

Early Versus Delayed Hip Reduction in Treating Femoral Head Fracture Combined With Posterior Hip Dislocation: A Comparative Study

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Abstract

Background: Few studies focus on the treatment of femoral head fracture combined with posterior hip dislocation, and the safe interval time between injury and reduction still remains controversial. The purpose of this study was to evaluate and compare the outcome of early and delayed hip reduction in treating femoral head fracture combined with posterior hip dislocation.

Methods: A total of 71 patients were evaluated in this retrospective study. Based on the time to hip reduction, they were divided into early group (within 6 hours after injury) and delayed group (between 6 - 12 hours after injury). The two groups were compared in reference to hospital day, fracture healing time, the occurrence of complications and final functional outcome. The Thompson-Epstein criteria, modified merled' Aubigne-Postel scores, visual analog scale (VAS) and Medical Outcomes Short Form 12-item questionnaire score (SF-12) were used for final functional evaluation.

Results: The mean hospital day and fracture healing time in the early group were significantly lower than delayed group. The incidence of infection, post-traumatic osteoarthritis, and avascular necrosis of the femoral head (ANFH) in the delayed group were higher than early group. The early group had better functional outcomes in term of Thompson-Epstein criteria, modified merled' Aubigne-Postel scores and physical component scale (PCS) than delayed group.

Conclusions: For the treatment of femoral head fracture combined with posterior hip dislocation, the early and prompt hip reduction can effectively facilitate the fracture healing and patient recovery as well as obtain better functional outcomes.

Background

Femoral head fractures are relatively infrequent injury, occurring often following traumatic posterior hip dislocation[1, 2]. As reported in previous literature, approximately 15% femoral head fractures were associated with posterior hip dislocation[1, 3, 4]. In 1957, Pipkin proposed the Pipkin classification for femoral head fractures combined with posterior hip dislocation, which based on the location of the fracture line relation to the fovea and the potential presence of the femoral neck or acetabulum[5]. Because of the Pipkin classification was widely used for clinical work, which greatly contributed to the understanding of femoral head fractures, the femoral head fractures combined with posterior hip dislocation is therefore also called Pipkin fractures[3].

Owing to the complexity of the hip anatomy, the treatment of femoral head fractures is particularly difficult. Although some studies have reported satisfactory results with nonsurgical treatment in the non-displaced Pipkin type I and type II fractures, this treatment has been almost abandoned because of the high rate of complications associated with longstanding patient immobility and the high cost of prolonged admission[1, 6-9]. Nowadays, more and more investigators recommend surgical treatment of femoral head fractures[2]. For an optimal outcome, there should be anatomic joint reconstruction, restoration of the hip congruency and fracture stabilization to facilitate union[1, 2].

In cases of femoral head fractures combine with posterior hip dislocation, the early and prompt hip reduction is associated with a good results[1, 2, 10, 11]. However, because of the the relatively infrequent and limited numbers of patients, there is still no consensus on the reduction timing of posterior hip dislocation in treating femoral head fracture-dislocations[2, 12]. Although some reports showed that the good results can be achieved when hip reduction was performed within 12 hours or 24 hours, some authors emphasize that the posterior dislocation of hip joint should be reduced within 6 hours[7, 13-15]. The purpose of this study was to compare the outcome of early and delayed hip reduction in treating femoral head fracture combined with posterior hip dislocation, with the objective of defining the best timing reduction.

Patients And Methods

Study design

After obtaining approval from our institutional review board, we retrospectively reviewed patients who suffered from femoral head fractures combined with posterior hip dislocation between July 2009 and March 2017. The inclusion criteria were as follow: (a) unilateral femoral head fracture combined with posterior hip dislocation, (b) femoral head fractures were treated operatively, (c) no severe neurovascular injury, (d) closed fractures. Exclusion criteria included femoral head fracture combined with anterior or central hip dislocation, pathological fracture, other fractures affecting the limb rehabilitation and polytrauma.

Interventions

All patients presented to our emergency department and then were assessed according to the Adult Trauma Life Support (ATLS™) guidelines, including a hip anteroposterior radiograph and three-dimensional computed tomography examination. The emergency closed reduction of posterior hip dislocation was attempted under general anaesthesia by Allis method in operating room[16]. If the hip can not be reduced closed or the concentric reduction cannot be achieved, an open reduction was performed immediately. After successful reduction of posterior hip dislocation, the skeletal traction was essential to maintain the reduction, and the fractures were treated operatively within 72 hours.

All surgeries were performed under general anesthesia by one surgical team consisting of 2 senior orthopaedics surgeons. The modified Heuter anterior approach or posterior Kocher-Langenbeck approach as previously described was chosen for Pipkin type I and type II fractures, and the Kocher-Langenbeck approach was applied for Pipkin type III and type IV fractures[9, 11]. The fractures reduction were performed under intraoperative fluoroscopy, small or comminuted fragments of the femoral head were removed and the large fragments or fragments within the weight-bearing portion were reduced anatomically and fixed with bioabsorbable screws or cannulated screws. The femoral neck fractures were reduced and fixed with cannulated screws, the acetabular fractures were reduced and fixed with reconstruction plates plus screws.

After operation, the prophylactic intravenous antibiotics were administered for 24 hours, and low molecular weight heparin were given to prevent deep venous thrombosis. The drainage was maintained for 24-48 hours and then was removed. Limb functional exercises were encouraged after recovery from anesthesia. All patients were instructed to non-weight bearing for six to eight weeks initially, and then gradually increased to partial weight-bearing. Once the radiographs showed bone union, full weight bearing was started. All patients would be followed at monthly until the radiographic bony union, and then at annually until the last follow-up. Serial radiographs were obtained at every follow up, and the complication were recorded.

Outcome measures

The clinical outcome included hospital stay, fracture healing time, complications and final functional score. The major complications included infection, post-traumatic osteoarthritis, heterotopic ossification (HO), avascular necrosis of the femoral head (ANFH) and nonunion. The Thompson-Epstein criteria[14], modified merled' Aubigne-Postel scores[17], visual analog scale (VAS)[18] and the Medical Outcomes Short Form 12-item questionnaire score (SF-12)[19] were used for functional evaluation.

Statistical analysis

All data management and statistical analysis were performed with Statistical Package for the Social Sciences (SPSS 20.0, IBM, New York City, USA). Categorical data were tabulated with frequencies or percentages, and continuous data were expressed as the mean \pm standard deviation(SD). Normality was tested using the Kolmogorov-Smirnov test. Independent t-tests were used for normally distributed continuous data and the Mann-Whitney test was used to compare abnormally distributed continuous data between two groups. Chi-square test or Fisher exact test was used to analyze the categorical variables. The level of significance was set at $p < 0.05$.

Results

Baseline characteristics

A total of 71 patients were evaluated in this retrospective study, the posterior hip dislocation were reduced within 6 hours after injury in 39 patients (early group), and 32 patients were reduced between 6 - 12 hours after injury (delayed group). All patients were attempted to closed reduction in the operating room by Allis method, three cases in early group and five cases in delayed group required open reduction after the failure of closed reduction. The mean time between injury to the reduction of posterior hip dislocation in early group was 4.2 ± 1.2 hours, which was significantly lower than the delayed group (10.0 ± 1.6 hours). The mean operative time for the early group was 146.5 ± 48.0 minutes and for the delayed group was 147.3 ± 54.6 minutes. The estimated blood loss was 305.6 ± 179.6 ml for the early group and 350.7 ± 214.3 ml for the delayed group. There was no statistically significant differences between the two groups in terms of Pipkin classification, age, gender, side, causes, reduction method of dislocation, Surgical

approach, operative time, blood loss and follow-up duration. The baseline characteristics of the patients were showed in Table 1.

Table 1. Comparison of the baseline data of the patients between the two groups.

	Early group (n=39)	Delayed group (n=32)	<i>p</i> value
Pipkin classification			0.986
Pipkin type I	7	7	
Pipkin type II	16	12	
Pipkin type III	6	5	
Pipkin type IV	10	8	
Age (years)	42.6 ± 13.6	39.2 ± 12.7	0.275
Gender (male/female)	24/15	24/8	0.309
Side (right/left)	21/18	15/17	0.637
Causes (%)			0.665
Traffic accident	29	23	
Falling from height	5	5	
Heavy pound injury	3	4	
Sport injury	2	0	
Reduction method			0.454
Closed reduction	36	27	
Open reduction	3	5	
Time to reduction (hours)	4.2 ± 1.2	10.0 ± 1.6	0.001
Surgical approach [#]			
Modified Heuter approach	15	10	0.531
Kocher-Langenbeck approach	8	9	
Operative time (min)	146.5 ± 48.0	147.3 ± 54.6	0.945
Blood loss (ml)	305.6 ± 179.6	350.7 ± 214.3	0.338
Follow-up duration (months)	66.3 ± 8.4	67.9 ± 9.0	0.420

Clinical outcomes

Our data show that patients in delayed group needed longer hospital stay than patients in early group (12.7±3.9 days, 14.7±2.7 days, P = 0.019). The fracture healing time in delayed group also longer than early group (13.1±2.3 weeks, 14.8±3.0 weeks, P = 0.008) . In early group, no infection occurred, and the wound healed well. The post-traumatic osteoarthritis was observed in four patients, which were treated with painkiller. Five patients developed HO, none of the patients elected to undergo surgical excision of the ectopic bone. ANFH occurred in two patients and nonunion occurred in one patient, the three chose total hip arthroplasty (THA) because the unbearable pain and the limitation of hip function. In delayed group, the wound infection was occurred to one cases, which was superficial infections and bacterial culture was pseudomonas aeruginosa, the wound infection was cured after change of dressing and antibiotic treatment. The post-traumatic osteoarthritis was occurred to six patients, all of them chose nonsurgical treatment. Four patients developed HO, one of the patient (Brooker type IV) chose surgical excision of the ectopic bone because of the limited hip flexion. ANFN was observed in five patients and nonunion was observed in one patient, the six patients also underwent THA because of the failure of nonsurgical treatment (Table 2).

Table 2. Comparison of hospital stay, time to bone union, complications and reoperation rate between the two groups.

	Early group (n=39)	Delayed group (n=32)	p value
Hospital stay (days)	12.7±3.9	14.7±2.7	0.019
Fracture healing time (weeks)	13.1±2.3	14.8±3.0	0.008
Complications			
Infection	0(0%)	1(3.1%)	0.451
Post-traumatic osteoarthritis	4(10.3%)	6(18.8%)	0.496
HO	5(12.8%)	4(12.5%)	1.000
ANFH	2(5.1%)	5(15.6%)	0.231
Nonunion	1(2.6%)	1(3.1%)	1.000

HO = heterotopic ossification, ANFH = avascular necrosis of the femoral head

At the final follow-up, the Thompson-Epstein criteria were excellent in nineteen cases, good in fifteen cases, fair in two cases, poor in three case for early group and excellent in six cases, good in fifteen cases, fair in six cases, poor in five case for delayed group. The mean modified merled' Aubigne-Postel

scores of early group was 16.1 ± 2.7 , while the mean modified merled' Aubigne-Postel scores of delayed group was 14.2 ± 3.6 . The average VAS scores of early group and delayed group were 1.7 ± 2.0 and 2.6 ± 2.7 , respectively. For the SF-12 scores, the mean PCS scores of early group and delayed group were 75.4 ± 24.1 and 58.8 ± 29.9 , respectively. The mean MCS scores of early group was 74.6 ± 10.4 while the mean MCS scores of delayed group was 69.1 ± 12.5 . There were statistically significant differences between the two groups in the Thompson-Epstein criteria, modified merled' Aubigne-Postel scores and PCS scores ($P=0.033$, $P=0.010$, $P=0.003$, respectively) (Table 3). Series radiographs of typical cases are shown in Fig. 1, 2.

Table 3. Comparison of function evaluation between the two groups.

	Early group (n=39)	Delayed group (n=32)	<i>p</i> value
The Thompson-Epstein criteria			0.033
Excellent	19	6	
Good	15	15	
Fair	2	6	
Poor	3	5	
Modified merled' Aubigne-Postel scores	16.1 ± 2.7	14.2 ± 3.6	0.010
VAS	1.7 ± 2.0	2.6 ± 2.7	0.117
SF-12			
PCS	75.4 ± 24.1	58.8 ± 29.9	0.003
MCS	74.6 ± 10.4	69.1 ± 12.5	0.050

VAS = visual analog scale, SF-12 = Medical Outcomes Short Form 12-item questionnaire score, MCS = mental component scale, PCS = physical component scale

Discussion

The main mechanism of injury for Pipkin fracture-dislocations is traumatic posterior hip dislocation, as a result, the early and prompt hip reduction is particularly important[1, 2, 4, 10, 20]. In general, operating room closed reduction under anesthesia or sedation is the most common method. In recent years, more and more evidences show that urgent closed reduction in the Emergency Department is also an effective and safe method[1, 21]. The most widely used reduction method for posterior hip dislocation is Allis manoeuvre, however, because of the residual intra-acetabular incarceration of the fracture fragments and soft tissue, failed closed reduction of posterior hip dislocation are not uncommon[22]. Chen et al.[20] reported a modified Allis manoeuvre which can effectively relieve the bony incarceration of the femoral

head, and achieve closed reduction in five Pipkin type I femoral head fracture cases who had experienced failed closed reduction via the Allis method. If the closed reduction fails or the concentric reduction cannot be achieved, the open reduction should be performed immediately. In our study, all patients were attempted to closed reduction in the operating room by Allis method, eight patients (three cases in early group and five cases in delayed group) required open reduction after the failure of closed reduction.

While lots of evidences suggested that the time to hip reduction in a femoral fracture-dislocation is critical, the safe interval time between injury and reduction still remains controversial[10, 23]. Early research suggested that the posterior hip dislocation should be reduced within 24 hours, otherwise the prognosis will be poor[14]. However, more and more studies reported that reduced within 6 hours help to minimize the incidence of complications and achieve a good result[15, 23]. There is also evidence that good results were achieved when reduction was performed within 12 hours[13].

In our study, we found that the early reduction of posterior hip dislocation within 6 hours could facilitate fractures healing. Femoral head fractures often accompanied by severe bone and soft tissue damage, and the prolonged posterior hip dislocation will caused vasospasm, which further damage the blood supply of the femoral head and influence the healing of fractures[1, 2, 10, 23, 24]. Early reduction of dislocation may recover earlier blood supply to the site of fractures by relieving tension across the femoral and circumflex vessel, which is beneficial to fracture healing[23]. Besides, our research also showed that the early reduction could shorten mean length of hospital stay, there might be several reasons for this. On one hand, the severe damage of soft tissue and blood supply cause by longer time dislocation may affect the healing of incision, which might increased the length of hospital. On the other hand, the dislocation of hip joint would aggravate the swelling of soft tissue and further affect the recovery of limb function.

The common complications of femoral head fractures included post-traumatic osteoarthritis, HO, ANFH and nonunion. The incidence of post-traumatic osteoarthritis is approximately 20%, which is related to the reduction quality of fracture and posterior hip dislocation[11]. Our data showed that the incidence of post-traumatic osteoarthritis is lower when reduction was performed within 6 hours. Similarly, prolonged dislocation of hip joint may have been associated with a higher rate of ANFH[10, 24, 25]. Mehlman et al. [26] reported that patients whose reduction was delayed greater than 6 hours had a 20 times higher risk of having avascular necrosis develop compared with patients whose hips were reduced in 6 hours or less. A meta-analysis showed that early reduction of posterior hip dislocation within 6 hours have a lower rate of osteonecrosis of the femoral head compare with delayed dislocation (over 6 hours from the time of injury)[23]. Our study also emphasize this point once again. At the final follow up, the function evaluation showed that a better functional outcome can be obtained in early group.

There are several limitations to our study. One of the limitations is that this was a retrospective study. Second, our data was based on the clinical records, there may be some margins of error in the exact time from injury to hip reduction. Furthermore, the length of follow up is relatively insufficient, the longer follow-up was needed to further assess the long-term effects of reduction timing of posterior hip

dislocation in treating femoral head fractures combined with posterior hip dislocation. We also found that some patients failed to complete the reduction of posterior hip dislocation within six hours because of the untimely transportation, therefore it is necessary to develop and improve the transport systems so as to transport such patients to the nearest trauma center immediately. This study was the first report focusing on femoral head fractures combined posterior hip dislocation comparing the outcomes between the early reduction (within 6 hours after injury) with the delayed reduction (between 6 - 12 hours after injury) of posterior hip dislocation.

Conclusion

In summary, in patients with femoral head fractures combined with posterior hip dislocation, the early and prompt hip reduction within 6 hours can effectively facilitate the fracture healing and patient recovery as well as obtain better functional outcomes. At the same time, our study indicate an association between early hip reduction and lower rate of complications in treating femoral head fractures combined with posterior hip dislocation.

Declarations

Ethical approval: The study was approved by the ethical committee of West China Hospital, Sichuan University. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from all patients included in this study.

Consent for publication: Not applicable.

Competing interests: The authors declare that they have no conflict of interest.

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Authors' contributions: Shanxi Wang wrote the manuscript. Shanxi Wang, Bohua Li and Zhengdong Zhang collected the data. Shanxi Wang, Xiaojun Yu and Qin Li assisted in the data analysis. Lei Liu designed and supervised this project.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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References

1. Droll K P, Broekhuysen H, O'Brien P(2008)Fracture of the Femoral Head. *J Am Acad Orthop Surg.* 15(12): 716-727. doi: 10.1097/01.bpo.0000300335.83378.77
2. Henle P, Kloen P, Siebenrock K A(2007)Femoral head injuries: Which treatment strategy can be recommended? *INJURY.* 38(4): 478-488. doi: 10.1016/j.injury.2007.01.023
3. Bartoník J, Rammelt S(2015)History of femoral head fracture and coronal fracture of the femoral condyles. *INT ORTHOP.* 39(6): 1245-1250. doi: 10.1007/s00264-015-2730-x
4. Chiron P, Lafontan V, Reina N(2013)Fracture-dislocations of the femoral head. *Orthop Traumatol Surg Res.* 99(1): S53-S66. doi: 10.1016/j.otsr.2012.11.007
5. Pipkin G(1957)Treatment of Grade IV Fracture-Dislocation of the Hip. *JBJS.* 39-A(5): 1027-1042. doi: 10.2106/00004623-195739050-00004
6. Tripathy S K, Sen R K, Goyal T(2011)Conservative versus surgical management of Pipkin type I fractures associated with posterior dislocation of the hip: a randomised controlled trial. *INT ORTHOP.* 35(12): 1907-1908. doi: 10.1007/s00264-011-1352-1
7. Ross J R, Gardner M J(2012)Femoral head fractures. *Current Reviews in Musculoskeletal Medicine.* 5(3): 199-205. doi: 10.1007/s12178-012-9129-8
8. Swiontkowski M F, Thorpe M, Seiler J G, et al(1992)Operative Management of Displaced Femoral Head Fractures. *J ORTHOP TRAUMA.* 6(4): 437-442. doi: 10.1097/00005131-199212000-00008
9. Wang S, Li B, Li J, et al(2019)Comparison of the modified Heuter approach and the Kocher-Langenbeck approach in the treatment of Pipkin type I and type II femoral head fractures. *INT ORTHOP.* 43(11): 2613-2620. doi: 10.1007/s00264-019-04301-5
10. Dwyer A J, John B, Singh S A, et al(2006)Complications after posterior dislocation of the hip. *INT ORTHOP.* 30(4): 224-227. doi: 10.1007/s00264-005-0056-9
11. Wang S X, Li B H, Li J, et al(2018)Middle-term follow-up results of Pipkin type IV femoral head fracture patients treated by reconstruction plate and bioabsorbable screws. *Chin J Traumatol.* 21(3): 170-175. doi: 10.1016/j.cjtee.2017.12.004
12. Ricci W M, McAndrew C M, Miller A N, et al(2018)Open Reduction and Internal Fixation of the Femoral Head via the Smith–Petersen Approach. *J ORTHOP TRAUMA.* 32: S16-S17. doi: 10.1097/BOT.0000000000001216
13. Chen Z W, Lin B, Zhai W L, et al(2011)Conservative versus surgical management of Pipkin type I fractures associated with posterior dislocation of the hip: a randomised controlled trial. *INT ORTHOP.* 35(7): 1077-1081. doi: 10.1007/s00264-010-1087-4
14. Epstein H C, WISS D A, COZEN L(1985)Posterior Fracture Dislocation of the Hip with Fractures of the Femoral Head. *Clin Orthop.* (201): 9-17. doi: 10.1097/00003086-198512000-00002
15. Cavaignac E, Laumond G, Regis P, et al(2015)Fixation of a fractured femoral head through a medial hip approach: an original approach to the femoral head. *HIP INT.* 25(5): 488-491. doi: 10.5301/hipint.5000248

16. Mcmurtry I A, Quaile A(2001)Closed reduction of the traumatically dislocated hip: A new technique. 32(2): 162-164. doi
17. Ovre S, Sandvik L, Madsen J E, et al(2005)Comparison of distribution, agreement and correlation between the original and modified Merle d'Aubigne-Postel Score and the Harris Hip Score after acetabular fracture treatment: moderate agreement, high ceiling effect and excellent correlation in 450 patients. ACTA ORTHOP. 76(6): 796-802. doi: 10.1080/17453670510045390
18. Huskisson E C(1997)Measurement of pain. LANCET. 2(7889): 1127-1131. doi: 10.1016/S0140-6736(74)90884-8
19. Nortvedt M W, Riise T, Myhr K M, et al(2000)Performance of the SF-36, SF-12, and RAND-36 Summary Scales in a Multiple Sclerosis Population. MED CARE. 38(10): 1022-1028. doi: 10.1097/00005650-200010000-00006
20. Chen W, Gao Z, Ma L(2020)Failed reduction of posterior hip dislocation accompanied by femoral head fracture: causes and resolving strategy. INT ORTHOP.: 1-6. doi: 10.1007/s00264-020-04856-8
21. Scolaro J A, Marecek G, Firoozabadi R, et al(2017)Management and radiographic outcomes of femoral head fractures. Journal of Orthopaedics & Traumatology. 18(3): 235-241. doi: 10.1007/s10195-017-0445-z
22. Uzel A P, Laflamme G Y, Rouvillain J L(2010)Irreducible Pipkin II femoral head fractures: Is transgluteal approach the best strategy? Orthop Traumatol Surg Res. 96(6): 695-701. doi: 10.1016/j.otsr.2010.04.011
23. Ahmed G, Shiraz S, Riaz M, et al(2017)Late versus early reduction in traumatic hip dislocations: a meta-analysis. Eur J Orthop Surg Traumatol. 27(8): 1109-1116. doi: 10.1007/s00590-017-1988-7
24. Giannoudis P V, Kontakis G, Christoforakis Z, et al(2009)Management, complications and clinical results of femoral head fractures. 40(12): 1245-1251. doi: 10.1016/j.injury.2009.10.024
25. ASGHAR, F(2004)Femoral head fractures: diagnosis, management, and complications. Orthop Clin North Am. 35(4): 463-472. doi: 10.1016/j.ocl.2004.05.004
26. Mehlman C T, Hubbard G W, Crawford A H, et al(2000)Traumatic hip dislocation in children. Long-term followup of 42 patients. Clin Orthop Relat Res. (376): 68-79. doi: 10.1097/00003086-200007000-00011

Figures

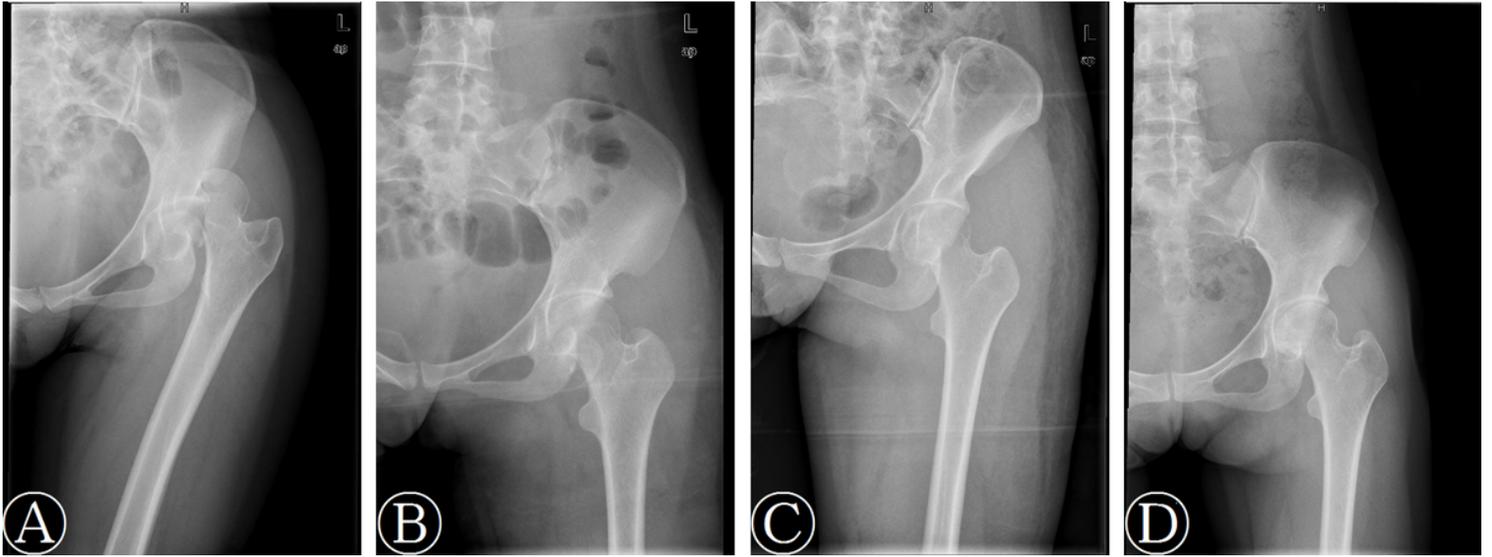


Figure 1

(A) Radiograph of an 30-year-old woman with left Pipkin type II fracture. (B) A radiograph shows the reduction of posterior hip dislocation. Post-operative (C) and final follow-up (D) radiographs.

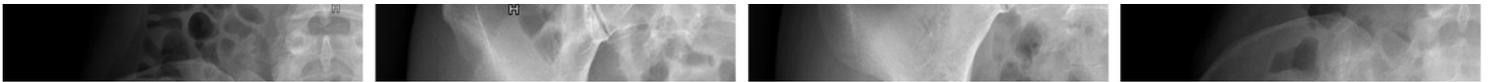


Figure 2

A-27-year-old woman with right Pipkin type III fracture, the emergency reduction of dislocation was performed within 6 hours after injury(A), Post-operative (B) and follow-up (C and D) radiographs demonstrating an bony union.