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The risk factors of fracture progression in fragility fractures of the pelvis Rommens classification type II

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Abstract

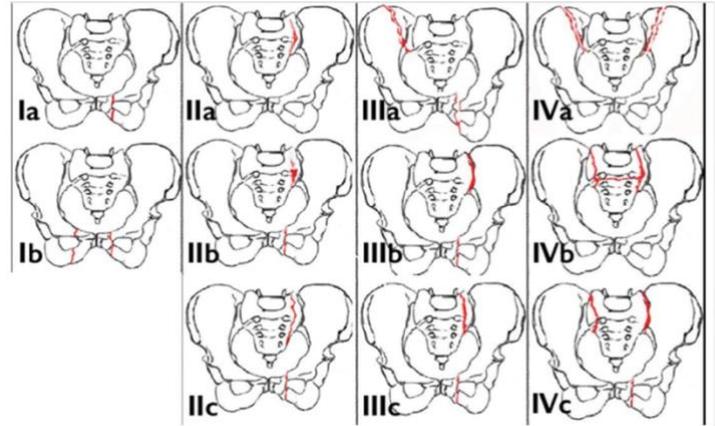
The purpose of this study was to investigate the factors of fracture type progression during conservative treatment of fragility fracture of pelvis (Rommens classification type II). 71 patients with Rommens classification type II (a, b, c) who underwent conservative treatment and had multiple CT scans were selected from 177 patients treated in our department over 8 years from 2011. The results were as follows. In this study, we compared the factors of fracture type progression in 25 patients in the progression group and 46 patients in the non-progression group. In the group of patients who progressed to Rommens classification type II to IIIc, there were more fractures of the suprapubic branch and both pubic symphysis, and in the group of patients who progressed to Rommens classification type II to IVb, there were more cases without a clear history of falls, and the anatomical Pelvic Tilt and Pelvic Incidence were higher.

I. Introduction

Fragility fractures of the pelvis (FFPs) are pelvic fractures caused by bone fragility, which have been increasing in recent years. [1] FFPs were classified by Rommens et al. in 2014 (Figure 1: Rommens classification type XX, hereafter R-type XX), and conservative treatment is generally chosen in the early stage for posterior pelvic ring fractures without dislocation classified as R-type I and II. [1,2] While most patients can be treated conservatively, there are some patients who show resistance to conservative treatment, such as prolonged pain and inability to leave the bed, and require reconsideration of the treatment plan.

In the course of conservative treatment of FFPs, some cases of fracture progression such as progressive

Figure 1: Rommens et al. classification (modified from Ref. 1)

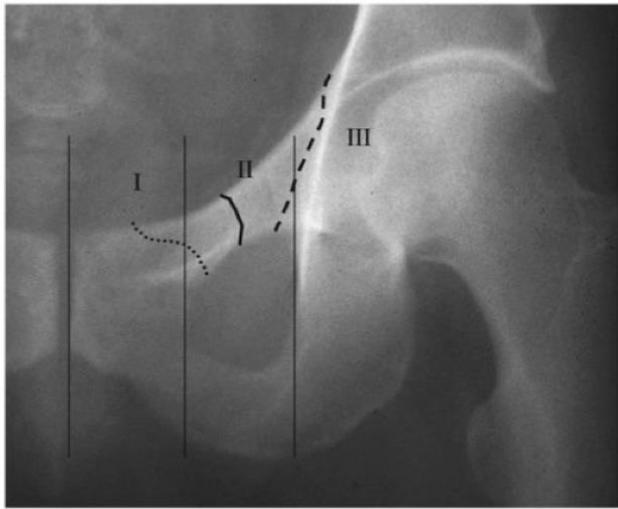


dislocation of the fracture and increase of new fracture line have been reported, but the detailed mechanism remains unclear. [1,3] Previous studies have shown that fracture progression leads to prolonged pain and may contribute to resistance to conservative treatment. [4] Therefore, clarification of fracture progression factors may help to determine the treatment strategy for FFPs. The purpose of this study was to investigate whether the patient background, fracture type, and patient-specific pelvic tilt are related to fracture progression during conservative treatment of FFPs.

II. Materials and Methods

One hundred and seventy-seven patients (18 males and 159 females, mean age 84.7 years) who underwent treatment for FFPs at the Nagoya Daini Red Cross Hospital from April 2011 to September 2018 were included in the study. FFPs were diagnosed in patients aged 65 years or older with minor injuries such as falls from standing position or no history of trauma. Exclusion criteria were pathological fracture, high-energy injury, open fracture, and infection. In all patients, fracture type was assessed posteriorly based on the Rommens classification using CT images at the time of initial examination. Fracture type was

Figure 2: Nakatani classification (modified from Ref. 5)



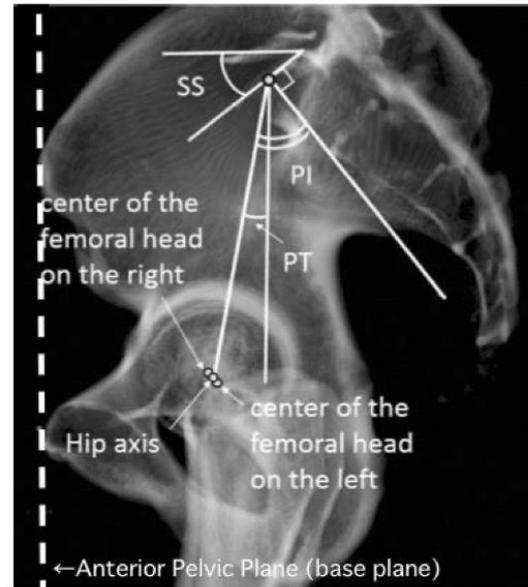
From left to right: Zone I (pubic symphysis), Zone II (suprapubic branch), Zone III (pubic body). The dotted line shows the classification of Zone I or III when it spans two Zones.

classified as R-type II for unilateral sacral fractures without dislocation and bilateral pubic fractures, and R-type IVb for bilateral sacral fractures with angular deformity on sagittal section of CT images.

In this study, we investigated the progression of fractures in 124 patients who underwent conservative treatment and had their fracture type reevaluated by CT due to prolonged pain during the course of treatment. Fracture type progression was defined as the progression of one or more of the types in the Rommens classification.^[3] We also examined changes in fracture type for R-type II (a, b, c), whose fracture type at the time of injury is considered to be subject to conservative treatment in initial therapy.^[1] In accordance with previous studies, the conservative treatment method was as follows: the patient was admitted to the hospital and encouraged to leave the bed within the range of pain control, and conservative treatment was continued if the patient was able to maintain a sitting posture within one week.^[1]

The study items were as follows: 1) Patient background and history, which were clearly described in the medical record: gender, age, BMI, history of trauma such as falls, osteoporosis, rheumatism, presence of spinal or hip implants, steroid medication, and history of pelvic radiation. 2) Fracture site of the sacrum (Denis classification: Zone I, II, III, hereafter D-Zone I, II, III), fracture site of the sacrum and pubis (ipsilateral, contralateral, anterior bilateral, no pubic fracture), fracture site of the pubis (Nakatani

Figure 3: Measurement of pelvic tilt (modified from Reference 6).



In the reconstructed 3D-CT pelvic lateral image, anatomical SS, anatomical PT, and PI were measured using the Anterior Pelvic Plane as a reference line.

classification: Zone I,II,III, hereafter N-Zone I,II,III) (Figure 2)^[5], Pelvic tilt: In accordance with previous studies, the pelvic tilt was measured in the reconstructed 3D-CT lateral pelvic image using the Anterior Pelvic Plane as the reference line for Sacral Slope (anatomical-SS), Pelvic Tilt (anatomical-PT), Pelvic incidence (PI) (Figure 3).^[6]

For the above items, we compared the groups with and without fracture progression. Statistical analysis was performed using EZR statistical software, Mann-Whitney U test, Fisher's exact test, and $p < 0.05$ was considered a significant difference. This study was approved by the Ethical Review Committee of the Nagoya Daini Red Cross Hospital.

III. Results

The fracture types of the entire patient group (177 patients) and the patients who underwent multiple CT scans (124 patients) are shown in Figure 4. The number of patients with fracture type progression was 27, and that without fracture type progression was 97. Of these cases classified as R-type II (a, b, c) at the time of initial examination, 46 did not progress the fracture type and 25 progressed the fracture type. (Figs. 4 and 5). Of these, 14 progressed to R-type IIIc and 11 to R-type IVb. (Fig. 6).

Figure 4: Evaluation of fracture type and evolution of fracture type in the patient group based on Rommens classification.

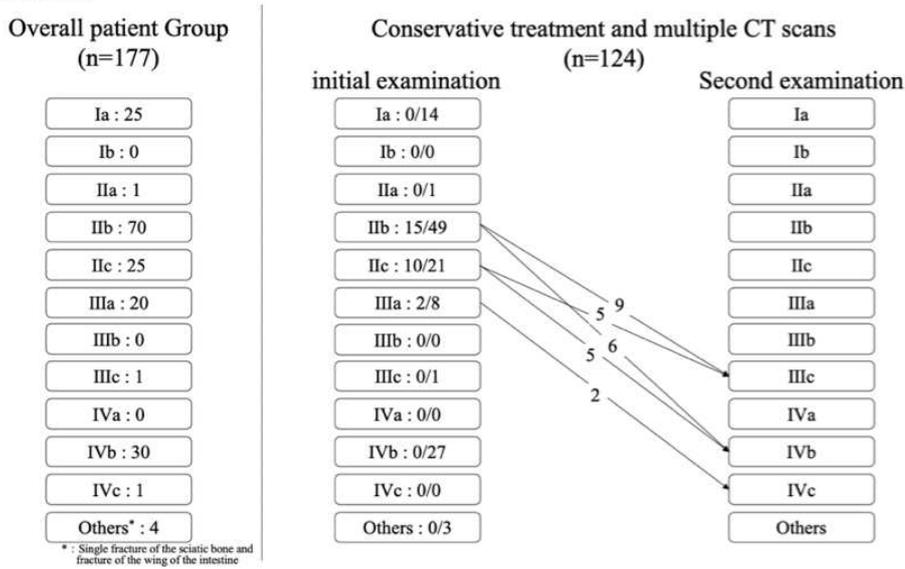


Figure 5: Selection of patient groups.

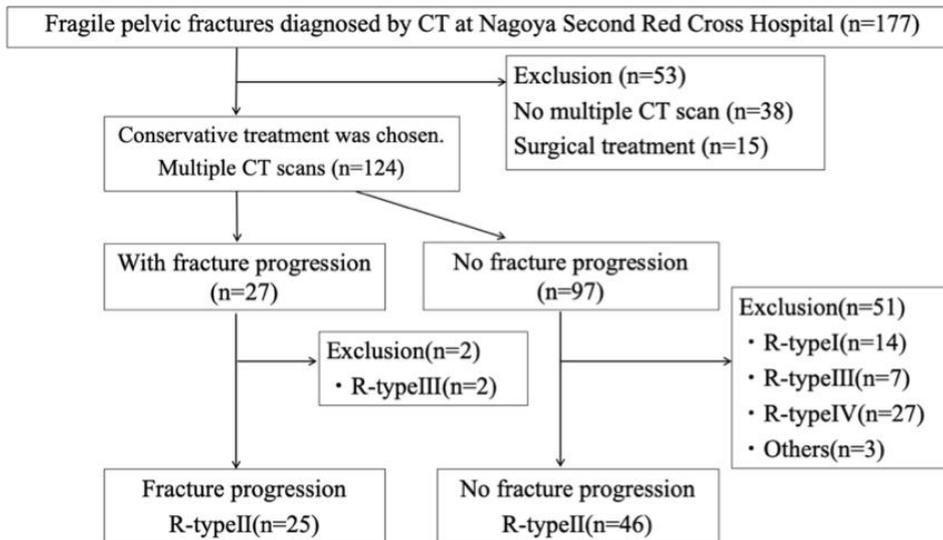


Figure 6. Course of conservative treatment and fracture type progression of Rommens classification type II (a, b, c).

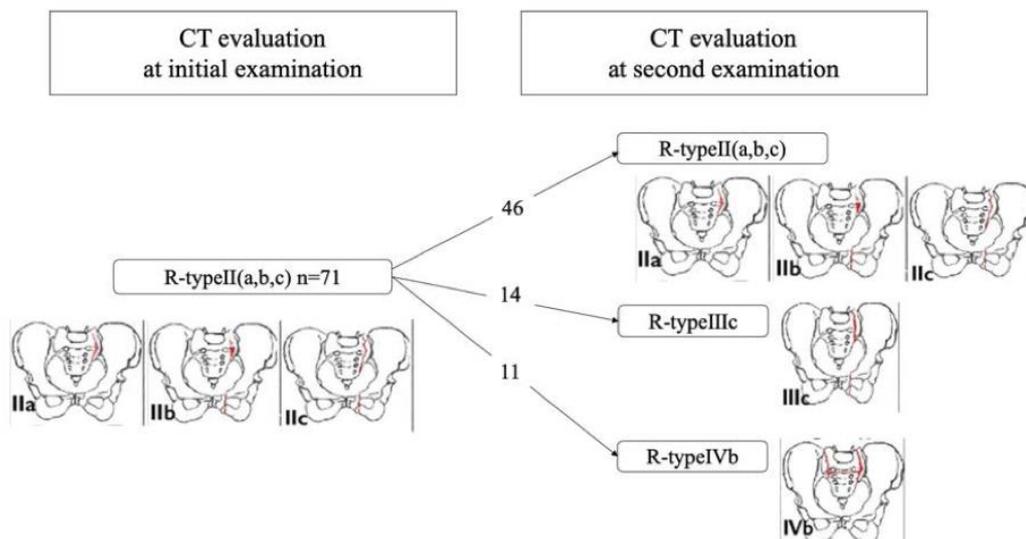


Table 1: Comparison between the groups in which the fracture developed (group P) and in which it did not develop (group N).

		Group P n=25	Group N n=46	p-value
Gender	Male	3	2	0.34
	Female	22	44	0.34
Mean age (years)		79.6±7.5	82.9±9.7	0.15
BMI		19.6±4.0	19.6±3.0	0.87
History of trauma such as fall "None"		6	3	0.06
History of osteoporosis treatment "None"		20	33	0.57
Steroid medication "Yes"		4	4	0.45
History of rheumatism "Yes"		1	2	1.00
History of radiation to pelvis "Yes"		2	2	0.61
Hip implant "Yes"		7	10	0.57
Spinal implant "Yes"		0	0	1.00
Fracture site of sacrum	D-Zone I	21	46	<0.01*
	D-Zone II	4	0	<0.01*
	D-Zone III	0	0	1.00
Sacral and pubic bone fracture site left-right difference	Ipsilateral	16	33	0.60
	Contralateral	5	7	0.74
Fracture site of pubis	Anterior bilateral	4	1	0.05
	No pubic bone fracture	0	5	0.15
	Unilateral N-Zone I	4	21	0.02*
	Unilateral N-Zone II	7	1	<0.01*
	Unilateral N-Zone III	9	17	1.00
	Unilateral N-Zone I+ III	1	1	1.00
	Bilateral N-Zone I	4	0	0.01*
	Bilateral N-Zone III	0	1	1.00
Pelvic tilt	No fracture	0	5	0.15
	Anatomical SS	44.1±6.9	41.8±9.7	0.30
	Anatomical PT	10.7±6.1	8.7±7.1	0.25
	PI	54.7±10.5	50.6±10.6	0.11

*: Signifies significance level less than 5%.

For patients classified as R-type II (a, b, c) at the time of initial examination, a comparison was made between the group in which the fracture type progressed (group P) and the group in which the fracture type did not progress (group N). The most common fractures in the P group were

sacral fracture: D-Zone II (4 cases in the P group: 0 cases in the N group, $p<0.01$), fracture of the suprapubic branch: N-Zone II (7 cases in the P group: 1 case in the N group, $p<0.01$), and fracture of the bilateral pubic symphysis: N-Zone I (4 cases in the P group: 0 cases in the N group, $p=0.01$), N-Zone I (4 cases in P group: 0 cases in N group, $p=0.01$). The most common fractures in the N group were sacral fracture: D-Zone I (21 cases in P group: 46 cases in N group, $p<0.01$), and fracture at the pubic symphysis: N-Zone III (4 cases in P group: 21 cases in N group, $p=0.02$) (Table 1).

Next, the results were compared between the group that progressed from R-type II to IIIc (hereinafter referred to as the II→IIIc group) and the N group, and between the group that progressed from R-type II to IVb (hereinafter referred to as the II→IVb group) and the N group.

The most common fractures in the II→IIIc group were fractures in the suprapubic branch: N-Zone II (7 cases in the II→IIIc group: 1 case in the N group, $p<0.01$), and fractures in the bilateral pubic symphysis: N-Zone I (3 cases in the II→IIIc group: 1 case in the N group, $p=0.04$). Fracture at the pubic symphysis: N-Zone III (Group II→IIIc: 1 case, Group N: 21 cases, $p=0.01$) was significantly more

Table 2: Comparison between the group that progressed to Rommens classification type II→IIIc (group II→IIIc) and the group that did not progress (group N).

		Group II→IIIc n=14	Group N n=46	p-value
Gender	Male	2	0.23	0.34
	Female	12	0.23	0.34
Mean age (years)		80.4±7.9	82.9±9.7	0.38
BMI		18.8±3.1	19.6±3.0	0.61
History of trauma such as fall "None"		1	1	1.00
History of osteoporosis treatment "None"		10	10	1.00
Steroid medication "Yes"		2	2	0.62
History of rheumatism "Yes"		1	1	0.56
History of radiation to pelvis "Yes"		1	1	0.56
Hip implant "Yes"		4	4	0.72
Spinal implant "Yes"		0	0	1.00
Fracture site of sacrum	D-Zone I	12	46	0.05
	D-Zone II	2	0	0.05
	D-Zone III	0	0	1.00
Sacral and pubic bone fracture site left-right difference	Ipsilateral	10	33	1.00
	Contralateral	1	7	0.67
Fracture site of pubis	Anterior bilateral	3	1	0.04*
	No pubic bone fracture	0	5	0.33
	Unilateral N-Zone I	1	21	0.01*
	Unilateral N-Zone II	7	1	<0.01*
	Unilateral N-Zone III	3	17	0.35
	Unilateral N-Zone I+ III	0	1	1.00
	Bilateral N-Zone I	3	0	0.01*
	Bilateral N-Zone III	0	1	1.00
Pelvic tilt	No fracture	0	5	0.33
	Anatomical SS	41.3±7.0	41.8±9.7	0.84
	Anatomical PT	8.2±4.9	8.7±7.1	0.77
	PI	49.4±9.1	50.6±10.6	0.71

*: Signifies significance level less than 5%.

Table 3: Comparison between the group that progressed to Rommens classification type II→IVb (group II→IVb) and the group that did not progress (group N).

		Group II→IVb n=11	Group N n=46	p-value
Gender	Male	1	2	0.48
	Female	10	44	0.48
Mean age (years)		78.6±7.2	82.9±9.7	0.18
BMI		20.8±4.4	19.6±3.0	0.40
History of trauma such as fall "None"		5	3	<0.01*
History of osteoporosis treatment "None"		10	33	0.26
Steroid medication "Yes"		0	4	0.58
History of rheumatism "Yes"		2	2	0.16
History of radiation to pelvis "Yes"		1	2	0.48
Hip implant "Yes"		3	10	0.7
Spinal implant "Yes"		0	0	1.00
Fracture site of sacrum	D-Zone I	9	46	0.03*
	D-Zone II	2	0	0.03*
	D-Zone III	0	0	1.00
Sacral and pubic bone fracture site left-right difference	Ipsilateral	6	33	0.30
	Contralateral	4	7	0.20
Fracture site of pubis	Anterior bilateral	1	1	0.35
	No pubic bone fracture	0	5	0.57
	Unilateral N-Zone I	3	21	0.33
	Unilateral N-Zone II	0	1	1.00
	Unilateral N-Zone III	6	17	0.32
	Unilateral N-Zone I+ III	1	1	0.35
	Bilateral N-Zone I	1	0	0.19
	Bilateral N-Zone III	0	1	1.00
Pelvic tilt	No fracture	0	5	0.57
	Anatomical SS	47.3±5.1	41.8±9.7	0.07
	Anatomical PT	13.6±5.6	8.7±7.1	0.03*
	PI	60.9±7.4	50.6±10.6	<0.01*

*: Signifies significance level less than 5%.

common in Group N (Table 2).

Significantly more patients in the II→IVb group had no history of trauma such as fall (II→IVb group 5 cases: N group 3 cases, $p < 0.01$), sacral fracture: D-Zone II (II→IVb group 2 cases: N group 0 cases, $p = 0.03$), anatomical PT (II→IVb group 13.6 ± 5.6 : N group 8.7 ± 7.1 , $p = 0.03$), PI (II→IVb group 60.9 ± 5.6 : N group 8.7 ± 7.1 , $p = 0.03$), and PI (II→IVb group 60.9 ± 5.6 : N group 8.7 ± 7.1 , $p = 0.03$). →Group IVb 60.9 ± 7.4 : Group N 50.6 ± 10.6 , $p < 0.01$). In the N group, sacral fracture: D-Zone I (9 cases in the II→IVb group: 46 cases in the N group, $p = 0.03$) was significantly more common. (Table 3)

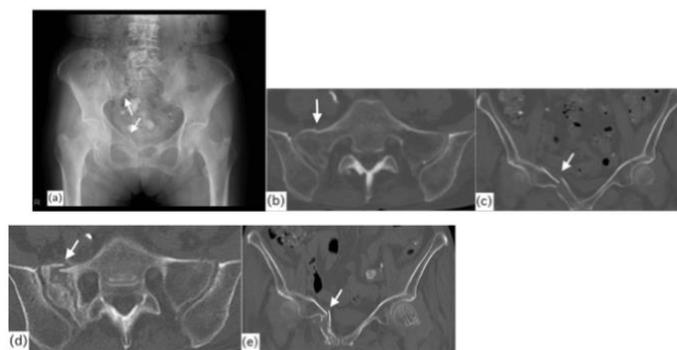
IV. Case presentation

Case 1: An 84-year-old woman was injured by a fall. CT scan showed a fracture of the right sacrum and right suprapubic branch, which was diagnosed as R-type IIb. The fracture was diagnosed as R-type IIb and was treated conservatively. During the course of treatment, prolonged fusion of the fracture was observed, and it was judged that the fracture had progressed to R-type IIIc (Figure 7).

Case 2: An 87-year-old woman was injured by a fall, and CT and MRI showed fractures of the right sacrum and left pubic symphysis, which were diagnosed as R-type

Figure 7. Case presentation 1.

84-year-old female with a fall from standing position. The initial diagnosis was FFPs R-type IIb, but the fracture progressed to R-type IIIc during the course of conservative treatment.

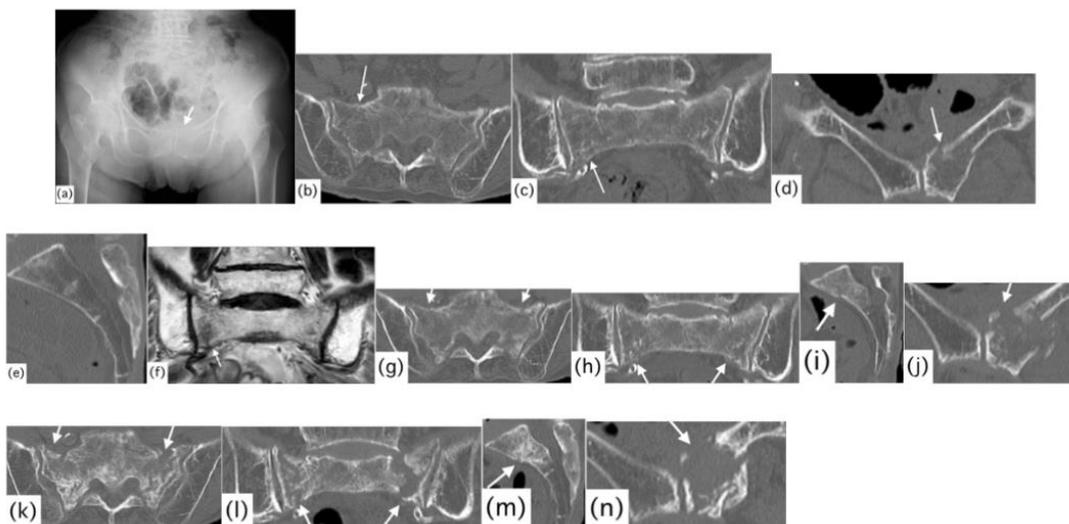


a) Simple X-ray image at the time of initial examination.
b-c) CT at the time of initial examination.
d-e) CT 1 month after injury.

IIb and treated conservatively. The anatomical PT and PI of the reconstructed 3D-CT were 10.5 and 62.05, respectively. During the course of treatment, a new fracture line in the left sacrum, prolonged fusion of the pubic symphysis, and angular deformity in the sagittal plane of the S1 sacrum were observed, and the fracture was considered to have progressed to R-type IVb (Figure 8).

Figure 8. Case presentation 2.

An 87-year-old woman with a fall from standing position. The initial diagnosis was FFPs R-type IIb, but the fracture progressed to R-type IVb during the course of conservative treatment.



a) Simple X-ray image at the time of injury.
b-e) CT at the time of injury.
f) MRI at the time of injury.
g-j) CT 1 month after injury.
k-n) CT 6 months after injury.

V. Discussion

Through this study, it was considered that during the course of conservative treatment of fragility pelvic fractures of Rommens classification type II, patients with fractures of the suprapubic branch or both pubic body, and patients with large anatomical PT or PI may have a possibility of progressive dislocation of the fracture site or an increase in new fracture lines.

FFPs are fragility fractures that occur in elderly patients with osteoporosis, and as with proximal femur fractures, the goal of treatment is not only to achieve bone healing, but also how to treat the fracture without decreasing ADL. In the initial examination of FFPs, about 70% of cases are reported to be diagnosed as R-type I or II, and conservative treatment is generally recommended. [1] However, there are some cases that show resistance to conservative treatment, such as prolonged pain, and the involvement of fracture type progression has been reported as a factor. [4] Therefore, it is a clinical challenge to identify patients who may progress the fracture type, so that we can consider when to switch to adjuvant therapy such as PTH or surgery.

As for risk factors for FFPs, previous studies pointed out osteoporosis treatment, steroids, rheumatoid arthritis, pelvic radiation, hip and spinal implants, [2,7] but no significant difference in fracture type progression was found in our study. In addition, it was reported that the factors for fracture type progression in previous studies were relatively young age and female, [3] but the same result was not obtained in our own study.

WHO defines fragility fracture as a fracture predisposed to decreased resistance to compression and torsion due to decreased bone density. [7] In the pelvic ring, the area of bone fragility correlates with the fracture area in FFPs, and can also cause occult fractures without trauma in the same area. [8] In our own study, there were many cases with no obvious history of trauma, especially in the group that progressed from R-type II to IVb. In this study, we investigated the possibility of fracture development in the pelvic ring due to the fragility of the pelvic bone.

The osteoporotic region of the sacral wing is commonly referred to as "alar voids" and is reported to be a

common site of sacral fractures in FFPs. [8] In our own study, we found that fractures of the suprapubic branch and bilateral pubic symphysis were more likely to result in dislocation than those of the pubic body and unilateral pubic symphysis, suggesting that the suprapubic branch has a smaller contact area when fractured than the pubic body and symphysis, and that the anterior instability of the pelvic ring in bilateral pubic fractures causes prolonged fusion. It is speculated that the anterior instability of the pelvic ring in both pubic fractures may cause prolonged fusion.

In a previous study, we reported the result that cases with large PI could develop fracture type, [3] and the same tendency was observed in this study. However, the possibility of its involvement was thought to differ depending on the mode of fracture progression. It is said that PI is independent of posture and is unique to each individual, but patients with a large PI are said to have a greater pelvic tilt due to kyphosis compensation for age-related kyphosis. [9] In addition, it is said that the pelvic tilt is stronger in the sitting > supine > standing position. [10] In a study using a finite element model of a fragile pelvic fracture, it was reported that posterior pelvic tilt caused stress concentration at the sacral S1 and S2 levels, and that this stress distribution was similar to the fracture line of R-type IVb. [1] These results suggest that patients with large anatomical PT and PI may have a strong pelvic tilt depending on their posture to compensate for age-related kyphosis, resulting in stress concentration at the S1 and S2 sacral levels, which may lead to prolonged fusion and new fragility fractures with repeated standing movements.

Fracture progression in the course of conservative treatment of FFPs may be related to multiple factors, and this study suggests that each factor may play a different role in the progression pattern. In this study, it was suggested that each factor may play a different role in the progression of fractures. In the case of type II-IIIc, where prolonged union at the same site occurs, mechanical instability due to the fracture site may be a factor. The mechanism of progression may be different in each type. The mechanism of progression may be different in each case, and further investigation is needed.

The limitations of this study are that it is a

retrospective study, the number of cases is insufficient, subclinical fractures cannot be pointed out because MRI was not performed in all patients at the time of injury, and sagittal plane alignment including spine, hip, and knee cannot be considered.

VI. Conclusion

During the course of conservative treatment of fragility pelvic fractures of Rommens classification type II, patients with fractures of the suprapubic branch or both pubic body, and patients with large anatomical PT or PI may have a possibility of progressive dislocation of the fracture site or an increase in new fracture lines.

References

- 1) Rommens PM, Hofmann A. Comprehensive classification of fragility fractures of the pelvic ring : Recommendations for surgical treatment . *Injury* 2013;44(12):1733-1744
- 2) Wagner D, Ossendorf C, Gruszka D, et al. Fragility fractures of the sacrum: how to identify and when to treat surgically? *Eur J Trauma Emerg Surg* 2015;41:349-362
- 3) Rommens PM, Arand C, Hopf C, et al. Progress of instability in fragility fractures of the pelvis: An observational study. *Injury* 2019;50(11):1966-73
- 4) Ueda Y, Inui T, Kurata Y, et al. Prolonged pain in patients with fragility fractures of the pelvis may be due to fracture progression. *Eur J Trauma Emerg Surg*. 2019
- 5) Starr AJ, Nakatani T, Reinert CM, Cederberg K. Superior pubic ramus fractures fixed with percutaneous screws: what predicts fixation failure? *Orthop Trauma*. 2008;22:81-87.
- 6) Imai N, Miyasaka D, Tsuchiya K, et al. Evaluation of pelvic morphology in female patients with developmental dysplasia of the hip using three- *Journal of Orthopaedic Science* 2018;23(5):788-792
- 7) World Health Organization : Guidelines for preclinical evaluation and clinical trials in osteoporosis . 1998
- 8) Rommens PM, Wagner D, Hofmann A. Fragility fractures of the pelvis. *J Bone Jt Surg Rev* 2017;5:1-13
- 9) Roussouly P, Nnadi C. Sagittal plane deformity: an overview of interpretation and management. *Eur Spine K* 2010;19:1824-2836
- 10) Chevillotte T, Coudert P, Cawley D, et al. Influence of posture on relationships between pelvic parameters and lumbar lordosis: comparison of A preliminary study. *Orthop Traumatol Surg Res* 2018; 104(5):565-568
- 11) Sato T, Shiota N, Sawaguchi T. Non-Operative Treatment. In: Rommens PM, Hofmann A, editors. *Fragility Fractures of the Pelvis*. Switzerland: Springer Nature; 2017. p.83-95.

Figures

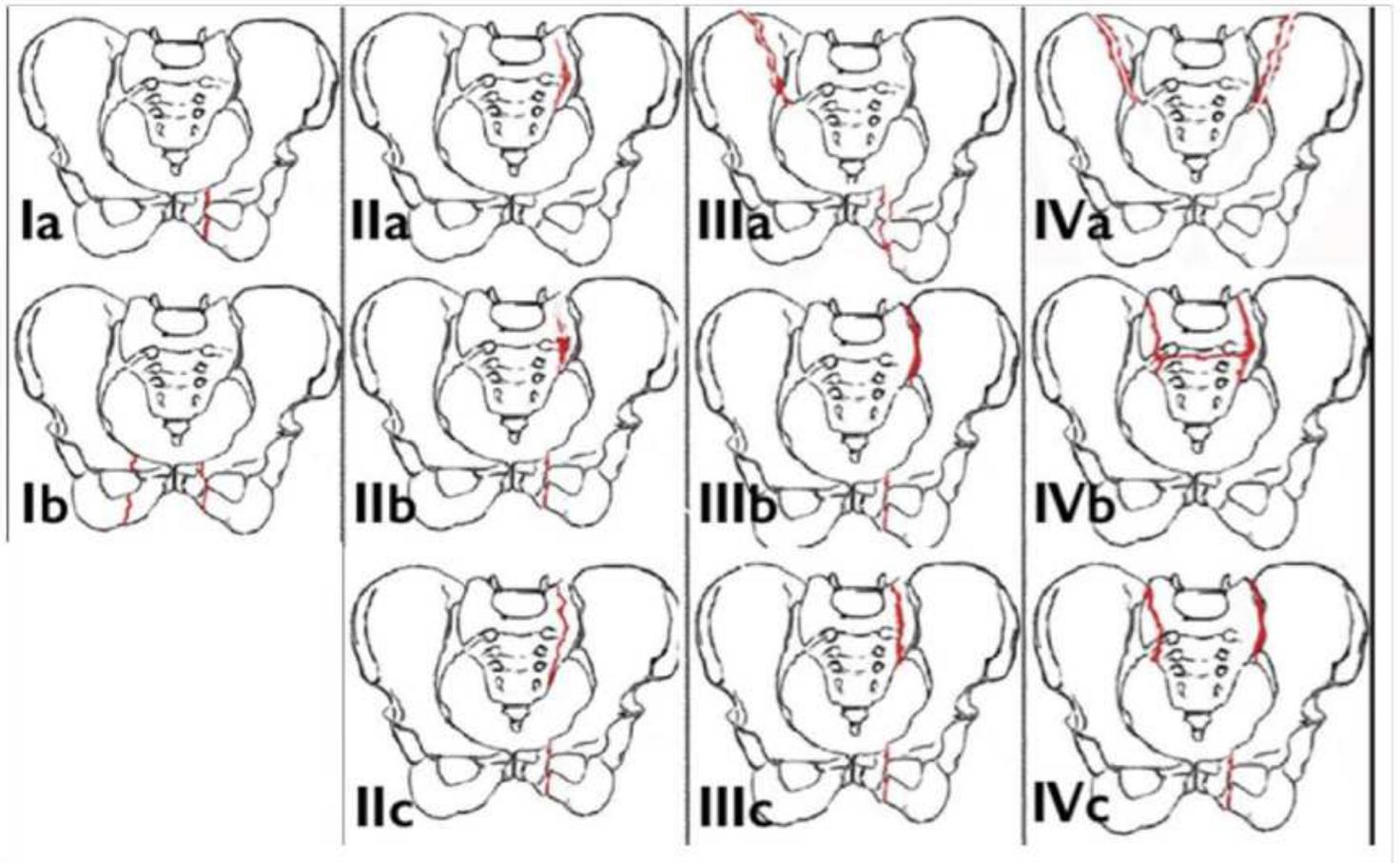


Figure 1

Rommens et al. classification (modified from Ref. 1)

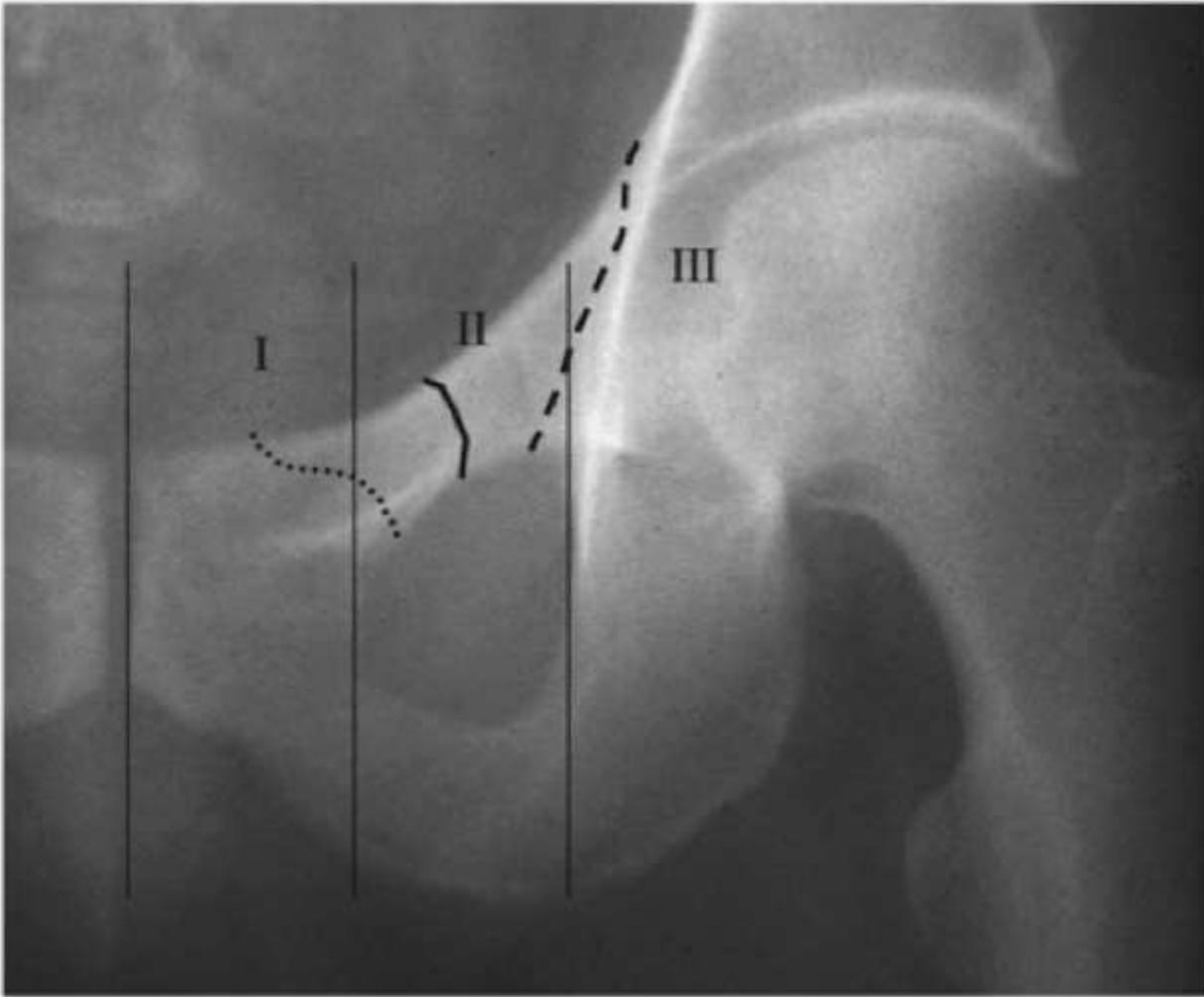


Figure 2

Nakatani classification (modified from Ref. 5) From left to right: Zone 1 (pubic Symphysis), Zone II (suprapubic branch), Zone II (pubic body). The dotted line shows the classification of Zone I or III when it spans two Zones.

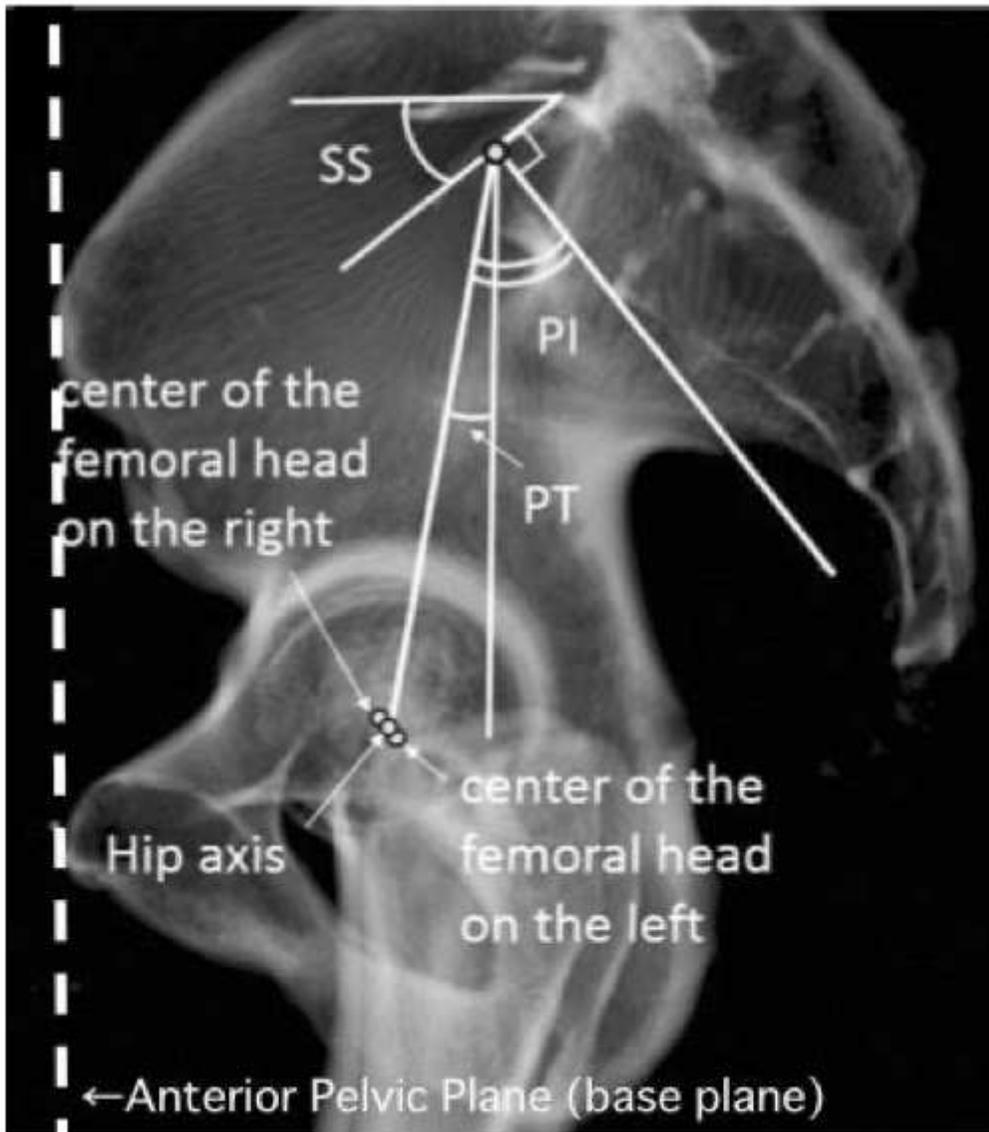


Figure 3

Measurement of pelvic title (modified from Reference 6). In the reconstructed 3D-CT pelvic lateral image, anatomical SS, anatomical PT, and PI were measured using the Anterior Pelvic Plane as a reference line.

**Overall patient Group
(n=177)**

Ia : 25
Ib : 0
IIa : 1
IIb : 70
IIc : 25
IIIa : 20
IIIb : 0
IIIc : 1
IVa : 0
IVb : 30
IVc : 1
Others* : 4

* : Single fracture of the sciatic bone and fracture of the wing of the intestine

**Conservative treatment and multiple CT scans
(n=124)**

initial examination

Ia : 0/14
Ib : 0/0
IIa : 0/1
IIb : 15/49
IIc : 10/21
IIIa : 2/8
IIIb : 0/0
IIIc : 0/1
IVa : 0/0
IVb : 0/27
IVc : 0/0
Others : 0/3

Second examination

Ia
Ib
IIa
IIb
IIc
IIIa
IIIb
IIIc
IVa
IVb
IVc
Others

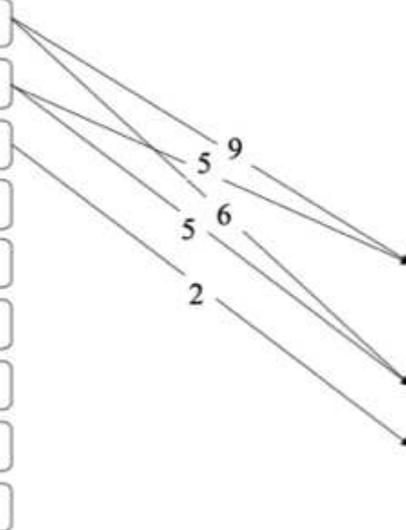


Figure 4

Evaluation of fracture type and evolution of fracture type in the patient group based on Rommens classification.

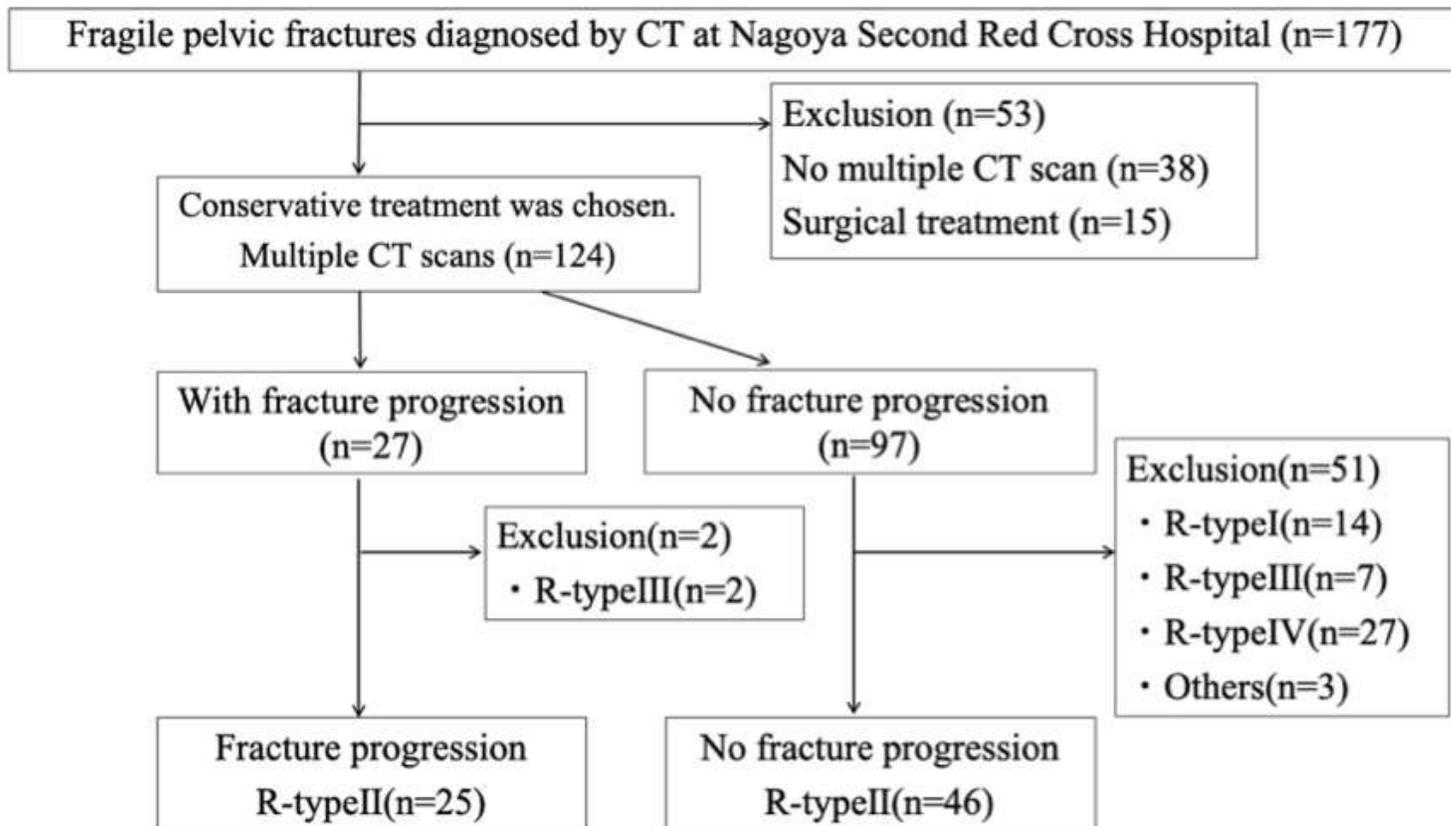


Figure 5

Selection of patient groups.

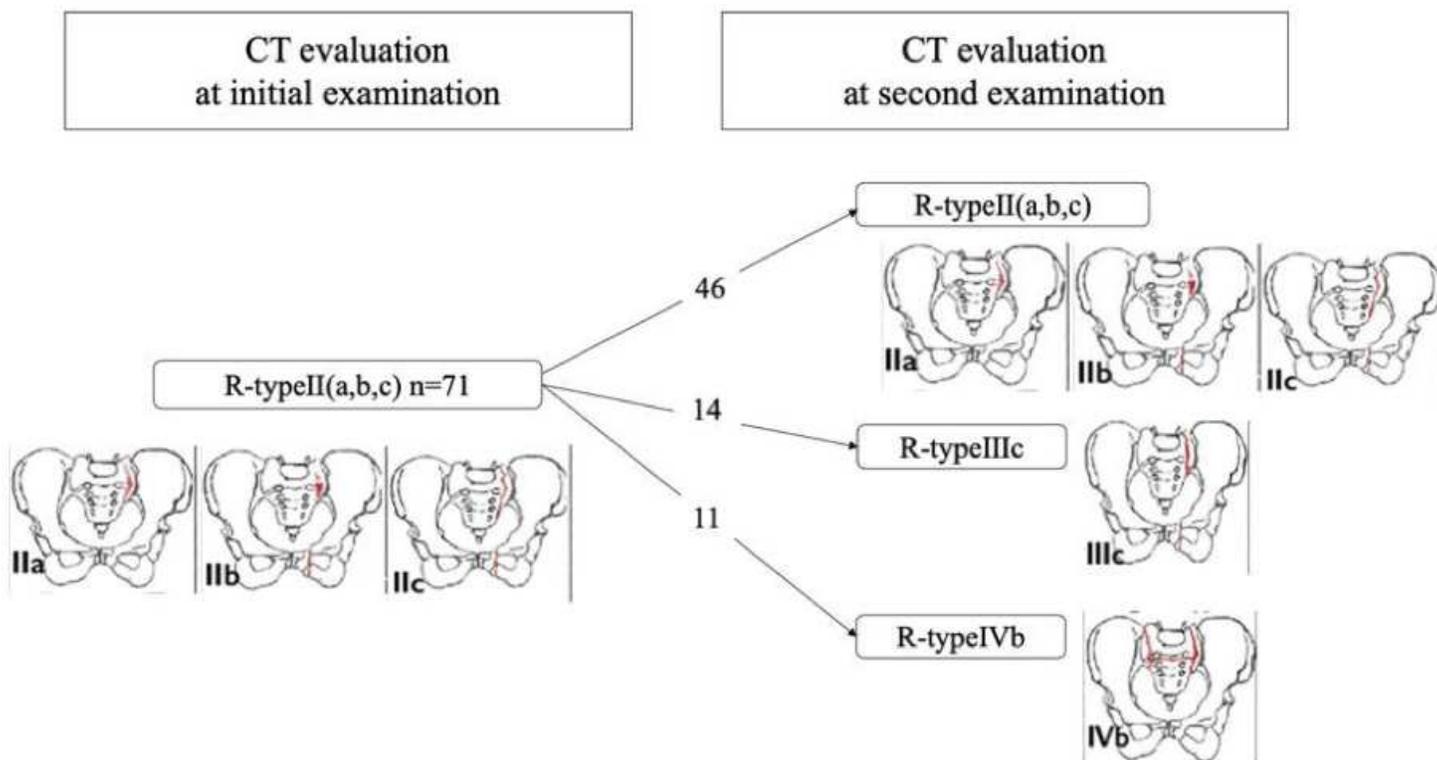


Figure 6

Course of conservative treatment and fracture type progression of Rommens classification type II (a, b, c).

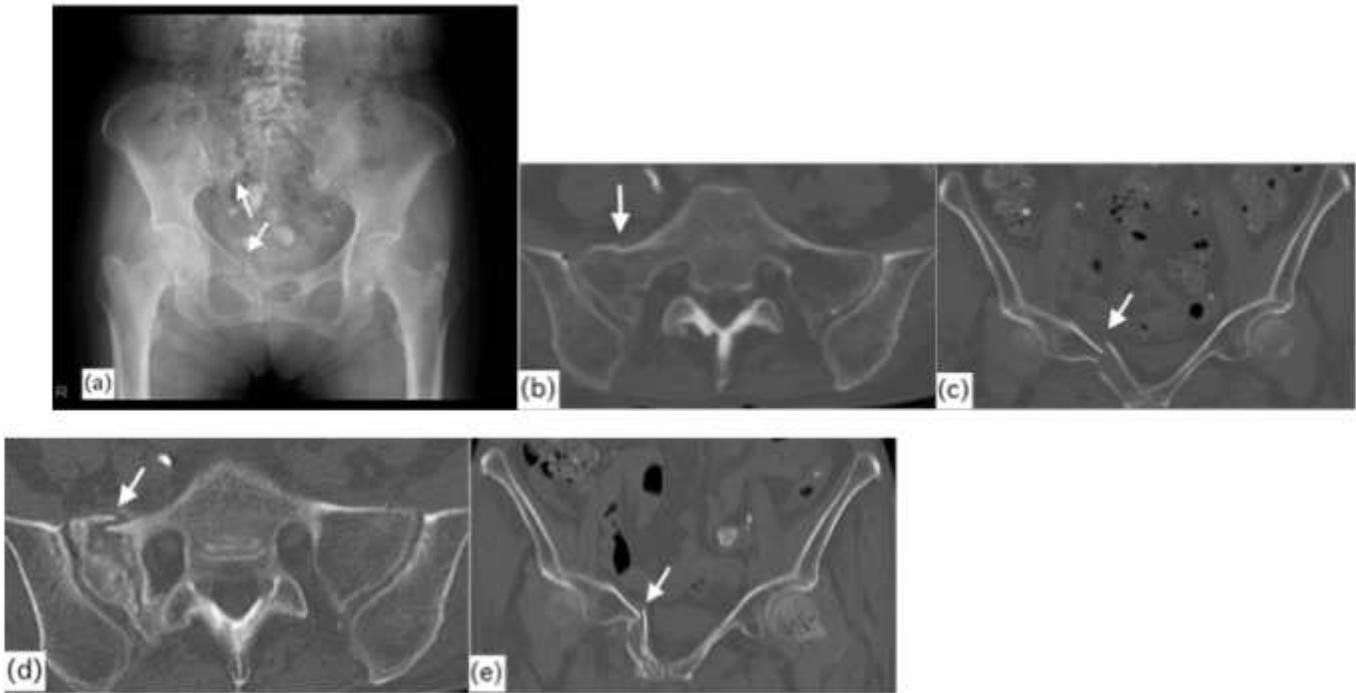


Figure 7

Case presentation 1. 84-year-old female with a fall from standing position. The initial diagnosis was FFPs R-type IIB, but the fracture progressed to R-type IIC during the course of conservative treatment. a) Simple X-ray image at the time of initial examination. b-c) CT at the time of initial examination. d-e) CT 1 month after injury.

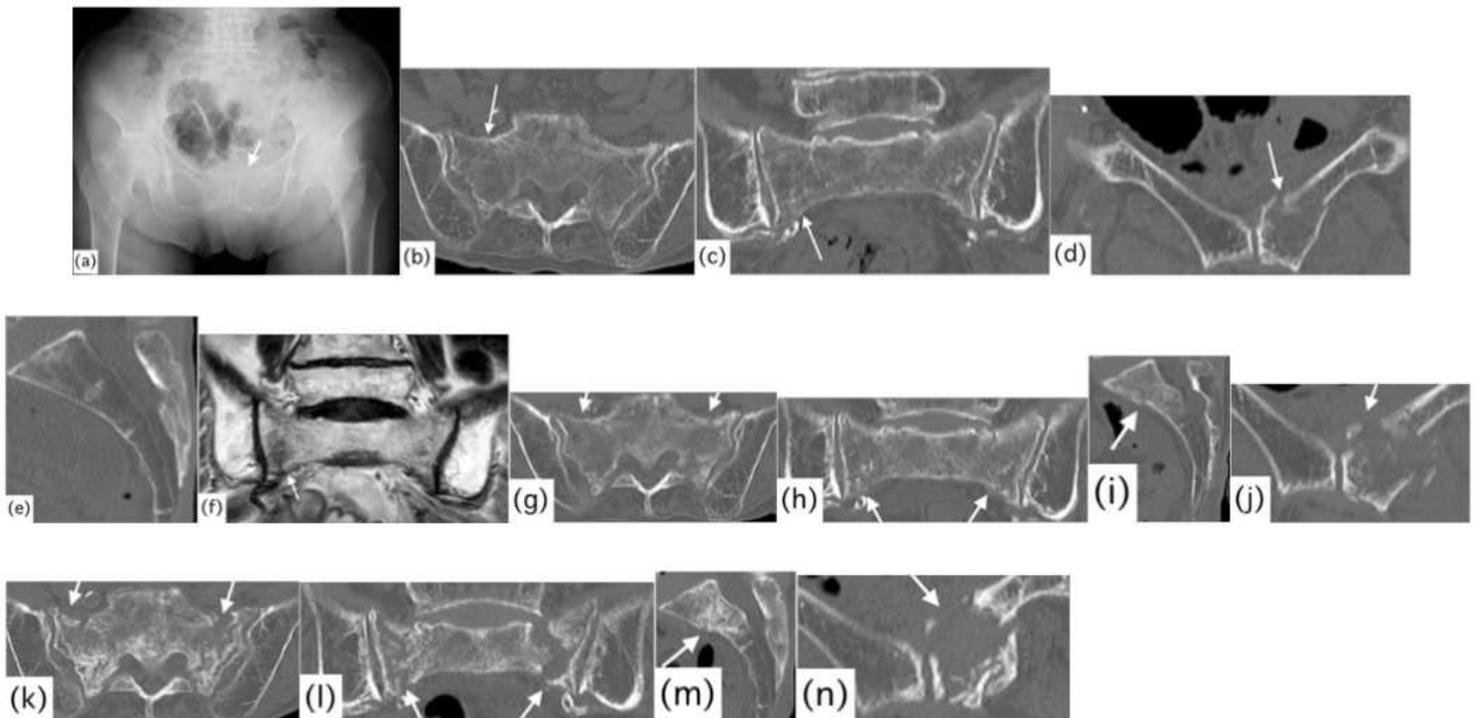


Figure 8

Case presentation 2. An 87-year-old woman with a fall from standing position. The initial diagnosis, was FFPs R-type IIb, but the fracture progressed to R-type IVb during the course of conservative treatment. a) Simple X-ray image at the time of injury. b-e) CT at the time of injury. f) MRI at the time of injury. g-j) CT 1 month after injury. k-n) CT 6 months after injury.