

Intentional Fallers with Complex Pelvic and Acetabular Fractures Do Not have Worse Radiological and Functional Outcomes than Accidental Fallers

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Abstract

Background: Individuals who fell from heights of >6 m accidentally or intentionally can suffer from complex pelvic and acetabular fractures. The extent to which an intentional fall correlates with prognosis and outcome after osteosynthesis is unclear. We aimed to investigate the clinical outcomes of fallers with pelvic and acetabular fractures after osteosynthesis and to compare the radiological and functional outcomes between intentional and accidental fallers.

Methods: Between 2014 and 2017, individuals who fell from heights of >6 m, developed pelvic and acetabular fractures, survived after resuscitation, and completed surgical treatments were enrolled. The fallers were divided into the intentional and accidental fallers, and their clinical parameters were statistically evaluated and compared.

Results: Forty-nine fallers who underwent osteosynthesis for pelvic and acetabular fractures were included. Sixteen patients were intentional fallers, whereas the rest of the patients fell accidentally. All patients who fell intentionally had pre-existing mental disorders, and the major diagnosis was adjustment disorder. The group with intentional fallers had female sex predominance, higher injury and new injury severity scores, and longer hospital stay. However, the early loss of fixation (less than three month) and functional outcomes (6- and 12-month follow-up) did not significantly differ between the intentional and accidental fallers.

Conclusions: The intentional fallers with pelvic and acetabular fractures might be accompanied by more severe injuries compared to accidental fallers. However, the radiological and functional outcomes of the intentional fallers after osteosynthesis were not inferior to those of the accidental fallers.

Introduction

The optimal treatment of pelvic and acetabular fractures is still challenging for orthopedic surgeons, especially for multi-planar unstable pelvic and complex acetabular fractures. Unstable pelvic and acetabular fractures are usually caused by high energy traumas, such as high-speed motor vehicular accidents, falls from height, and crush injuries [1]. Among the different mechanisms of unstable pelvic and acetabular fractures, the mechanism of falling from great heights always causes great instability of the pelvic ring or multiple levels of injury of the acetabulum, thereby resulting in treatment difficulty and unpredictable prognosis [2–4].

There is a high incidence of unstable pelvic and acetabular fractures in patients who fell from great heights [2, 3]. Most patients may fall accidentally; however, some fall from jumping intentionally. According to the literature, intentional fallers tend to have pre-existing mental disorders and easily fail to comply with medical orders because of their mood changes, psychological abnormalities, and history of drug abuse [5–8], contributing to their unpredictable prognosis after undergoing orthopedic procedures.

Previous studies majorly focused on the epidemiology, resuscitation outcomes, and quality of life assessments of patients with mental disorders who experienced pelvic fractures after attempting to commit suicide by jumping. However, we did not know that their high or low performance after injury was only related to injury itself or by the combined influences with their mental disorders. Therefore, the primary outcome evaluation of the current study was aimed to investigate the radiological and functional outcomes of patients with unstable pelvic and acetabular fractures caused by an intentional fall and to compare their clinical outcomes to those of accidental fallers who have similar injury mechanism and fracture patterns.

Material And Methods

Study design, participants, and data collection

The current study retrospectively reviewed the patients with unstable pelvic and acetabular fractures who were admitted between 2014 and 2017. The inclusion criteria were patients with unstable pelvic and acetabular fractures due to a fall from heights of > 6 m who underwent osteosynthesis during the study period. Patients with unstable pelvic and acetabular fractures resulting from the etiologies other than falls from great heights, such as < 6 m, traffic accidents, or crush injuries, or those who underwent conservative treatment for any reason were excluded. Furthermore, the enrolled patients would be divided into the following two groups according to the etiology of fall for clinical parameter and outcome comparisons: intentional fallers (I group) and accidental fallers (A group). The review process of the patients' complete medical and imaging records was approved by the Institutional Review Board (IRB no. 201900247B0).

As a tertiary referral trauma center, the patients were transferred to the emergency department either from the trauma scene or local hospitals. The resuscitation protocol was standardized and individualized, following the guideline from Acute Trauma Life Support and the resuscitative algorithm of pelvic fracture of the hospital. The injured patients were admitted to the regular wards or intensive care units after they were hemodynamically stabilized during the resuscitation stage. Osteosynthesis was performed once the patient's medical condition was optimized and suitable for anesthesia and operation.

Patient Resuscitation, Management, and Rehabilitation

The postoperative rehabilitation protocol was individualized according to the patient's medical condition or concomitant injuries. In general, toe-touch weight-bearing could be allowed 6 to 8 weeks after the index surgery and crutch- or walker-free ambulation could be started 6 weeks after toe-touch ambulation. Prophylaxis of venothromboembolism was routinely applied mechanically with compressions socks for 12 weeks but not pharmacochemically. There was no routine prophylactic practice for heterotrophic ossification following operations. For all the patients with intentional fall injuries, routine psychiatric

consultations were done to confirm diagnosis, stabilize mental condition, and prevent occurrence of the next suicide attempts.

The current study adapted the classification of AO/OTA for pelvic fractures, Judet-Letournal classification for acetabular fractures, and the classification of Denis and Roy-Camille for sacral fractures. Detailed records of out-patient-clinic follow-up were documented during the 12-month follow-up, at least. Functional outcome evaluations were conducted by using questionnaires of the modified Merle d'Albinague score and Majeed hip score at 6 and 12 months.

Statistical Analysis

Statistical analysis was conducted using SPSS 18.0 (SPSS Inc., Chicago, IL, USA). Continuous variables are presented as the mean and standard deviation. The normal distribution of the cohort was tested by Shapiro-Wilk test. We compared the preoperative and perioperative variables between the accidental and intentional fallers using the nonparametric Mann-Whitney U-test. Categorical variables are reported as frequencies, and we compared the data of the two groups by using the Fisher's exact test. A two-tailed P-value of 0.05 was considered significant. In addition, a post hoc power analysis was performed with the G*Power software (version 3.1.9.4; Franz Paul, University Kiel, Germany) to determine the power of primary outcomes of difference in trauma scores, early loss of follow-up, early loss of fixation, and functional score evaluations between the two groups.

Results

Study population and characteristics

During the study period, a total of 848 patients with fractures involving the pelvis and acetabulum were admitted to the emergency department of our hospital. The incidence of index fracture resulting from fall injury (> 6 m) was 21.9% (186/848). Forty-nine patients (26.3%, 49/186) were treated surgically for their unstable fracture patterns. The complete demographic data of the 49 patients are presented in Table 1.

Table 1
Demographic distribution of 49 patients with pelvic
and acetabular fractures who underwent
osteosynthesis

All patients	49
Sex	
Male	35
Female	14
Age	43.5 ± 15.3
Injury mechanism	
Intentional	16
Accidental	33
Injury severity score (ISS)	16.6 ± 10.2
New injury severity score (NISS)	19.8 ± 9.9
Fracture site and its classification	
Pelvis	31
61-B	16
61-C	15
Acetabulum	23
Involve 1 column	2
Involve 2 columns	17
Involve columns and walls	4
Sacrum	17
Dennis zone I	8
Dennis zone II	9
Roy-Camille type 1	2
Roy-Camille type 2	7
Roy-Camille type 3	1
Intensive care unit stay (days)	3.6 ± 5.4
Hospital stay (days)	21.2 ± 12.2
Follow-up (months)	15.3 ± 12.5

Among the enrolled patients, 16 were injured from intentional falls, including seven men and nine women, with a mean age of 36.9 years (range: 18–92 years). All 16 patients had documented pre-existing mental disorders. The majority of the patients had adjustment disorders (n = 9, 56.2%) as the pre-existing mental disorder, whereas the others were diagnosed with schizophrenia, substance abuse disorder, and mixed type mental disorders. Ten patients (81.2%) were diagnosed with pelvic ring and sacral injuries, whereas the remaining patients had complex fractures involving the pelvic ring, sacrum, and acetabulum. Four patients (25%) never returned to the out-patient clinic department for follow-up evaluations after they received complete treatments and discharged from the hospital. For the remaining 12 patients who had regular follow-ups, three patients (25%) showed early loss of reduction or broken implants within 3 months after the osteosynthesis (Fig. 1). However, none of them underwent revision surgery even though it was always highly recommended to the patients.

Comparison between the intentional and accidental fallers

The comparison of the radiological and functional results between the patients whose injuries were caused by intentional falls (I group) or those whose injuries were caused by accidental falls (A group) is presented in Table 2. The I group was significantly more likely to be female (post hoc power, 80.3%), had a higher frequency of mental disorders (post hoc power, 100%), had higher injury severity score (ISS) (post hoc, 72.8%), new injury severity score (NISS) (post hoc power, 64.7%), abbreviated injury scale (AIS)-chest score (post hoc power, 62.6%), and AIS-abdomen (post hoc power, 41.9%) score, and longer length of hospital stay (post hoc power, 54.2%);

Table 2
Clinical comparison between intentional and accidental fallers

	Intentional	Accidental	P value
Sex			0.006
Male	7	28	
Female	9	5	
Age	36.9 ± 21.1	46.6 ± 10.6	0.099
ISS	21.9 ± 10.3	14.1 ± 9.2	0.01
NISS	24.3 ± 9.0	17.5 ± 9.7	0.023
AIS-head	0.6 ± 1.3	0.5 ± 1.0	0.357
AIS-face	0.3 ± 0.8	0.2 ± 0.5	0.915
AIS-chest	2.4 ± 1.7	1.2 ± 1.6	0.020
AIS-abdomen	1.7 ± 1.3	1.0 ± 1.2	0.049
AIS-extremity	2.6 ± 0,7	2.5 ± 0.6	0.942
Mental disorder	16	0	< 0.001
Intensive care unit stay	4.6 ± 4.6	3.1 ± 5.7	0.053
Hospital stay	26.5 ± 12.6	18.6 ± 10.8	0.018
Follow-up duration	19.9 ± 15.0	13.7 ± 11.4	0.154
Follow-up of < 3 months	25% (4/16)	27.3 (9/33)	1.000
Unstable pelvic fracture	81.3% (13/16)	54.5% (18/33)	0.165
Unstable acetabular fracture	45.4 (5/11)	77.4 (24/31)	0.0006

The results of outcome evaluations and comparisons are listed in Table 3. Radiological outcome evaluations were performed by X-ray examinations during each clinical follow-up. Two patients in the I group who completed at least 3 months of follow-up showed a dislodge or broken implant (3/12, 25%). In the A group, three out of the 31 patients showed broken implants under the same assessment parameters (9.7%), but no significant difference ($P = 0.325$, Fisher's exact test) was found between the two groups.

Functional outcome evaluations were performed at 6 and 12 months after the index surgery. Overall, 30 patients (11 and 19 patients in I and A groups, respectively) completed the functional outcome evaluations. Regardless of the time point of functional evaluation, there was no significant difference between the two groups.

Table 3
Primary outcome comparison between the two groups

Loss of fixation (< 3 months)	3/12 = 25.0%	3/31 = 9.7%	0.325
Functional follow-up			
Merle d'Aubigné hip score			
6 months	9.0 ± 4.5 (n = 11)	10.0 ± 3.7 (n = 19)	0.084
12 months	11.9 ± 4.5 (n = 11)	13.4 ± 3.6 (n = 19)	0.475
Majeed hip score			
6 months		55.3 ± 17.2 (n = 19)	0.090
12 months	51.0 ± 17.8 (n = 11)		0.094
	68.3 ± 17.4 (n = 11)	72.6 ± 17.8 (n = 19)	

Discussion

The present study investigated the radiological and functional outcomes of intentional fallers after osteosynthesis for their pelvic and acetabular fractures and compared their clinical outcomes to those who fell accidentally. The results revealed that all patients who fell intentionally had pre-existing mental disorders. Additionally, intentional fallers presented with female sex predominance, higher ISS, NISS, AIS-chest, AIS-abdomen, and longer hospital stay. However, the result of early loss of fixation and functional outcomes at the 6- and 12-month follow-up did not significantly differ between the intentional and accidental fallers.

Falls, regardless of the etiologies, cause great impact to the socio-economic development. Accidental fallers are usually at the working age; hence, they have financial contributions to their families and society [2]. Functional disability following a fall injury may impact their work productivity. On the other hand, intentional fallers, also called suicide jumpers, are a popular public health concern affecting low to advanced societies [8–16]. In Taiwan, suicide is the second leading cause of death among young people aged 15–24 years, the third among those aged 25–44 years, and the 12th in the general population [17]. Regardless of the reason of fall, all survivors in our case series fell from a height of > 6 m and hit architectural ledges or fell onto hard-impact sites. Thus, they obtained higher ISS and NISS when compared to those patients in previous reports [2, 8].

According to the literature, the suicidal risk is 10 times higher in patients with psychiatric disorder than those without such disorders; at least one psychiatric disorder was reported between 60% and 98% of individuals who committed or attempted suicide [18–20]. The most common mental disorder found in people who committed suicide is depressive disorder (35–80%), followed by schizophrenia (10%) and dementia or delirium (5%), which was in line with the result of our study [21]. Prevention of suicidal

attempts is also a key point to reduce the morbidity and mortality from suicide. In our series, all intentional fallers were reported to have pre-existing mental disorders. A routine psychiatric consultation was performed for each faller with an existing mental disorder in our series, and medication treatment and mental health consultation were conducted to prevent fall accidents from occurring again. Fortunately, more than half of the intentional fallers complied well to the medical orders; thus, there were no recidivisms during our follow-up period.

In general, post-osteosynthesis patients should strictly follow the medical advice and rehabilitation protocols in the early postoperative stage to prevent fixation failure, especially for those with unstable pelvic and acetabular fractures. The patients with mental disorders were thought to have a poorer compliance to medical orders [2, 22, 23]. Under this concept, we expected that intentional fallers with pelvic and acetabular fractures would have a higher incidence of fixation failure than accidental fallers. Although 25% of the incidental fallers experienced fixation failure at the early stage, no significant difference was found between the I and A groups ($P = 0.15$). This finding might indicate that a secure fixation against the fractures was made for all of the patients, which allowed them to start with gait training as soon as possible. For the accidental fallers, they were too eager to return to their activities of daily living as well as return to work so that they could earn and would not be laid out from their jobs. Therefore, we noticed a 13% loss of reduction and fixation in accidental fallers during our follow-up.

Several factors were associated with functional outcomes following orthopedic surgeries, such as the characteristic of fractures, quality of reduction and fixation, complications, rehabilitation protocol, patients' compliance, and so on [23–28]. During the study period, the principles, implants, surgical techniques, and physical therapies for treating pelvic and acetabular fractures were similar for all patients. Therefore, the influence of surgeons' and therapists' factors could be minimized. Our data revealed that the severity of injury and length of hospital were statistically higher and longer in the I group than in the A group. However, at the 6-month and 12-month evaluations, there was no difference in the functional outcomes between the two groups. During the interviews of all patients, we found that most of the intentional fallers were satisfied and thankful of the outcomes, whereas the accidental fallers had more complaints with their present situation and their functional disability.

Although we made efforts to prevent any biases from occurring, there were still some limitations in the current study. First, relatively small populations were enrolled into this study. Although we tried to contact the cohort for outcome evaluation, only 73.5% of the patients completed radiological and functional outcomes. Nevertheless, two of the important findings of our study were that the functional outcomes of the intentional fallers were not inferior to those of the accidental fallers if the fractures were managed appropriately and that there was no recidivism during the follow-up period. Second, we classified the patients by etiologies of injuries according to their self-report history. The true numbers of intentional fallers with mental disorders might be under-reported, thereby affecting the results of the analysis. Lastly, the concept of functional evaluations of pelvic and acetabular fractures may be different. We found that 22.4% (11/49) of the cohort were diagnosed with commitment pelvic and acetabular fractures. Therefore, we used two evaluation scales (Merle d'Aubigné hip score and Majeed hip score) to evaluate their

functional performance during activities of daily living. In the future, a large sample size should be enrolled, and these patients should undergo routine psychiatric examination to determine their mental condition. In addition, different evaluation tools, such the Short Form-36 and other hip functional scores, should be applied to comprehensively evaluate the patients.

In conclusion, intentional fallers with pelvic and acetabular fractures might not have worse clinical presentations compared to accidental fallers. Under a well-designed surgical protocol and individualized physical and mental rehabilitation program, the radiological and functional outcomes of the intentional fallers could be comparable to those of the accidental fallers.

Abbreviations

AIS: abbreviated injury scale; ISS: Injury severity score; NISS: New injury severity score

Declarations

Ethics approval and consent to participate

The review process of the patients' complete medical and imaging records was approved by the Institutional Review Board (IRB no. 201900247B0).

Consent for publication

All authors read the final manuscript and approved it for publication.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable requires.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Literature search: Hsu YH and Chou YC; study design: Wei LC and Yu YH; data collection: Yu YH; data analysis and interpretation: Chen IJ and Yu YH; writing: Yu YH; and critical revision: Yu YH.

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Figures

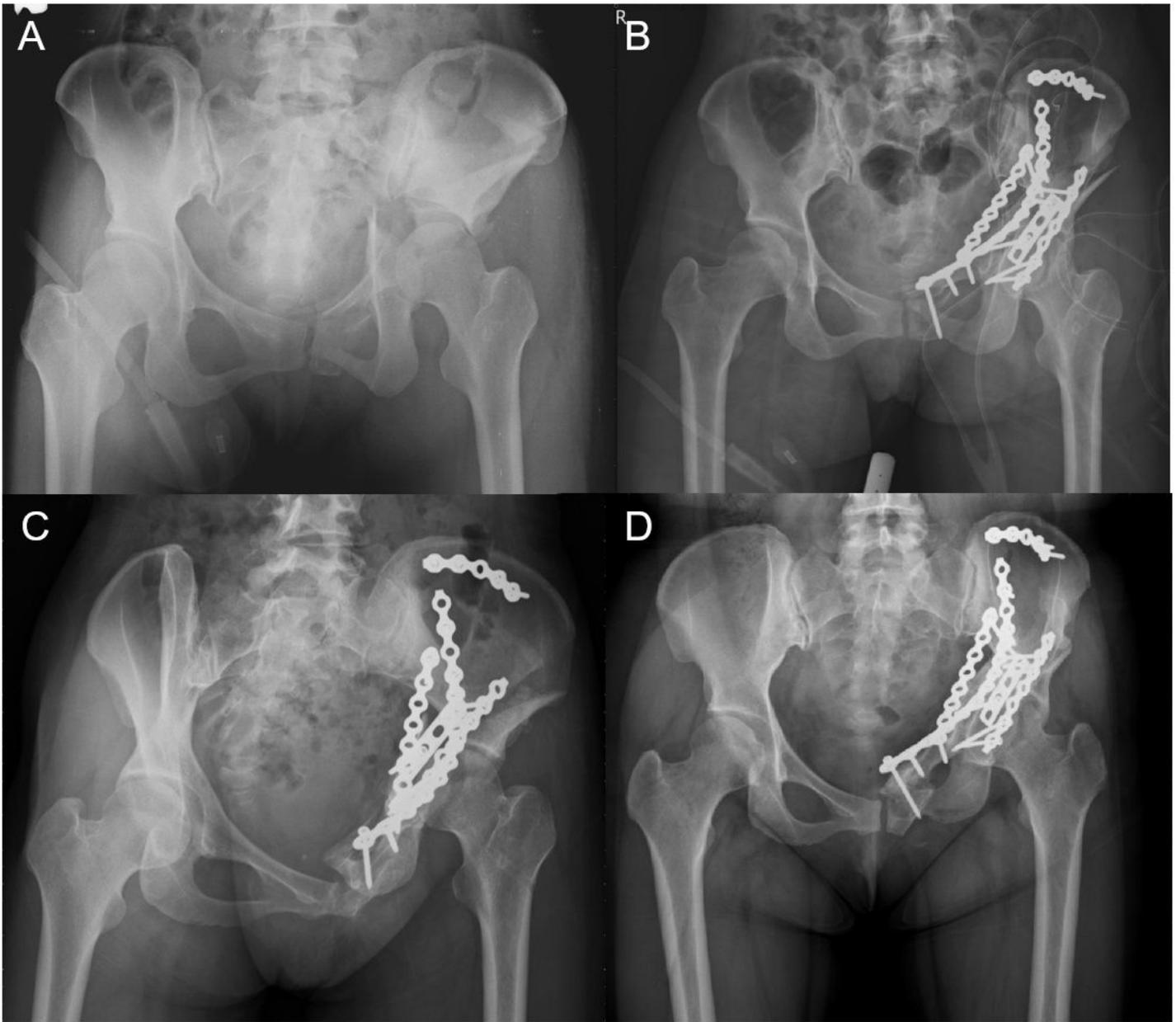


Figure 1

A 34-year-old woman with schizophrenia underwent osteosynthesis for acetabular fracture. (A) Initial presentation of a disrupted acetabulum. (B) Image after osteosynthesis. (C) Loss of reduction and fixation at 1 month after the index surgery. (D) Image at the 24-month follow-up.

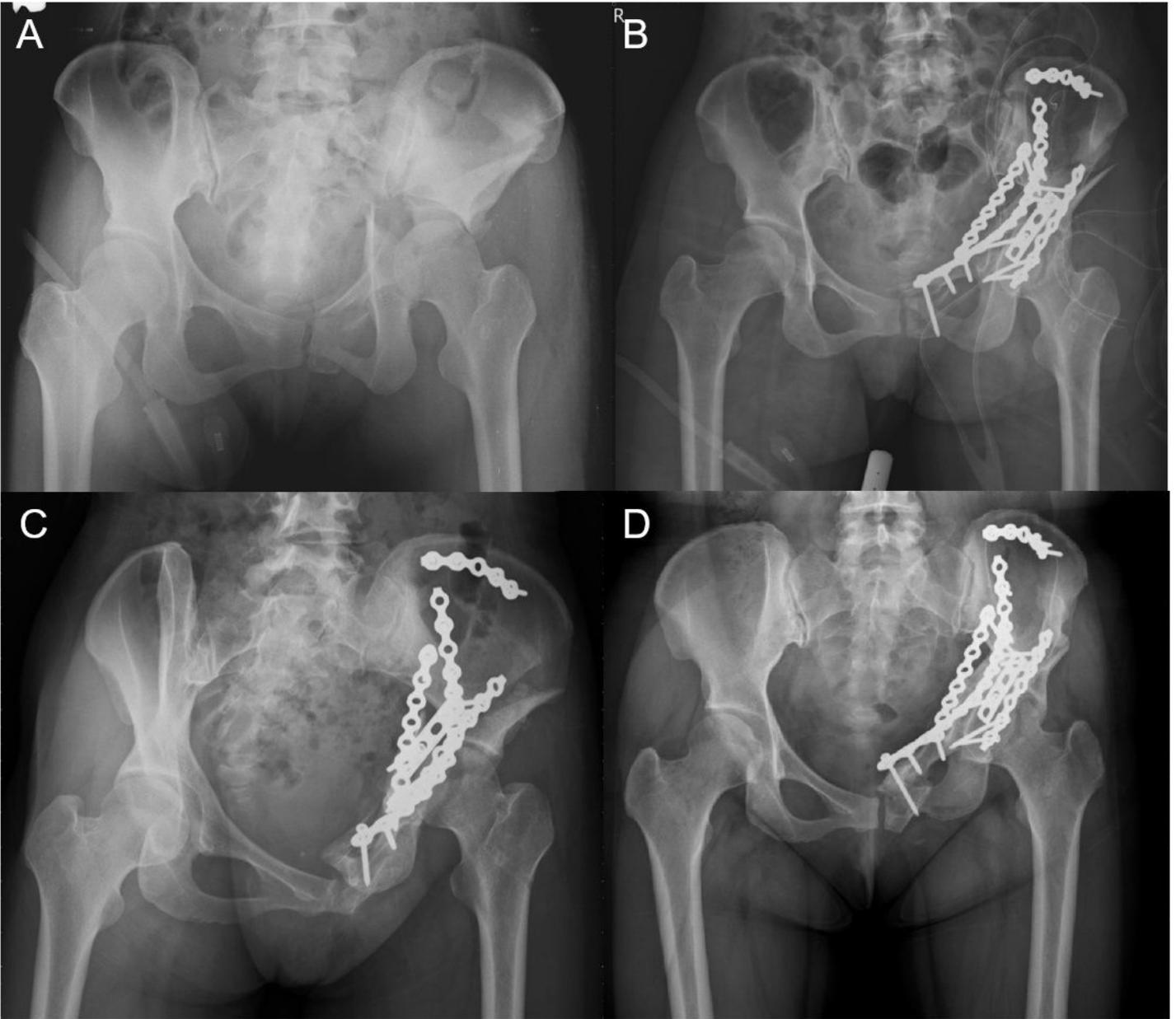


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