



Original Article

The effect of preperitoneal pelvic packing for hemodynamically unstable patients with pelvic fractures

Shi-Shui Lin ^{a, b, *}, Shi-Guo Zhou ^{a, b}, Lin-Sheng He ^c, Zhong-Xiang Zhang ^d, Xu-Ming Zhang ^e^a Department of Orthopedic Surgery, Fujian Provincial Hospital Jinshan Branch, Fuzhou, 350028, China^b Shengli Clinical Medical College of Fujian Medical University, Fuzhou, 350001, China^c Department of Orthopedic Surgery, General Hospital of Jianning County, Jianning County, Sanming City, 354500, Fujian Province, China^d Department of Orthopedic Surgery, Traditional Chinese Medicine Hospital of Lianjiang, Lianjiang County, Fuzhou, 350500, China^e Department of Trauma Surgery, Fujian Provincial Hospital, Fuzhou, 350001, China

ARTICLE INFO

Article history:

Received 20 August 2020

Received in revised form

25 December 2020

Accepted 18 January 2021

Available online 27 January 2021

Keywords:

Pelvic fractures

Preperitoneal pelvic packing

Haemorrhage shock

Multidiscipline cooperation

ABSTRACT

Purpose: Hemodynamically unstable patients with pelvic fractures still represent a challenge to trauma surgeons and have a very high mortality. This study was designed to explore the effect of the interventions of direct preperitoneal pelvic packing for the hemodynamically unstable pelvic fractures.

Methods: This retrospective study enrolled 67 cases of severe pelvic fractures with unstable hemodynamics from October 2011 to December 2019. All patients presented in our emergency center and received preperitoneal pelvic packing were included in this study. The indication was persistent systolic blood pressure ≤ 90 mmHg during initial resuscitation and after transfusion of two units of red blood cells. Patients with hemodynamic stability who need no preperitoneal pelvic packing to control bleeding were excluded. Their demographic characteristics, clinical features, laboratory results, therapeutic interventions, adverse events, and prognostic outcomes were collected from digital information system of electronic medical records. Statistics were described as mean \pm standard deviation or median and analyzed using pair sample *t*-test or Mann-Whitney *U*-test.

Results: The patients' average age was 41.6 years, ranging from 10 to 88 years. Among them, 45 cases were male (67.2%) and 22 cases were female (32.8%). Significant difference was found regarding the systolic blood pressure (mmHg) in the emergency department (78.4 ± 13.9) and after preperitoneal pelvic packing in the surgery intensive care unit (100.1 ± 17.6) ($p < 0.05$). Simultaneously, the arterial base deficit (mmol/L) were significantly lower in the surgery intensive care unit (median -6, interquartile range -8 to -2) than in the emergency department (median -10, interquartile range -14 to -8) ($p < 0.05$). After preperitoneal pelvic packing, 15 patients (22.4%) underwent pelvic angiography for persistent hypotension or suspected ongoing haemorrhage. The overall mortality rate was 29.5% (20 of 67).

Conclusions: Preperitoneal pelvic packing, as a useful surgical technique, is less invasive and can be very efficient in early intra-pelvic bleed control.

© 2021 Production and hosting by Elsevier B.V. on behalf of Chinese Medical Association. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Nearly 9.3% of all blunt skeletal fractures were pelvic fractures, which usually were the result of high-energy injury.¹ The incidence of unstable hemodynamic in pelvic fractures can be as high as 10%.² Until now, a useful treatment to stop bleeding is very crucial,

because the loss of blood components is the major concerns for the cause of death in patients with severe pelvic fracture.^{3–6}

Many previous studies suggested that angiography with subsequent embolization and immediate external fixation should be performed to control the bleeding of pelvic fracture.^{2,7,8} But the incidence of pelvic fracture patients who need the embolization treatment is estimated to be less than 10%,^{2,9} and the application of embolization under the guidance of angiography is only efficacious in addressing arterial haemorrhage which only presents in 15% of lethal pelvic fractures.¹⁰ Moreover, the procedures of embolization under the guidance of angiography can be time-consuming and the treatment for other associated injuries would be delayed.

* Corresponding author. Department of Orthopedic Surgery, Fujian Provincial Hospital Jinshan Branch, Fuzhou, 350028, China.

E-mail address: 2634856180@qq.com (S.-S. Lin).

Peer review under responsibility of Chinese Medical Association.

Almost 85% of the unstable pelvic fractures were combined with bleeding, which comes from pelvic venous plexus and fractures surface. We performed the technique of preperitoneal pelvic packing according to the damage control theory and investigate its effect on outcomes of pelvic fracture patients.

Methods

In this retrospective study, clinical data of pelvic fracture patients admitted in our emergency center, from October 2011 to September 2019, were collected from the system of medical records. Altogether 67 cases received preperitoneal pelvic packing due to unstable hemodynamics. The indication for preperitoneal pelvic packing was persistent SBP ≤ 90 mmHg during initial resuscitation and after transfusion of two units of red blood cells. In combined injury cases with abdominal haemorrhage, thoracic haemorrhage, etc., patients should be taken to the operating center to address the bleeding source following preperitoneal pelvic packing. External fixation or C-clamp of pelvis was applied during the initial operating room encounter.

Surgical technique of preperitoneal pelvic packing were mentioned in some previous studies.^{11–14} Patients were placed in the supine position for anterior external fixator or posterior pelvic C-clamp to stabilize the ring before preperitoneal pelvic packing. We made an about 8 cm midline incision from the pubic symphysis cephalad. Skin and the linea alba were sharply incised and the peritoneum was bluntly dissected free from pelvic ring. Three large pieces of opaque strip gauze were placed to each side of the bladder, into the true pelvis between the bony pelvic ring and the peritoneum. Packing procedures were finished within 20 min. If a laparotomy was performed, another incision was needed. Before then, preperitoneal fascia should be closed to protect the integrity of anatomy. After the admission to surgical intensive care unit (SICU), a careful judgment of the hemodynamic status should be made. To patients that presented symptoms with suspected ongoing haemorrhage, angiography must be applied. Packing should be changed or removed between 24 - 48 h after injury (Fig. 1).

For cases without laparotomy, orthopedic team performed the external fixation and preperitoneal pelvic packing. All these pelvic fracture patients with unstable hemodynamics were managed by the same multidisciplinary team. Additional surgeries, such as abdominal or thoracic related surgical procedure, craniotomy etc., would be performed by the multidisciplinary team in the first instant. And all angiographies were performed by professional radiologists qualified with national certificate.

In this study, related data of the enrolled cases were collected from the digital information system of electronic medical records. Baseline information includes demographic characteristics, mechanism of injury, type of fracture, vital signs, laboratory results and initial radiographs. Interventions and prognosis included transfusion requirements, need for angiography, surgical intervention, complications and mortality. Physical signs during hospitalization were including the lowest SBP and the worst laboratory results, which were chosen for statistical analysis.

In this study, related data for preperitoneal pelvic packing intervention were analyzed by SPSS program (the 20th edition) on windows system. These parameters were described by mean \pm standard deviation or medium (interquartile range) according to their distributions. Continuous variables were compared and analyzed using pair sample *t*-test and Mann-Whitney *U* test. Only variables with a *p* value < 0.05 in the final model were considered as significant. All *p* values were two-sided.

Results

In this study, 67 cases were analyzed, including 45 males (67.2%) and 22 females (32.8%), with the age ranging from 10 to 88 years (average of 41.6 years). Their injuries were mainly due to high-energy mechanism, respectively 23 cases caused by car crashes, 19 related with electric bicycle, 13 of motorcycle collision, 6 of fall from height, 2 of crushed, and 4 of other causes. Analysis of these unstable pelvic fractures showed 7 lateral compression (LC) I, 12 LC II, 9 LC III, 1 anteroposterior compression (APC) I, 9 APC II, 17 APC III, 5 vertical shear and 7 combined mechanism fractures according to the Young and Burgess fracture classification.⁹ The majority of these patients were multiple injured, with a mean injury severity score of (46.7 ± 13.3) . The overall mortality rate was 29.5% (20 of 67).

Statistical analyses found that after preperitoneal pelvic packing there was a significant difference between SBP (mmHg) in the SICU (100.1 ± 17.6) and that in the emergency department (ED) (78.4 ± 13.9) ($p < 0.05$). Similarly, a significant decrease of arterial base deficit (mmol/L) was detected in the SICU (median -6, interquartile range -8 to -2) than that in the ED (median -10, interquartile range -14 to -8) ($p < 0.05$). Hematocrit level of patients was markedly decreased by 5.1% after pelvic packing ($28.6 \pm 4.0\%$) compared with at admission ($33.7 \pm 7.0\%$) ($p < 0.05$). In contrast, heart rate (beats/min) (ED (111.7 ± 22.1) vs. SICU (106.4 ± 24.0), $p = 0.20$) and lactate levels (mmol/L) (ED (5.1 ± 2.3) vs. SICU (4.9 ± 2.5), $p = 0.54$) were similar in both groups. We also confirmed that there was a significant reduction in packed red blood cells (units) transfusion requirements in the postoperative

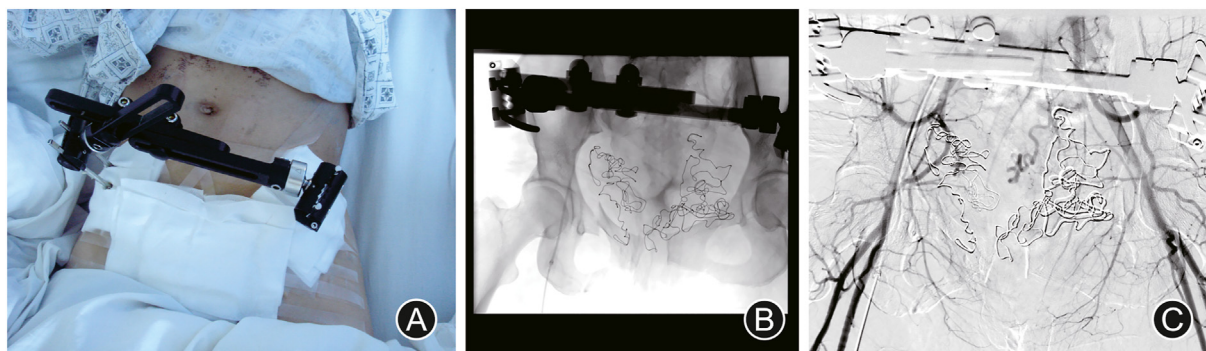


Fig. 1. (A) An anterior external fixation of pelvis and preperitoneal pelvic packing were performed in operation room. (B) Pelvic anteroposterior view showed that bilateral radioopaque swabs were placed on both sides of bladder. (C) Pelvic angiography was performed after preperitoneal pelvic packing.

24 h (4.3 ± 2.4) compared with the pre-SICU period (10.3 ± 5.2) ($p < 0.05$).

Pelvic angiography was performed in 15 patients (22.4%) secondary to preperitoneal pelvic packing for persistent hypotension or suspected ongoing haemorrhage. Among the 15 patients, 13 were treated with subsequent embolization. The 2 remaining cases were found no active bleeding and thus did not undergo pre-emptive embolization. They were successfully resuscitated. The average time to pelvic angiography was (9.5 ± 2.3) h after admission. All patients were sent to the SICU after operative procedures. The mean length of SICU stay of all the patients was 12 days. The overall length of hospital stay was (23.3 ± 7.5) days.

Twenty patients (29.5%) in this study died in the hospital, as a result of multiple organ failure in 5, traumatic brain injury in 4, aspiration and progressive pulmonary failure in 3, pulseless electrical activity arrest in 2, sepsis/necrotizing fasciitis in 2, acute renal failure in 1 and severe facial injury in 1. The remaining 2 deaths were due to acute blood loss, uncontrolled haemorrhage from a thoracic aorta rupture and a liver laceration. There was no death of exsanguination from pelvic haemorrhage. Time of death indicated that 8 non-survivors (40.0%) died within the first 24 h after hospital admission and 3 (15.0%) died within the next 24 h, whereas only 4 non-survivors (20.0%) died after 1 week.

Discussion

Pelvic fracture with hemodynamic instability continues to remain a significant challenge in its management in terms of mortality and morbidity. Nearly 90% of the unstable pelvic fractures are associated with other injuries and the sources of major haemorrhage in almost half of them are not a pelvic fractures, which makes the patient condition more complicated.^{8,15,16} Different strategies have been put forward by many previous studies, to solve the problem of unstable hemodynamics in some pelvic fracture patients.^{4,17–22} Unfortunately, the ideal resuscitation has high reliance on the presented symptoms, so as to their treatment options can be varied from individuals.²³ Our purpose was to observe efficacy of preperitoneal pelvic packing in early intrapelvic bleed control.

In the current study, all patients with unstable pelvic fractures were performed by standard anterior external fixation or C-clamp, which was consistent with previous studies.^{2,9,16,24,25} The reduction and stabilization of the pelvic ring resulted in spontaneous hemostasis of retroperitoneal bleeding by decreasing pelvic volume and exerting self-tamponade effect. In addition, external fixation decreased bony motion to facilitating stable clot formation at the fractured bone surfaces. Therefore, the external fixation was applied before other resuscitation procedures and completed within 30 min by an orthopaedic surgeon.

Since it is difficult to accurately identify the major source of pelvic haemorrhage during initial resuscitation and arterial bleeding only accounts for 15% of the haemorrhage. We performed preperitoneal pelvic packing as the main intervention to address pelvic bleeding in hemodynamically unstable patients with pelvic fractures. The concept of this technique was advocated by several European trauma surgeons.^{26,27} They suggested that most of haemorrhages with complex pelvic trauma were well controlled by localized packing of the pelvis after an exploratory laparotomy. However, exploratory laparotomy may disrupt the intact peritoneum and increase pelvic volume, which disrupting the tamponade effect of the preperitoneal space.²⁸ Therefore, we performed pelvic packing through the transabdominal approach into the preperitoneal approach, as mentioned above. This procedure leaves the peritoneum intact to help develop a tamponade effect and more

rapidly and directly access to the primary source of bleeding with pelvic fractures, with minimal blood loss.

We observed that after packing there was a significant increase in SBP in the SICU compared with that in the ED, which was also consistent with results of previous studies.¹² Correspondingly, blood transfusion requirements in the postoperative 24 h markedly declined compared with the period before completion of pelvic packing. These favorable outcomes may be attributed to the effective control of torrential venous bleeding and reduction of the overall potential space required to tamponade bleeding from the pelvic. In previous reports, the amount of blood transfusion is often associated with ICU length of stay, the development of multiple organ failure, and mortality.^{4,29,30} Obviously, the reduction of blood product requirements should be considered during the initial resuscitation.

The levels of arterial base deficit and lactate are sensitive parameters to estimate response to resuscitation and thus were used in our study to evaluate tissue oxygenation. The result showed that after packing the level of arterial base deficit (mmol/L) decreased from (median -10, interquartile range -14 to -8) to (median -6, interquartile range -8 to -2). Blood lactate level in the ED was higher (5.1 ± 2.3) compared to that in the SICU (4.9 ± 2.5), but this difference was not statistically significant. In the current study, we found that the lactate level in non-survivors increased continually until death and we only compared the level before and after packing, rather than survivors and non-survivors. This article also showed that there was no difference between heart rates in the SICU and ED. The reason might be the patients still under the condition of hypoxia and ischemia after pelvic packing. Additionally, hematocrit level have not yet been completely reversed during primary resuscitation.

Preperitoneal packing may contribute to controlling pelvic arterial haemorrhage, and may help to select those individuals who might benefit most from pelvic angiography.^{6,23,31,32} In our study, pelvic angiography was performed in 15 patients (22.4%) and 13 patients required subsequent embolization after preperitoneal packing and other additional necessary procedures, such as external fixation of fractures, craniotomy, thoracotomy, laparotomy, fasciotomy, or debridement of open wounds. For the pelvic fracture patients with hemodynamic instability, the rate of pelvic angiography and subsequent embolization in this study (22.4%) was apparently less than those without pelvic packing in previous studies, which were reported as high as 50%–75%.^{2,31,33,34} Besides, most of the patients with pelvic fractures die due to blood loss instead of major arterial injury.^{10,15,35} This may explain why the mortality rate of such cases is still high up to 50%, even though successful control of arterial bleeding has been achieved by angiography guidance embolization.^{17,20,21} In 2016, Chiara et al.²⁹ reported a mortality rate up to 52% in hemodynamically unstable patients who did not receive extraperitoneal packing. In the present study, we noted that the preperitoneal packing provided direct benefit on the rate of mortality, which was decreased to 29.5%.

There were some limitations in our study. As a retrospective study, the quality of the data relied on the accuracy and completeness of the electronic medical records. Another important limitation is related to the follow-up period of patients. Since the preperitoneal packing is an aggressive haemostatic procedure during the initial resuscitation, we only reviewed the medial records during their hospital course and in-hospital mortality.

Though different techniques have been used in treatment for persistent hemodynamic instability along with pelvic fracture, no definitive evidence can demonstrate the effectiveness of any single technique. The technique of direct preperitoneal packing is simple and easy to perform. Moreover, this surgical procedure is appropriate for patients with various severity levels of hemodynamic

instability. Therefore, it is reasonable that the direct preperitoneal packing followed by angiography may represent a feasible management strategy for hemodynamically unstable patients with pelvic fractures.

Funding

This work was sponsored by Fujian Provincial Health Technology Project, China (2016-CX-16).

Ethical statement

This study was approved by the Medical Ethics Committee of Fujian Provincial Hospital (approval certificate No.K2015-12-028).

Declaration of competing interest

All authors confirm that they have no financial and personal relationships with any commercial party, which could inappropriately influence this work.

References

- Demetriades D, Karaiskakis M, Toutouzas K, et al. Pelvic fractures: epidemiology and predictors of associated abdominal injuries and outcomes. *J Am Coll Surg*. 2002;195:1–10. [https://doi.org/10.1016/S1072-7515\(02\)01197-3](https://doi.org/10.1016/S1072-7515(02)01197-3).
- Eastridge BJ, Starr A, Minei JP, et al. The importance of fracture pattern in guiding therapeutic decision-making in patients with hemorrhagic shock and pelvic ring disruptions. *J Trauma*. 2002;53:446–451. <https://doi.org/10.1097/00005373-200209000-00009>.
- Zhao XG. Emergency management of hemodynamically unstable pelvic fractures. *Chin J Traumatol*. 2011;14:363–366. <https://doi.org/10.3760/cma.-j.issn.1008-1275.2011.06.008>.
- Smith W, Williams A, Agudelo J, et al. Early predictors of mortality in hemodynamically unstable pelvic fractures. *J Orthop Trauma*. 2007;21:31–37. <https://doi.org/10.1097/BOT.0b013e31802ea951>.
- Tesoriero RB, Bruns BR, Narayan M, et al. Angiographic embolization for hemorrhage following pelvic fracture: is it "time" for a paradigm shift? *J Trauma Acute Care Surg*. 2017;82:18–26. <https://doi.org/10.1097/TA.0000000000001259>.
- Cothren CC, Osborn PM, Moore EE, et al. Preperitoneal pelvic packing for hemodynamically unstable pelvic fractures: a paradigm shift. *J Trauma*. 2007;62:834–842. <https://doi.org/10.1097/TA.0b013e31803c7632>.
- Guerado E, Bertrand ML, Valdes L, et al. Resuscitation of polytrauma patients: the management of massive skeletal bleeding. *Open Orthop J*. 2015;9:283–295. <https://doi.org/10.2174/1874325001509010283>.
- White CE, Hsu JR, Holcomb JB. Hemodynamically unstable pelvic fractures. *Injury*. 2009;40:1023–1030. <https://doi.org/10.1016/j.injury.2008.11.023>.
- Burgess AR, Eastbridge BJ, Young JW, et al. Pelvic ring disruptions: effective classification system and treatment protocols. *J Trauma*. 1990;30:848–856.
- Huittinen VM, Slati P. Postmortem angiography and dissection of the hypogastric artery in pelvic fractures. *Surgery*. 1973;73:454–462.
- Burlew CC, Moore EE, Smith WR, et al. Preperitoneal pelvic packing/external fixation with secondary angioembolization: optimal care for life-threatening hemorrhage from unstable pelvic fractures. *J Am Coll Surg*. 2011;212:628–635. <https://doi.org/10.1016/j.jamcollsurg.2010.12.020>.
- Totterman A, Madsen JE, Skaga NO, et al. Extraperitoneal pelvic packing: a salvage procedure to control massive traumatic pelvic hemorrhage. *J Trauma*. 2007;62:843–852. <https://doi.org/10.1097/01.ta.0000221673.98117.c9>.
- Burlew CC. Preperitoneal pelvic packing for exsanguinating pelvic fractures. *Int Orthop*. 2017;41:1825–1829. <https://doi.org/10.1007/s00264-017-3485-3>.
- Filiberto DM, Fox AD. Preperitoneal pelvic packing: technique and outcomes. *Int J Surg*. 2016;33:222–224. <https://doi.org/10.1016/j.ijssu.2016.05.072>.
- Papadopoulos IN, Kanakaris N, Bonovas S, et al. Auditing 655 fatalities with pelvic fractures by autopsy as a basis to evaluate trauma care. *J Am Coll Surg*. 2006;203:30–43. <https://doi.org/10.1016/j.jamcollsurg.2006.03.017>.
- Huang GB, Hu P, Gao JM, et al. Analysis of early treatment of multiple injuries combined with severe pelvic fracture. *Chin J Traumatol*. 2019;22:129–133. <https://doi.org/10.1016/j.cjtee.2019.03.001>.
- Agolini SF, Shah K, Jaffe J, et al. Arterial embolization is a rapid and effective technique for controlling pelvic fracture hemorrhage. *J Trauma*. 1997;43:395–399. <https://doi.org/10.1097/00005373-199709000-00001>.
- Costantini TW, Coimbra R, Holcomb JB, et al. Current management of hemorrhage from severe pelvic fractures: results of an American Association for the Surgery of Trauma multi-institutional trial. *J Trauma Acute Care Surg*. 2016;80:717–725. <https://doi.org/10.1097/TA.0000000000001034>.
- Skitch S, Engels PT. Acute management of the traumatically Injured Pelvis. *Emerg Med Clin*. 2018;36:161–179. <https://doi.org/10.1016/j.emc.2017.08.011>.
- Miller PR, Moore PS, Mansell E, et al. *External Fixation or Arteriogram in Bleeding Pelvic Fracture: Initial Therapy Guided by Markers of Arterial Hemorrhage*. vol. 54. 2003:437–443. <https://doi.org/10.1097/01.TA.0000053397.33827.DD>.
- Stahel PF, Burlew CC, Moore EE. Current trends in the management of hemodynamically unstable pelvic ring injuries. *Curr Opin Crit Care*. 2017;23:511–519. <https://doi.org/10.1097/MCC.0000000000000454>.
- Lewis RH, Sharpe JP, Berning B, et al. Impact of a simplified management algorithm on outcome following exsanguinating pelvic fractures. *J Trauma Acute Care Surg*. 2019;86:658–663. <https://doi.org/10.1097/TA.0000000000002162>.
- Suzuki T, Smith WR, Moore EE. Pelvic packing or angiography: competitive or complementary? *Injury*. 2009;40:343–353. <https://doi.org/10.1016/j.injury.2008.12.006>.
- Coccolini F, Stahel PF, Montori G, et al. Pelvic trauma: WSES classification and guidelines. *World J Emerg Surg*. 2017;12:5. <https://doi.org/10.1186/s13017-017-0117-6>.
- Halawi MJ. Pelvic ring injuries: emergency assessment and management. *J Clin Orthop Trauma*. 2015;6:252–258. <https://doi.org/10.1016/j.jcot.2015.08.002>.
- Pohlmann T, Gansslen A, Bosch U, et al. The technique of packing for control of hemorrhage in complex pelvic fractures. *Tech Orthop*. 1995;9:267–270. <https://doi.org/10.1097/00013611-199400940-00004>.
- Ertel W, Keel M, Eid K, et al. Control of severe hemorrhage using C-clamp and pelvic packing in multiply injured patients with pelvic ring disruption. *J Orthop Trauma*. 2001;15:468–474. <https://doi.org/10.1097/00005131-200109000-00002>.
- Flint Jr LM, Brown A, Richardson JD, et al. Definitive control of bleeding from severe pelvic fractures. *Ann Surg*. 1979;189:709–716. <https://doi.org/10.1097/00006558-197906000-00006>.
- Chiara O, di Fratta E, Mariani A, et al. Efficacy of extra-peritoneal pelvic packing in hemodynamically unstable pelvic fractures, a Propensity Score Analysis. *World J Emerg Surg*. 2016;11:22. <https://doi.org/10.1186/s13017-016-0077-2>.
- Wong YC, Wang LJ, Ng CJ, et al. Mortality after successful transcatheter arterial embolization in patients with unstable pelvic fractures: rate of blood transfusion as a predictive factor. *J Trauma*. 2000;49:71–75. <https://doi.org/10.1097/00005373-200007000-00010>.
- Osborn PM, Smith WR, Moore EE, et al. Direct retroperitoneal pelvic packing versus pelvic angiography: a comparison of two management protocols for haemodynamically unstable pelvic fractures. *Injury*. 2009;40:54–60. <https://doi.org/10.1016/j.injury.2008.08.038>.
- Hak DJ, Smith WR, Suzuki T. Management of hemorrhage in life-threatening pelvic fracture. *J Am Acad Orthop Surg*. 2009;17:447–457. <https://doi.org/10.5435/00124635-200907000-00005>.
- Metz CM, Hak DJ, Goulet JA, et al. Pelvic fracture patterns and their corresponding angiographic sources of hemorrhage. *Orthop Clin N Am*. 2004;35:431–437. <https://doi.org/10.1016/j.ocl.2004.06.002>.
- Hagiwara A, Minakawa K, Fukushima H, et al. Predictors of death in patients with life-threatening pelvic hemorrhage after successful transcatheter arterial embolization. *J Trauma*. 2003;55:696–703. <https://doi.org/10.1097/01.TA.0000053384.85091.C6>.
- Kataoka Y, Maekawa K, Nishimaki H, et al. Iliac vein injuries in hemodynamically unstable patients with pelvic fracture caused by blunt trauma. *J Trauma*. 2005;58:704–710. <https://doi.org/10.1097/01.ta.0000159346.62183.8f>.