Trauma Mon. 2019 March; 24(2):e84945. doi: 10.5812/traumamon.84945.

Published online 2019 March 5. **Research Article**

Impression of Delayed Pelvic and Acetabular Fracture Fixation on the Prevalence of Preoperative Venous Thromboembolic Events

Mohamad Qoreishi [1, *], Seyed Mahdi Hosseini Khameneh [1], Omid Jafari [1] and Farshad Safdari [2]

[1] Department of Orthopedics, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2] Bone Joint and Related Tissues Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

[*] *Corresponding author*: Department of Orthopedics, Akhtar Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Email: smqoreishi.ortho@gmail.com

Received 2018 October 04; **Accepted** 2018 December 03.

Abstract

Background: Pelvic ring fractures (PRF) and acetabular fractures (AF) are among the most challenging orthopedic injuries. These injuries usually involve operative fixation, with considerable delay after the accident. There are limited studies regarding the effects of delayed surgery on the risk of venous thromboembolism (VTE) in these patients.
Objectives: In this study, the effect of delayed fixation of PRF and AF on the risk of preoperative VTE was investigated.
Methods: There were 86 patients with PRF and/or AF enrolled in the current study. Preoperatively, the presence of deep venous thrombosis (DVT) was examined utilizing Color Doppler ultrasound (CDU). The time interval between accident and CDU was recorded (time delay). Finally, the time delay was compared between patients with and without DVT formation.
Results: The CDU revealed the presence of DVT in lower limb veins of 11 patients (12.8%). The time delay between the accident and CDU was significantly longer in patients with DVT formation (12.4 $\pm$ 4.1 days versus 7.6 $\pm$ 2.4 days; $P < 0.001$).
Conclusions: Delayed fixation of PRF and AF may increase the risk of preoperative VTE. The authors suggest surgical fixation in these patients as soon as possible in cases without definite contraindication for early fixation.

Keywords: Acetabular Fracture, Pelvic Ring Fracture, Thromboembolism, Deep Venous Thrombosis, Color Doppler Ultrasound

1. Background

Severe pelvic ring fractures (PRF) and acetabular fractures (AF) are among challenging injuries for orthopedic surgeons. Although PRF is not a common injury, it may be found in most patients with multiple trauma. In general, these injuries account for 2% to 8% of total fractures (1) and the prevalence has been reported from 23 to 34.4 cases per 100,000 individuals (2, 3). On the other hand, the prevalence of these injuries in patients with multiple trauma is much higher and can be seen in 20% to 25% of patients (4). The prevalence of AF has been reported as three per 100,000 per year (5-7). It is important to mention that PRF is associated with the involvement of acetabulum in 10% of patients (8).

One of the most important challenges encountered by patients with multiple trauma or high energy trauma, such as PRF patients, is the increased risk of venous thromboembolism (VTE) problems. In previous studies, it has been reported that the prevalence of VTE in patients with pelvic trauma is between 25% and 61% (9-16). Pulmonary embolism (PE) also occurs in 2% to 21.7% of patients, of which 2% are fatal (9-13, 15, 17). Concerns regarding VTE occurrence are worsening, as in many patients, there are no clear findings or symptoms associated with the problem. It has been reported that in less than 5% of patients, clinical signs of VTE can be found (18, 19).

Since many patients with PRF and/or AF experience multiple trauma and have a critical general condition, the fixation of these fractures is usually delayed. On the other hand, there is concern that delayed surgery may increase the risk of VTE, and if it occurs, it may be accompanied by significant morbidity and mortality.

To the best of the author's knowledge, there are limited studies that address the consequences of delayed surgery in patients with AF or PRF (14, 17, 20-23) without special focus on the risk of VTE. Furthermore, the incidence of VTE was investigated after the operation in most of these studies while it seems that formation of deep venous thrombosis (DVT) can occur in the time interval between injury and surgery.

2. Objectives

Regarding the lack of clinical evidence, in the current study whether delayed surgery could increase the risk of preoperative VTE in patients with AF or PRF was investigated. One should note that currently these patients usually undergo delayed fixation due to referral from small cities or ICU admission. It is expected that the results of the current study play a significant role in improving the outcomes of treatment and care of these patients.

3. Methods

Between 2015 and 2017, there were 143 patients with PRF or AF referred to the emergency department or clinics of the researcher's orthopedic hospital. Before the study, the institutional review board approved the protocol. Furthermore, the patients or their legal representatives were asked to sign the written consent.

The study exclusion criteria included concomitant fracture, history of thromboembolic accidents, history of anticoagulant administration other than enoxaparin after the injury, pathologic fracture, and phlebitis. Accordingly, 57 patients were excluded from the study as below:

Ipsilateral femoral fracture in 19 patients, ipsilateral tibial fracture in 14 patients, vertebral fracture in two patients, history of thromboembolic accidents in three patients, and history of anticoagulation in 19 patients. Finally, the study was completed with 86 patients.

After the patients were included in the study, the type of fracture and the site of damage were determined based on the X-rays and CT images. Plain radiography was performed in anteroposterior, inlet, outlet, iliac oblique, and obturator oblique views. The CT scanning was performed with 2 mm. Letournel classification and Young and Burgess classification were used to classify the AFs and PRFs. The demographic information, such as age, gender, comorbidity, mechanism of injury, smoking, and fracture type, were recorded in a pre-prepared form.

Early after the admission, enoxaparin (Enoxan® Alborz Darou, IR Iran) 40 mg daily was administered, subcutaneously. On the day of admission, Color Doppler ultrasound (CDU) was performed to detect potential DVTs formed in lower extremity veins. The time interval between the day of injury and the day of CDU (time delay) was also recorded. Finally, the fractures were fixated on the next day.

In CDU, the presence of compressible lumen in femoral, tibial, popliteal and/or peroneal veins ruled out DVT formation. If DVT was detected, an inferior vena cava filter was placed before surgical fixation.

Data analysis was performed using SPSS statistical software version 15.0. Mann-Whitney U test was used to compare the time delay between patients with and without preoperative DVT formation. Also, to investigate the correlation between time delay and DVT formation, Spearman's correlation test was used. $P < 0.05$ was significance.

4. Results

Patients were aged 39.5 ± 15.5 years (ranged from 18 to 60 years). Among them, 72 patients were male (83.7%) and 14 patients were female (16.3%). Body Mass Index averaged 24.6 ± 2.2 kg/m^2. Three and seven patients had diabetes mellitus and hypertension, respectively. Also, 27 patients were smokers or had a history of smoking. Furthermore, LC, APC, vertical shearing, posterior column-posterior wall, and both column fractures were found in 18, 10, 6, 21, and 14 patients. Furthermore, 17 patients had other types of fractures.

CDU revealed DVT formation in 11 patients (12.8%). Among them, four patients had a posterior column-posterior wall fracture (36.3%). Further, each of the column and vertical shearing fractures and each of the LC and APC fractures were found in two patients and one patient with DVT formation, respectively. Another patient, who was diagnosed with DVT formation had other types of fractures (9.1%).

The mean time delay in patients with and without DVT formation was 10.4 ± 4.1 and 5.6 ± 2.4 days, respectively. Mann-Whitney U test showed that the difference between the two groups was statistically significant ($P < 0.001$).

Finally, Spearman's correlation test showed that time delay is positively correlated with the risk of preoperative DVT formation in patients with PRF or AF ($rho = 0.383$; $P < 0.001$).

5. Discussion

The most important finding of the current study was that delayed surgery in PRF and AF could result in significantly increased risk of thromboembolic problems in these patients.

Surgical treatment of PRF and AF is optimal because non-operative treatment can be associated with longer hospitalization and immobilization, leading to higher risk of PE and urinary problems. However, often because of comorbidities or concomitant injuries in multiple trauma patients, early surgical fixation of PRF and/or AF is not possible. In addition, a longer preoperative period may be required for further evaluation and stabilization of the patient's general condition.

Currently, the appropriate time for the surgical fixation of PRF or AF remains controversial and there are many inconsistencies in this regard. Lack of adequate evidence regarding the impression of delayed hospital admission and surgery on the risk of VTE in PRF or AF patients has made it necessary to design and conduct studies similar to the current study to investigate whether delayed surgery can increase the risk of VTE.

In the current study, it was found that the time delay in hospital admission and surgery was significantly higher in patients with preoperative DVT formation compared to patients without DVT formation. The time interval between injury and CDU in patients without DVT was 5.6 days, while the time delay was 10.4 days in patients with DVT formation.

To the best of the author's knowledge, there was no similar study investigating the effects of delayed hospital admission and surgery on the risk of preoperative VTE in patients with PRF or AF. However, routine radiological screening has been advocated for PRF patients, in whom the surgical fixation was postponed at least for three days (24). Kim et al. evaluated the prevalence of VTE risk factors among Korean patients with PRF or AF and found that 33.7% of VTEs occurred on average 11 days after the trauma (14). In addition, in a retrospective study on 207 AF patients, who underwent surgical fixation between 21 and 120 days after the injury, Johnson et al. found that PE occurred in five patients (2.4%), which was a considerable percentage in clinical settings (17).

Although not about risk of VTE, there are some studies indicating that delayed fixation of AF may affect the postoperative outcomes. For example, Cahueque et al. stated that the most important factor in preventing posttraumatic osteoarthritis after AF was obtaining anatomical reduction associated with early surgery (within the first seven days) (20). Madhu et al. found that if surgery was performed within the first 15 days, it would be very effective on obtaining anatomical reduction (23). Meena et al. also showed that delayed surgery led to reduced Modified Postel Merle d'Aubigné score. In other words, there was a significant difference between patients, who had undergone delayed surgical fixation for more than two weeks and those, who had underwent surgery within the first two weeks (21). Of course, there are controversies in this regard. For example, in the study of Shin et al., delay in AF surgical fixation had no effect on clinical and radiographic results and the incidence of posttraumatic OA (22).

Although not related to AF and PRF, several studies, which addressed hip fractures, confirmed that delayed surgery is an important risk factor for preoperative thromboembolism (25-27). For example, Smith et al. found that the incidence of preoperative thromboembolism in these patients was about 11.9%. They found a positive correlation between the period of delay and the risk of thromboembolism and suggested preoperative Doppler ultrasound for patients with longer than one day delay in surgery (26).

Based on the results of the current study as well as studies that have investigated the risk of VTE after AF and PRF fixation, it seems essential for these patients to undergo surgery as soon as possible and after ensuring hemodynamic stability. Of course, it is clear that in some patients, such as when some of the associated injuries actually make AF or PRF fixation impossible, there is no way to delay surgery. However, in other patients, the surgeon should not wait and considering the complication of VTE, especially when there are other VTE risk factors, AF and PRF fixation should be performed early as soon as possible.

Using ultrasound screening, Hamada et al. showed that in spite of early thromboprophylaxis, the prevalence of VTE was 30% in critically ill trauma patients (28). Such findings necessitate looking for approaches to minimize the risk of VTE in multiple trauma patients, thus inspite of using the current methods of thromboprophylaxis, the rate of VTE remains considerable in these patients.

The most important feature of the current study was the investigation of preoperative incidence of VTE, which has received less attention in other studies. The findings remind that in many of AF and PRF patients with postoperative VTE, it may be possible that DVT formation has occurred, preoperatively. Therefore, it is crucial to preoperatively evaluate the presence of DVT, especially in patients with prolonged delay before surgical fixation.

Like all other studies, the current study also had some limitations, such as the limited sample size. Furthermore, because of the small sample size, it was not possible for the authors to determine the cut-off value for surgical delay, after which the risk of VTE increases significantly. Due to the invasive nature of venography, CDU was utilized in the current study. Although the diagnostic efficacy of CDU has been proven previously (29), however, it seems that the incidence of VTE was underestimated. The CDU is suitable for diagnosing and following symptomatic DVTs (30), however, it does not seem appropriate for DVT screening (28).

5.1. Conclusions

The current study showed that delayed fixation of AF and PRF can be accompanied by significantly increased preoperative incidence of venous thromboembolic events. It is essential to perform surgical fixation as early as possible if there is no specific contraindication for fixation and the patient is hemodynamically stable.

Footnotes

Authors' Contribution: Study concept and design: Mohamad Qoreishi and Seyed Mahdi Hosseini Khamenei; acquisition of data: Mohamad Qoreishi, Seyed Mahdi Hosseini Khamenei and Omid Jafari; analysis and interpretation of data: Omid Jafari and Farshad Safdari; drafting of the manuscript: Mohamad Qoreishi, Omid Jafari and Farshad Safdari; critical revision of the manuscript for important intellectual content: Mohamad Qoreishi and Seyed Mahdi Hosseini Khamenei; statistical analysis: Farshad Safdari and Omid Jafari; administrative, technical, and material support: Mohamad Qoreishi and Seyed Mahdi Hosseini Khamenei; study supervision: Mohamad Qoreishi and Seyed Mahdi Hosseini Khamenei.

Conflict of Interests: There was no conflict of interest in this manuscript.

Ethical Approval: The research project received the confirmation of the Ethical Committee of Shahid Beheshti University of Medical Sciences.

Financial Disclosure: There is no to disclose.

Funding/Support: The research project was not partially or fully sponsored.

Patient Consent: The patients or their legal representatives were asked to sign the written consent.

References

1. Pereira GJC, Damasceno ER, Dinhane DI, Bueno FM, Leite JBR, Ancheschi BDC. Epidemiology of pelvic ring fractures and injuries. *Rev Bras Ortop*. 2017;**52**(3):260–9. doi: 10.1016/j.rboe.2017.05.012. [PubMed: 28702382]. [PubMed Central: PMC5497009].
2. Balogh Z, King KL, Mackay P, McDougall D, Mackenzie S, Evans JA, et al. The epidemiology of pelvic ring fractures: A population-based study. *J Trauma*. 2007;**63**(5):1066–73. discussion 1072-3. doi: 10.1097/TA.0b013e3181589fa4. [PubMed: 17993952].
3. Buller LT, Best MJ, Quinnan SM. A nationwide analysis of pelvic ring fractures: Incidence and trends in treatment, length of stay, and mortality. *Geriatr Orthop Surg Rehabil*. 2016;**7**(1):9–17. doi: 10.1177/2151458515616250. [PubMed: 26929851]. [PubMed Central: PMC4748159].
4. Pizanis A, Pohlemann T, Burkhardt M, Aghayev E, Holstein JH. Emergency stabilization of the pelvic ring: Clinical comparison between three different techniques. *Injury*. 2013;**44**(12):1760–4. doi: 10.1016/j.injury.2013.07.009. [PubMed: 23916903].
5. Hanschen M, Pesch S, Huber-Wagner S, Biberthaler P. Management of acetabular fractures in the geriatric patient. *SICOT J*. 2017;**3**:37. doi: 10.1051/sicotj/2017026. [PubMed: 28534471]. [PubMed Central: PMC5441132].
6. Laird A, Keating JF. Acetabular fractures: A 16-year prospective epidemiological study. *J Bone Joint Surg Br*. 2005;**87**(7):969–73. doi: 10.1302/0301-620X.87B7.16017. [PubMed: 15972913].
7. Ahmed M, Abuodeh Y, Alhammoud A, Salameh M, Hasan K, Ahmed G. Epidemiology of acetabular fractures in Qatar. *Int Orthop*. 2018;**42**(9):2211–7. doi: 10.1007/s00264-018-3824-z. [PubMed: 29430606].
8. Mears DC, Velyvis JH, Chang CP. Displaced acetabular fractures managed operatively: Indicators of outcome. *Clin Orthop Relat Res*. 2003;(407):173–86. doi: 10.1097/00003086-200302000-00026. [PubMed: 12567145].
9. Geerts WH, Code KI, Jay RM, Chen E, Szalai JP. A prospective study of venous thromboembolism after major trauma. *N Engl J Med*. 1994;**331**(24):1601–6. doi: 10.1056/NEJM199412153312401. [PubMed: 7969340].
10. Montgomery KD, Geerts WH, Potter HG, Helfet DL. Thromboembolic complications in patients with pelvic trauma. *Clin Orthop Relat Res*. 1996;(329):68–87. doi: 10.1097/00003086-199608000-00010. [PubMed: 8769438].
11. Buerger PM, Peoples JB, Lemmon GW, McCarthy MC. Risk of pulmonary emboli in patients with pelvic fractures. *Am Surg*. 1993;**59**(8):505–8. [PubMed: 8338280].
12. Spencer JD, Lalanadham T. The mortality of patients with minor fractures of the pelvis. *Injury*. 1985;**16**(5):321–3. doi: 10.1016/0020-1383(85)90136-6. [PubMed: 4008010].
13. Niikura T, Lee SY, Oe K, Koh A, Koga T, Dogaki Y, et al. Incidence of venous thromboembolism in pelvic and acetabular fractures in the Japanese population. *J Orthop Sci*. 2012;**17**(3):233–8. doi: 10.1007/s00776-012-0203-2. [PubMed: 22453360].
14. Kim JW, Oh CW, Oh JK, Baek SG, Lee BJ, Hong HP, et al. The incidence and the risk factors of venous thromboembolism in Korean patients with pelvic or acetabular fractures. *J Orthop Sci*. 2014;**19**(3):471–7. doi: 10.1007/s00776-014-0553-z. [PubMed: 24627176].
15. Sen RK, Kumar A, Tripathy S, Aggarwal S, Khandelwal N. Risk factors of venous thromboembolism in Indian patients with pelvic-acetabular trauma. *J Orthop Surg (Hong Kong)*. 2011;**19**(1):18–24. doi: 10.1177/230949901101900105. [PubMed: 21519070].
16. Yumoto T, Naito H, Yamakawa Y, Iida A, Tsukahara K, Nakao A. Venous thromboembolism in major trauma patients: A single-center retrospective cohort study of the epidemiology and utility of D-dimer for screening. *Acute Med Surg*. 2017;**4**(4):394–400. doi: 10.1002/ams2.290. [PubMed: 29123899]. [PubMed Central: PMC5649298].
17. Johnson EE, Matta JM, Mast JW, Letournel E. Delayed reconstruction of acetabular fractures 21-120 days following injury. *Clin Orthop Relat Res*. 1994;(305):20–30. doi: 10.1097/00003086-199408000-00004. [PubMed: 8050229].
18. Norwood SH, McAuley CE, Berne JD, Vallina VL, Kerns DB, Grahm TW, et al. A potentially expanded role for enoxaparin in preventing venous thromboembolism in high risk blunt trauma patients. *J Am Coll Surg*. 2001;**192**(2):161–7. doi: 10.1016/S1072-7515(00)00802-4. [PubMed: 11220715].
19. Knudson MM, Collins JA, Goodman SB, McCrory DW. Thromboembolism following multiple trauma. *J Trauma*. 1992;**32**(1):2–11. doi: 10.1097/00005373-199201000-00002. [PubMed: 1732568].
20. Cahueque M, Martinez M, Cobar A, Bregni M. Early reduction of acetabular fractures decreases the risk of post-traumatic hip osteoarthritis? *J Clin Orthop Trauma*. 2017;**8**(4):320–6. doi: 10.1016/j.jcot.2017.01.001. [PubMed: 29062212]. [PubMed Central: PMC5647687].
21. Meena UK, Tripathy SK, Sen RK, Aggarwal S, Behera P. Predictors of postoperative outcome for acetabular fractures. *Orthop Traumatol Surg Res*. 2013;**99**(8):929–35. doi: 10.1016/j.otsr.2013.09.004. [PubMed: 24183746].
22. Shin JK, An SJ, Go TS, Lee JS. Analysis of predictors of results after surgical treatment of acetabular fractures. *Hip Pelvis*. 2015;**27**(2):104–9. doi: 10.5371/hp.2015.27.2.104. [PubMed: 27536611]. [PubMed Central: PMC4972624].
23. Madhu R, Kotnis R, Al-Mousawi A, Barlow N, Deo S, Worlock P, et al. Outcome of surgery for reconstruction of fractures of the acetabulum. The time dependent effect of delay. *J Bone Joint Surg Br*. 2006;**88**(9):1197–203. doi: 10.1302/0301-620X.88B9.17588. [PubMed: 16943472].

24. Montgomery KD, Geerts WH, Potter HG, Helfet DL. Practical management of venous thromboembolism following pelvic fractures. *Orthop Clin North Am*. 1997;**28**(3):397–404. doi: 10.1016/S0030-5898(05)70297-2. [PubMed: 9208832].
25. Rodriguez-Fernandez P, Adarraga-Cansino D, Carpintero P. Effects of delayed hip fracture surgery on mortality and morbidity in elderly patients. *Clin Orthop Relat Res*. 2011;**469**(11):3218–21. doi: 10.1007/s11999-010-1756-z. [PubMed: 21210312]. [PubMed Central: PMC3183186].
26. Smith EB, Parvizi J, Purtill JJ. Delayed surgery for patients with femur and hip fractures-risk of deep venous thrombosis. *J Trauma*. 2011;**70**(6):E113–6. doi: 10.1097/TA.0b013e31821b8768. [PubMed: 21817966].
27. Hefley FG Jr, Nelson CL, Puskarich-May CL. Effect of delayed admission to the hospital on the preoperative prevalence of deep-vein thrombosis associated with fractures about the hip. *J Bone Joint Surg Am*. 1996;**78**(4):581–3. doi: 10.2106/00004623-199604000-00012. [PubMed: 8609137].
28. Hamada SR, Espina C, Guedj T, Buaron R, Harrois A, Figueiredo S, et al. High level of venous thromboembolism in critically ill trauma patients despite early and well-driven thromboprophylaxis protocol. *Ann Intensive Care*. 2017;**7**(1):97. doi: 10.1186/s13613-017-0315-0. [PubMed: 28900890]. [PubMed Central: PMC5595705].
29. Bernardi E, Camporese G. Diagnosis of deep-vein thrombosis. *Thromb Res*. 2018;**163**:201–6. doi: 10.1016/j.thromres.2017.10.006. [PubMed: 29050648].
30. Rogers FB, Cipolle MD, Velmahos G, Rozycki G, Luchette FA. Practice management guidelines for the prevention of venous thromboembolism in trauma patients: the EAST practice management guidelines work group. *J Trauma*. 2002;**53**(1):142–64. doi: 10.1097/00005373-200207000-00032. [PubMed: 12131409].