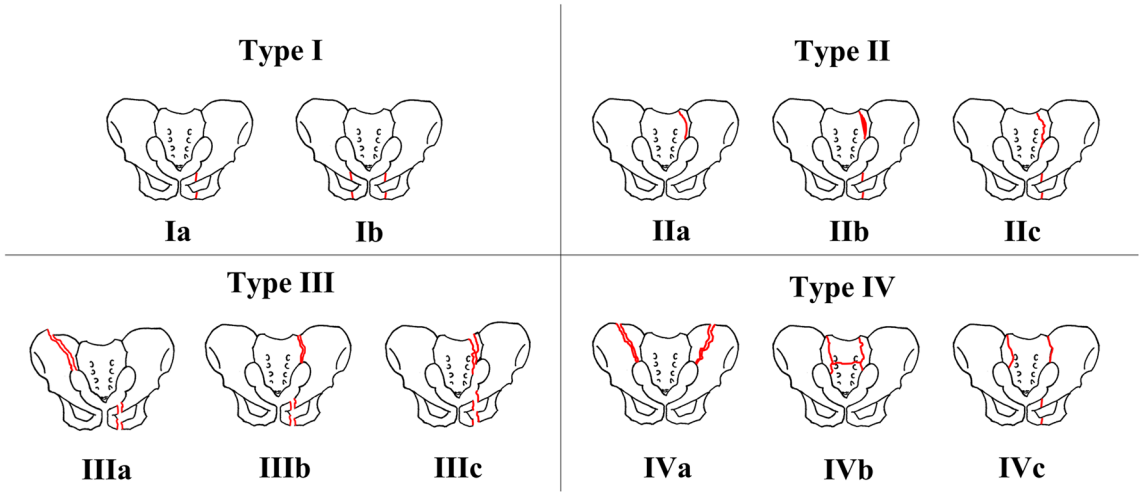

Fig. 1 Rommens classification of fragility fractures of the pelvis (FFP). Type I: anterior disruption only; type II: non-displaced posterior disruption; type III: displaced unilateral posterior disruption; type IV: displaced bilateral posterior disruption. This figure was created by the author based on Fig. 3 in Reference [9]

Thus, we also believe that it is best to avoid surgery, if possible, because of the risk of postoperative wound infection and intraoperative vascular injury.

Furthermore, although there are numerous reports on the timing and criteria for transitioning from conservative treatment to surgery, there is no clear consensus on these criteria, and they vary from facility to facility [10–12, 14]. At our hospital, we treat patients with FFP using a protocol based on conservative treatment. The aim of this study is to investigate the effectiveness of our FFP management protocol.

Materials and methods

Participants

Of the 151 patients with pelvic ring fractures treated at our hospital between 2015 and 2021, 74 patients (5 male and 69 female patients) who met the following criteria were included in the study: 1) being ≥ 65 years of age, 2) sustaining a low energy trauma, 3) not having received external fixation at another hospital prior to referral to our clinic, and 4) having undergone follow-up at least 3 months after the injury.

Data collection

We collected data on patient age, body mass index (BMI), time to the last follow-up, fracture type at admission (Rommens classification), walking ability both pre-injury and at the final follow-up (assessed across four stages: walking without support, walking with a cane, walking with a walker, or wheelchair use), presence of complications after admission, number of days in the hospital, presence of fracture union (ascertained by radiographic images [AP, inlet, and outlet views] and CT), and surgical treatment. For patients who underwent surgical treatment, we also investigated the comorbidities, factors requiring surgery, and the duration from admission to surgery. In addition, all patients were divided into two groups: the stable group (Rommens classification Type I/II) and the unstable group (Type III/IV). Statistical comparisons were performed between the two groups to determine the ratio of patients with complications after admission, the ratio of patients with decreased walking ability before and after the injury, and the ratio of patients requiring surgical treatment. Statistical analyses were performed using Fisher's exact test. Statistical significance was set at $p < 0.05$. Fracture union was determined using radiographs by two blinded orthopedic surgeons.

FFP management protocol in our institution

The FFP management protocol was applied to all patients and is depicted in Fig. 2.

All patients are hospitalized regardless of fracture type. At the time of admission, we check whether wheelchair transfer and repositioning are possible; if not possible, surgical treatment is performed, and if possible, conservative treatment is started. After admission, the patient is limited to wheelchair transfers for two weeks. During this period, the patients spend as much time as possible in the sitting position rather than in the supine position. This is performed to prevent aspiration pneumonia and disuse muscle weakness. Physical therapy is also started at the time of admission. If the pain is so severe that the level of activities of daily living (ADL) does not increase during the first two weeks

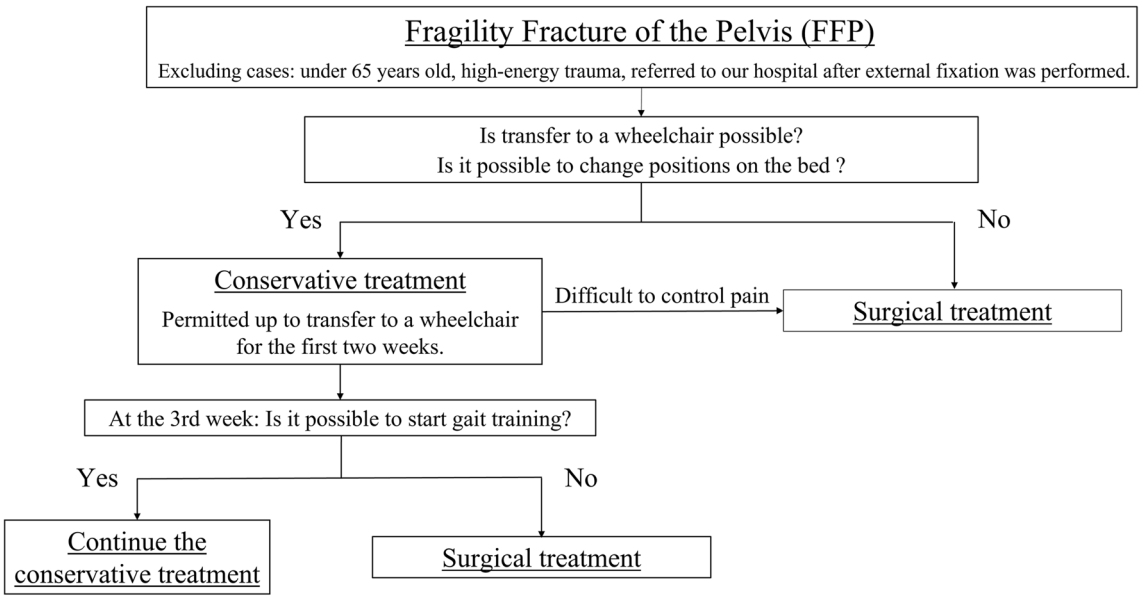

Fig. 2 FFP management protocol at our hospital. Regardless of the type of fracture, we check whether wheelchair transfer and repositioning themselves are possible, and if not possible, surgical treatment is performed; and if possible, conservative treatment is started. The patient is limited to wheelchair transfers for two weeks during conservative treatment. If the pain is so severe that the level of activities of daily living (ADL) does not increase, the management plan is shifted to surgical treatment. Full-weight gait training is initiated in the third week. If gait training is possible at this point, conservative treatment is continued; otherwise, surgical treatment is performed

of conservative treatment, management is shifted to surgical treatment. Gait training with full weight-bearing using a walker is initiated depending on pain level at the beginning of the third week. If gait training is possible at this point, conservative treatment is continued; otherwise, surgical treatment is performed. After gait training, the goal is to discharge patients to their homes, but if they are found to require further rehabilitation, they are transferred to a nearby rehabilitation hospital.

Results

The mean age was 83 (range, 65–96) years; the mean BMI was 20.4 (range, 16.1–30.4) kg/m^2, and the mean follow-up period was 448.3 (range, 91–2047) days. The distribution of fracture types among patients are listed in Table 1 as follows: type Ia, ten patients; Ib, one; IIa, five; IIb, 18; IIc, 13; IIIa, 13; IIIb, one; IIIc, zero; IVa, zero; IVb, 13, and IVc, zero. There were 47 cases in the stable group (type I/II) and 27 in the unstable group (type III/IV). The changes in walking ability are shown in Table 2. At the last follow-up, walking ability was maintained in 39 of 42 patients (92.8%) who were able to walk unaided before the injury, 11 of 13 patients (84.6%) who walked with a cane before the injury, and 13 of 15 patients (86.7%) who walked with a walker before the injury. In total, seven of the 74 patients (9.5%) had decreased walking ability. Complications after admission included anemia in five cases, urinary tract infection in four cases, delirium in two cases, and aspiration pneumonia in two cases. The mean hospital stay was 33.4 (range, 7–64) days. Fracture union was achieved in all cases. Six of the 74 patients required surgical treatment (8.1%), and the distribution of fracture types among patients was as follows: type IIc in one, type IIIa in four, and type IVb in one patient. The ratio of patients who underwent surgical treatment was one in 13 cases (7.7%) of type IIc, four (30.8%) in 13 cases of type IIIa, and one in 13 cases (7.7%) of type IVb fractures

Table 1 Fracture types classified with Rommens classification and the percentage of cases who ultimately required surgery

Rommens classification [9]	Cases	Surgically treated cases (%)
Ia	10	
Ib	1	
IIa	5	
IIb	18	
IIc	13	1 (7.7%)
IIIa	13	4 (30.8%)
IIIb	1	
IIIc	0	
IVa	0	
IVb	13	1 (7.7%)
IVc	0	

(Table 1). The details of the six patients who underwent surgical treatment are shown in Table 3. The mean age was 85 (range, 79–89) years, and all patients were females. Dementia was observed in three of the six cases. Five of the six patients underwent surgical treatment within two weeks of admission due to difficulty at rest, severe pain, and increased dislocation of the fracture site, and the last of the six patients required surgery because of difficulty in starting gait training in the third week. Surgery was performed at an average of 9.8 (range, 6–21) days after admission. In these six patients, there was no decrease in walking ability at the last follow-up. The ratio of complications after admission was eight of 47 (17%) in the stable group and five of 27 (18.5%) in the unstable group. At the most recent follow-up, the ratio of patients with decreased walking ability compared with pre-injury was three of 47 (6.4%) in the stable group and four of 27 (15.8%) in the unstable group, and the differences were not statistically significant. The ratio of patients who required surgery was significantly higher in the unstable group than in the stable group (five of 27 [18.5%] and one of 47 (2.1%), respectively; $p < 0.05$; Table 4).

Case presentation

Here, we present the case of an 87-year-old woman who visited our hospital with symptoms of lower back pain of two weeks duration with no history of falls and a gradual increase in walking difficulty. The patient had undergone total hip arthroplasty for bilateral hip osteoarthritis and originally walked with a cane. At the time of the initial visit, she experienced severe back pain and was unable to maintain a seated position. Radiographs showed bilateral sacral fractures (Fig. 3a–c). CT revealed a horizontal fracture line in addition to the fracture lines in both sacral bones, and we diagnosed the patient with Type IVb FFP

Table 2 Comparison between patient walking ability pre-injury and at the most recent follow up

Pre-injury				Latest follow-up				Maintenance ratio
Walk			Wheelchair	Walk			Wheelchair	
Without support	With a cane	With a walker		Without support	With a cane	With a walker		
42				39	2	1	0	92.8% (39/42)
	13				11	1	1	84.6% (11/13)
		15				13	2	86.7% (13/15)
			4				4	100% (4/4)

Maintenance ratio refers to the percentage of patients who maintained walking ability compared to pre-injury

Table 3 Comparison between stable and unstable groups regarding complications, walking ability and surgery

	Stable group (type I/II: $N=47$)	Unstable group (type III/IV: $N=27$)	p-value
Cases with complications after admission (%)	8 (17%)	5 (18.5%)	0.554
Cases with decreased walking ability (%)	3 (6.4%)	6 (15.8%)	0.215
Cases with required surgical treatment (%)	1 (2.1%)	5 (18.5%)	0.022*

*Statistical significance was set at $p < 0.05$

Table 4 Patient characteristics of the 6 cases who underwent surgical treatment

Age (year)	Sex (M/F)	Rommens classification [9]	Comorbidities	Factors of cases requiring surgery	Duration from hospitalization to surgery (days)
81	F	IIIa	Dementia	Unable to rest	7
79	F	IIIa	None	Severe pain (+), Progression of dislocation (+)	6
87	F	IVb	None	Severe pain (+), Progression of dislocation (+)	12
87	F	IIIa	Dementia	Unable to rest, Progression of dislocation (+)	6
87	F	IIIa	Dementia	Unable to rest, Severe pain (+)	7
89	F	IIc	None	Walking training impossible at 3 weeks	21

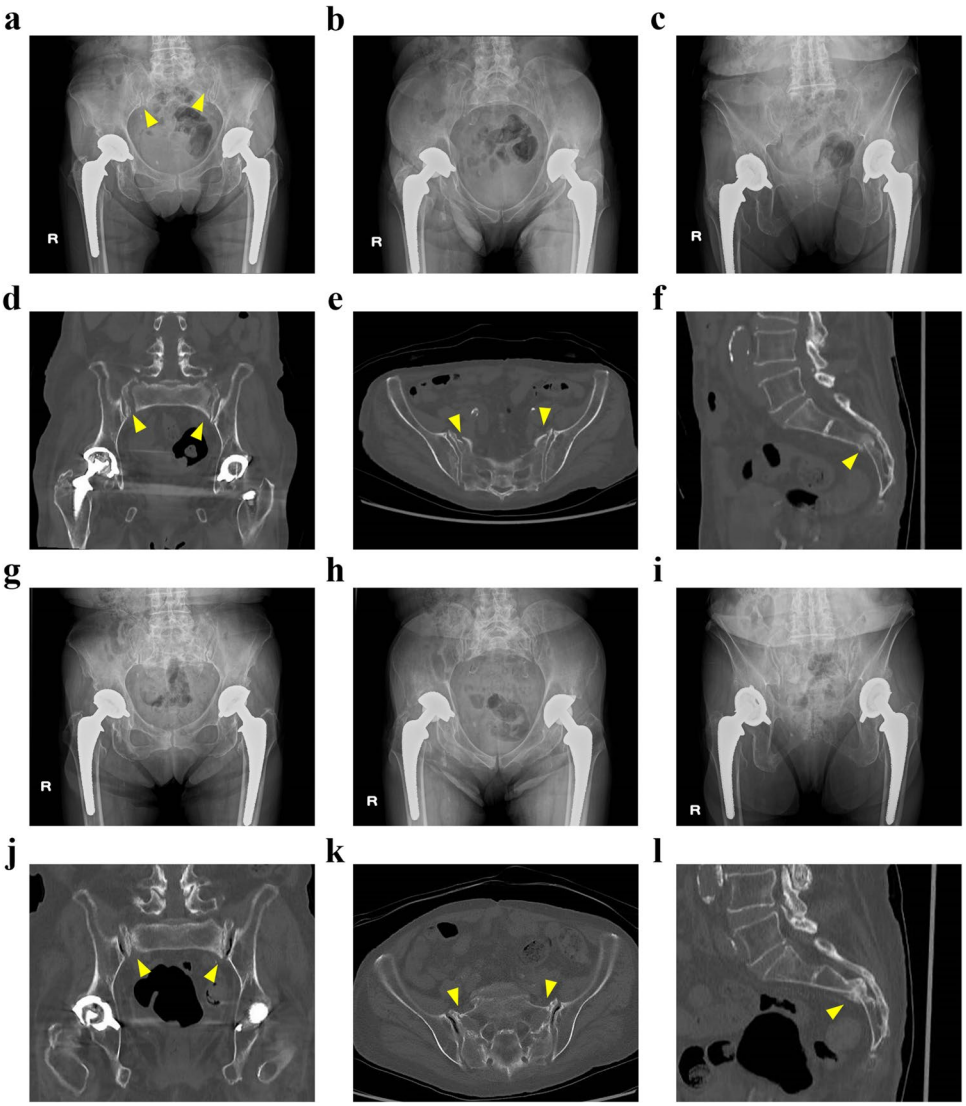

Fig. 3 Clinical images of a representative case of fragility fractures of the pelvis. Radiographs (**a**–**c**) and computed tomography (CT) (**d**–**f**) of the pelvis on arrival. Views of radiographs: **a**, anteroposterior; **b**, inlet; and **c**, outlet. CT images: **d**, coronal; **e**, axial, and **f**, sagittal. The yellow arrows indicate the fracture lines. Radiographs showed bilateral sacral fractures and CT revealed a horizontal fracture line; therefore, we diagnosed the patient with FFP-type IVb. Radiographs (**g**-**i**) taken six months after treatment started: **g**, anteroposterior; **h**, inlet; and **i**, outlet views. Dislocation of the fracture site was not observed. CT images (**j**-**l**) taken six months after treatment started: **d**, coronal; **e**, axial, and **f**, sagittal. The yellow arrows indicate the location of the fracture line. The fracture lines became unclear, and we concluded that fracture union was achieved

(Fig. 3d–f). Conservative treatment according to our FFP management protocol was initiated when we were able to transfer her to a wheelchair. Blood examination revealed no anemia (Hb:11.8 g/dL). Transfer to a wheelchair was possible without pain on day six of hospitalization, and gait training with a walker was initiated on day 17. On day 38, she was transferred to a nearby rehabilitation hospital. At that time, she was able to walk without pain using a walker. During admission, there were no complications, such as anemia, urinary tract infection, or aspiration pneumonia. Six months after the start of treatment, radiographs showed no dislocation of the fracture site and CT confirmed that fracture union had been achieved (Fig. 3g–l). She could walk with a cane without pain, and there was no decrease in walking ability compared to that before she was diagnosed with FFP.

Discussion

This study investigated the effectiveness of an FFP management protocol at our hospital. Regardless of the fracture type, 68 of 74 patients (91.9%) completed treatment without surgery, and 67 of 74 patients (90.5%) were able to maintain their pre-injury walking ability. No progression in Rommens classification was observed during the follow-up period, and our FFP management protocol was considered effective.

As a treatment strategy for FFP, Rommens recommended conservative treatment for type I or II fractures and surgical treatment for type III or IV fractures [9]. However, Pieroh et al. pointed out that classification results are not always consistent among examiners and that opinions may differ, especially regarding whether fractures

are classified as type II or III [15]. In other words, it is difficult to determine a treatment method based only on the fracture type. We determined the instability of the fracture by considering the clinical findings and course of the patient after injury, in addition to the fracture type. There was no difference in the incidence of complications after hospitalization or the rate of decrease in walking ability before and after injury between the stable (type I/II) and unstable groups (type III/IV). In addition, even in type III/IV cases that were considered unstable on imaging, only five of the 27 cases (18.5%) required surgery, indicating that surgical treatment was not necessary in many cases. To avoid unnecessary surgery, we believe that the presence of instability should be evaluated carefully based on the patient's clinical course, and not only imaging findings.

Regarding FFP hospitalization, the criteria for determining which fracture type requires hospitalization and when hospitalization should be initiated remain controversial. We immediately hospitalize all patients diagnosed with FFP for two main reasons. The first reason is to prevent the progression of fracture type in the Rommens classification. In this study, the ratio of patients who required surgery was significantly higher in the unstable group (type III/IV) than in the stable group (type I/II). In other words, we believe that preventing fracture type progression is critical for avoiding surgery. It has also been reported that patients who took a long time before being hospitalized exhibited a more unstable fracture type than those who were hospitalized immediately after injury [16]. There was no progression of the Rommens classification observed in our patients during the follow-up period in this study, indicating that early admission is appropriate. The second reason is to manage bleeding. Although a rare complication, bleeding has been reported in some patients with FFP [17, 18]. In this study, anemia was observed in five patients, four of whom required blood transfusions. We believe that treatment upon admission is necessary to ensure a prompt response to such pathological conditions.

Moreover, it has been reported that there is a high possibility that a sacral fracture will be overlooked with radiography alone [19]. Thus, to accurately diagnose fracture type, we performed CT for all cases of FFP, and we consider this examination essential for the accurate evaluation of posterior elements. Although the treatment plan is determined not only by fracture type, we also believe that there are characteristics of the fracture type that have a high probability of requiring surgical treatment. For example, it has been reported that Rommens classification type IIIa is particularly unstable and often requires surgery [20, 21]. Type IIIa is a fracture type similar to the lateral compression type in the Young-Burgess classification in cases of high-energy trauma [22]. In addition, almost no strong pelvic ligament is anatomically attached to the ilium. Therefore, we believe that this type of fracture is likely to be highly unstable, difficult to manage, and may require surgery. In this study, there was no statistically significant difference between the fracture types because of the small number of cases that required surgery; however, many cases with type IIIa were shifted to surgical treatment. In fracture types, such as Type IIIa, that are more likely to progress to surgical treatment, it is necessary to consider from the outset that conservative treatment may not be successful.

To assess instability accurately, it is necessary to observe the patient for a certain period to determine their pathological condition. However, there are no clear criteria regarding when to decide on a transition from conservative to surgical treatment. Several studies on Japanese patients have reported that a decision on the indication for surgery was made within 1–2 weeks, resulting in a conversion ratio to surgery of 4.7–9.5% [10–12]. The ratio of conversion to surgery in this study was 8.1%, which is similar to that reported in other studies. In addition, more than 90% of the patients maintained their walking ability, indicating that our protocols were extremely effective. In contrast, a study conducted at a trauma center in Germany reported that the indication for surgery was determined six days after the initiation of conservative treatment for type II fractures and above, and surgery was performed for 21.8% of type II and 69.4% of type III/IV fractures. In Germany, it is believed that surgical treatment reduces pain and promotes early rehabilitation, and the goal is to reduce the length of hospital stay as much as possible as an economic factor, which may have caused discrepancies with the results of this study. Differences in physique between Japanese (the mean BMI of the patients in this study was 20.4 kg/m^2) and German (the mean BMI for adults in Germany was reported to be over 26 kg/m^2 [23]) patients may also have had an effect. It has been reported that the higher the BMI, the higher the risk of functional decline [24], and we suspect that the rest period should be adjusted according to their physiques.

We also believe it is useful to evaluate instability through imaging studies. Radiographs taken under manual stress were effective in determining the presence or absence of pelvic instability and determining the indication for surgery in a case of lateral compression type-1 pelvic ring injury [25]. Based on this report, we are currently investigating the possibility of performing a stress test under fluoroscopic guidance to confirm the presence or absence of instability and pain, and to determine the indication for surgery. We believe that if we can accurately identify patients who do not need a non-weight bearing period, and those who are candidates for surgery, by performing this test soon after admission, we can shorten the length of hospital stays.

Rommens et al. listed bed rest, pain therapy, and mobilization as tolerated as the three pillars of conservative treatment [7]. Therefore, we developed a protocol keeping in

consideration whether resting was possible with pain management in our hospital. Of the six patients who required surgery in this study, there were three patients with dementia who could not rest. Pain management is difficult if proper rest is not possible, and there is a risk of dislocation of the fracture site, even upon hospital admission. Thus, if there is a factor that makes it impossible for a patient to rest, surgery must be considered at an early stage.

Surgical treatment of FFP is, of course, effective. In particular, early surgery for Types III and IV, which are defined as unstable, has proven to be effective in much of the literature [14, 26, 27]. It is well known that surgical treatment provides tremendous support for the improvement of the patient's walking ability. In this study, four of the 22 patients (18.1%) in the unstable group who were treated conservatively observed a decrease in walking ability. In contrast, five patients who underwent surgical treatment in the unstable group did not observe a decrease in walking ability. Although no statistically significant difference was observed because there were few cases that progressed to surgery, it was suggested that surgical treatment may prevent the decrease in walking ability. This result suggests that even if surgery is avoided and fracture union is achieved, there are cases in which the patient's walking ability may still be decreased. To reduce the number of such cases, it is necessary to accurately and quickly identify cases that are initially successful with conservative treatment but ultimately require surgery. This identification is extremely important and will be the subject of our future studies. We believe that a pelvic stress test under fluoroscopic guidance may be an effective test, and we are currently collecting data. There is no doubt that the benefits of surgical treatment are effective, but conservative treatment still has advantages in terms of avoiding surgical invasiveness and complications. Our future goal is to develop a treatment protocol that is based on conservative treatment, that determines the indication for surgery as early as possible during the period of bed rest after hospitalization, and that allows for prompt conversion to surgery when necessary. Although there is much literature recommending early surgical treatment, we believe that our treatment protocol, which is based on conservative treatment, can be easily implemented in hospitals where surgery is not feasible, and may be an option for the treatment strategy of FFP.

Our management protocol has two problems. First, the length of the hospital stay is inevitably longer. The mean length of hospitalization was 33.4 days. Prolonged hospitalization is undesirable because it increases medical costs and hinders patient reintegration into society. Efforts should be made to shorten the length of hospital stay by collaborating with local medical institutions such as rehabilitation hospitals from an early stage. The second problem was muscle weakness. One study on healthy elderly subjects reported that resting on a bed for 10 days reduced muscle mass by as much as 6.3% [28]. Therefore, we instruct the patients to avoid the supine position as much as possible and increase the time spent in the sitting position during the two weeks set as the rest period after hospitalization. It has also been reported that parathyroid hormone (PTH) 1–84 promotes fracture healing and improves functional outcomes in pelvic fractures among elderly patients [29]. Given these findings, we are considering the integration of PTH into our FFP management protocol. It is very important to consider whether this "two-week" period can be shortened further. In particular, for type I fractures with only anterior disruption, we believe that gait training can be performed earlier. However, many cases of anterior disruption involve fractures in the posterior segment [30], and an accurate diagnosis is essential. Magnetic resonance imaging (MRI) is considered effective for diagnosing fractures of the posterior segment [31], but it cannot be performed in all cases. In recent years, dual-energy CT has been used as an alternative imaging modality to MRI. This CT imaging method uses two types of X-rays with different energies, and its diagnostic sensitivity and specificity for sacral fractures is reported to be 100%. [32]. Currently, we use this diagnostic imaging method to identify patients for whom gait training can be initiated earlier.

This study had some limitations. First, no comparison group treated with other methods was included because we treated all patients with FFP using this protocol in our hospital. We understand that it is important to compare these cases with those treated using other strategies, and we consider this a subject for future studies. Second, because the study was conducted at a single institution, the number of cases was small ($N = 74$). We believe that it is necessary to conduct a multicenter study based on this protocol to accumulate adequate data.

Conclusion

Conservative treatment of FFP based on our management protocol allowed for the maintenance of walking ability without the need for surgical treatment. Surgical indications should be determined carefully, not only by fracture type but also by the clinical course.

Author contributions TO analyze all data, performed the statistical analysis, and was the major contributors in the writing of the manuscript. SK conceived the study design. SK and TN contributed to the critical revisions of manuscript. HH, YT, and KI participated in the study design and coordination. All authors read and approved the final version of the manuscript. SK is the guarantor of this work and, as such, had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Data availability The original dataset generated during the current study is available from the corresponding author on reasonable request.

Declarations

Ethics approval This study was approved by the appropriate Institutional Review Board (approval number: R4-22), and the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Consent Written informed consent was obtained from all the patients whose clinical courses or images are presented in this manuscript.

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

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