Extra Peritoneal Packing for Exsanguinating Pelvic Hemorrhage: Should We Do It in the Emergency Department?

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ABSTRACT **Background:** Extra peritoneal packing (EPP) is a quick and highly effective method to control pelvic hemorrhage.

Objectives: To determine whether EPP can be as safely and efficiently performed in the emergency department (ED) as in the operating room (OR).

Methods: Retrospective study of 29 patients who underwent EPP in the ED or OR in two trauma centers in Israel 2008–2018.

Results: Our study included 29 patients, 13 in the ED-EPP group and 16 in the OR-EPP group. The mean injury severity score (ISS) was 34.9 ± 11.8. Following EPP, hemodynamic stability was successfully achieved in 25 of 29 patients (86.2%). A raise in the mean arterial pressure (MAP) with a median of 25 mmHg (mean 30.0 ± 27.5, $P < 0.001$) was documented. All patients who did not achieve hemodynamic stability after EPP had multiple sources of bleeding or fatal head injury and eventually succumbed. Patients who underwent EPP in the ED showed higher change in MAP ($P = 0.0458$). The overall mortality rate was 27.5% (8/29) with no difference between the OR and ED-EPP. No differences were found between ED and OR-EPP in the amount of transfused blood products, surgical site infections, and length of stay in the hospital. However, patients who underwent ED-EPP were more prone to develop deep vein thrombosis (DVT): 50% (5/10) vs. 9% (1/11) in ED and OR-EPP groups respectively ($P = 0.038$).

Conclusions: EPP is equally effective when performed in the ED or OR with similar surgical site infection rates but higher incidence of DVT.

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The approach to hemodynamically compromised patients with pelvic fractures is one of the most complex challenges for trauma surgeons. With overall mortality rate as high as 20–40% [1,2], more than one third of the patients will die in the first day due to exsanguinations [1].

Pelvic bleeding can be attributed to several sources: the presacral venous plexus (80–90%), the pelvic bone itself and the pelvic arteries [3]. Late complications after pelvic hemorrhage such as infection, cardiac incidents, and thromboembolic events are common and cause significant morbidity and mortality [4]. There are three approaches to pelvic bleeding control: skeletal immobilization with external fixator or binder, direct extra peritoneal packing, and angioembolization. Angioembolization plays a pivotal role in pelvic hemorrhage control and is highly efficient and safe for arterial bleeding. However, it is not useful for venous bleeding control and it is more time consuming and logistically challenging [5].

The extra peritoneal packing (EPP), otherwise known as pre-peritoneal or retroperitoneal packing, was first reported in Germany in 1995 [6]. It is a quick and highly effective method to control pelvic hemorrhage by surgically tamponading the pelvic cavity with multiple pads [2,7,8,9]. Several studies have reported better survival rates in patients undergoing EPP compared to angioembolization [1]. Although still not widely accepted, EPP has been gradually adopted in many major trauma centers and recently has been approved as pivotal by the Italian consensus meeting in patients with an unstable pelvic hemorrhage [10].

So far, only scarce reports in the literature have described the option to perform EPP in the emergency department (ED-EPP) [10]. Performing ED-EPP may be appropriate for patients in profound shock who might not survive the transfer to the OR. It may also facilitate faster hemodynamic improvement and allow the trauma team to obtain an early computed tomography (CT) scan to diagnose concomitant significant injuries. To the best of our knowledge, the safety and efficiency of ED-EPP has never been specifically studied.

We hypothesized that ED-EPP is equal to OR-EPP in terms of efficiency in controlling hemorrhage, surgical infections rate and venous thromboembolism (VTE) incidence.

PATIENTS AND METHODS

This retrospective study is based on patient data from two trauma centers in Israel. The data for the study were extracted from the electronic medical records, national trauma registry, and blood bank records. The study protocol was approved by the institutional independent ethics committee (Helsinki Committee, approval 3715-16-SMC).

The study population consisted of all patients with hemodynamically unstable pelvic fractures who underwent EPP in the ED or in the OR by a single attending trauma surgeon (Y.K.) in two trauma centers (Level II and Level I) in 2008–2014.

The primary endpoints of the study included the efficacy of bleeding control and achievement of hemodynamic stability calculated by the amount of blood products and mean arterial pressure before and after the packing. The blood pressure values were recorded in the electronic medical record as mean arterial pressure and collected as such. The secondary outcomes of interest were the incidence of surgical site infection (SSI), thromboembolic events, and length of stay (LOS) in hospital. The variables that were collected included vital signs before and after packing, amount of blood products transfused during the first 24 hours, LOS, and rate of deep venous thromboembolic events. The baseline characteristics were collected from the hospital files and the national trauma registry.

PROTOCOL OF TREATMENT

All patients were treated following a standardized protocol [Figure 1]. The evaluation of trauma pattern and resuscitation were performed strictly by the Advanced Trauma Life Support (ATLS) guidelines [11]. All patients were sedated and intubated in the ED or in the pre-hospital setting. After the primary survey, portable chest and pelvic X-rays were performed followed by focused assessment with sonography (FAST).

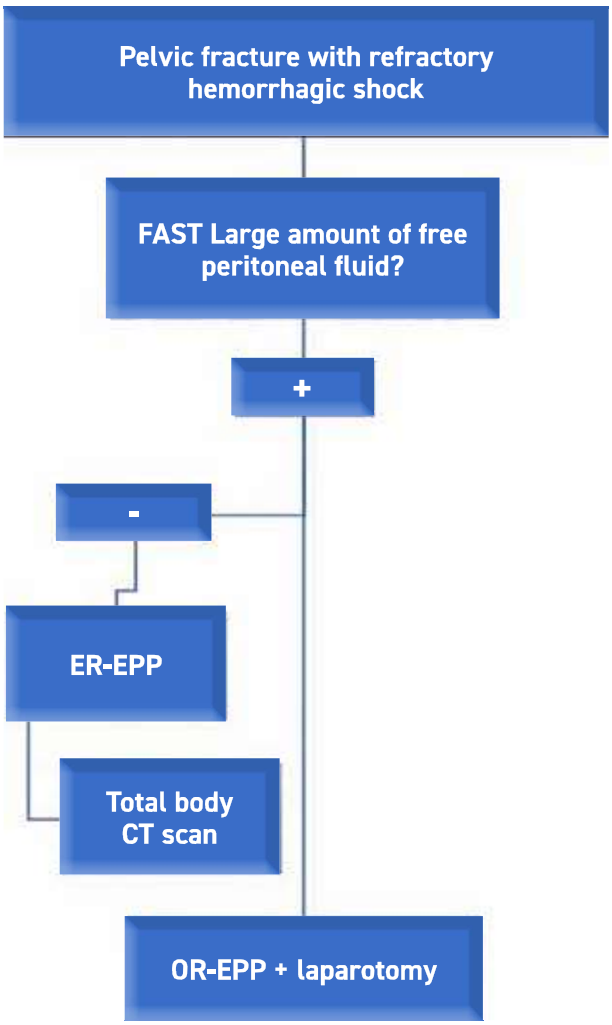
The initial resuscitation consisted of two type 0 negative packed red blood cells followed by two units of type AB fresh frozen plasma that were kept thawed in the blood bank for emergency use. After cross-matching completion, patients were transfused according to the institutional massive blood transfusion protocol with first pack of three packed red blood cells (PRBC) and three fresh frozen plasma units (FFP).

EPP was performed in the ED only if the following conditions were met:

- Hemodynamic instability (systolic blood pressure < 60) with no response after two units of PRBC and two units of FFP
- Major pelvic fracture diagnosed by either pelvic X-ray in the resuscitation bay or by mechanically unstable pelvis on physical examination

Figure 1. Standardized extra peritoneal packing protocol

CT = computed tomography, ED-EPP = emergency department extra peritoneal packing, FAST = focused assessment with sonography, OR-EPP = operative room extra peritoneal packing



- No other obvious origin for exsanguination on physical examination, FAST, or chest X-ray

EPP in the OR was performed in patients who met the two first criteria but had positive FAST or CT scan suggesting other source of exsanguination that necessitated urgent laparotomy or thoracotomy in the OR. External pelvic fixators were used in the ED setting until the patient arrived at the intensive care unit.

EPP SURGICAL TECHNIQUE

All trauma rooms were equipped with an EPP set consisted of quick iodine-based paint, draping, a scalpel, Mayo scissors, deep retractors, and laparotomy pads. Trauma nurses were trained to assist during the procedure.

The adopted surgical technique for EPP consisted of a horizontal suprapubic skin incision and a similar fascial cut. This followed by identification of the rectopubic (Retzius) space and bladder retraction. The packing was performed by inserting sterile laparotomy pads with continuous pressure directed inferiorly and caudally on each side. Four to six surgical pads were inserted usually inserted into each side. The skin was temporarily closed on top of the pads without primary fascial closure. Forty-eight hours after admission, the patients were taken to the interventional radiology (IR) suite where a retrievable inferior vena cava (IVC) filter was inserted and an angiographic catheter was introduced via the femoral artery. The EPP pads were then removed followed by an arteriography. If active arterial bleeding was diagnosed, selective embolization was performed. If necessary, the patient was then transferred to the operating room for internal pelvic fixation. If no internal fixation was planned at this stage, the fascia and skin were closed over two pelvic drains

STATISTICAL ANALYSIS

Statistical analyses were performed by a certified statistician (HFG) using IBM Statistical Package for the Social Sciences statistics software, version 25 (SPSS, IBM Corp, Armonk, NY, USA). The analysis included categorical variables (e.g., demographic background, medical history, injury type,) that were described using frequency, percentage, and continuous variables and displayed as mean ± standard deviation. The differences between ED-EPP and OR-EPP were analyzed using the Fisher exact test in case of categorical variables. The differences in the mean arterial pressure before and after packing were examined using a paired *t*-test.

RESULTS

Our study was comprised of 29 patients, 13 in the ED-EPP group and 16 in the OR-EPP group. Ten patients were recruited from Kaplan Medical Center (Level II trauma center) and 19 from Sheba Medical Center (Level I trauma center). The baseline characteristics of the patients are presented in Table 1. There were no significant differences between the ED-EPP and OR-EPP groups in the major demographic variables, previous medical history, severity of the traumatic injury, and hemodynamic status on arrival to the ED. All patients sustained blunt trauma. The most common mechanism of injury was motor vehicle crash (55.1%) followed by falls from height (44.8%). The ED-EPP group had significantly lower Glasgow Coma Scale (GCS) score in the field and on arrival (P = 0.001). The mean injury severity score (ISS) and the median mean arterial pressure (MAP) before EPP were similar in both groups, with a mean of 34.9 ± 11.8 and 47 mmHg, respectively.

Table 1. Baseline characteristics

	Whole cohort n=29 (mean ± SD)	ED EPP n=13 (mean ± SD)	OR EPP n=16 (mean ± SD)	*P* value
Age (years)	45.5 ± 22	44.5 ± 21.7	46.3 ± 22.8	0.839
Weight (kg)	69.3 ± 22.5	71.5 ± 15.4	66.3 ± 30.7	0.632
Body mass index (kg/m²)	25.3 ± 4.2	24.7 ± 4.3	26.1 ± 4.2	0.522
Injury severity score	34.9 ± 11.8	37.3 ± 11.5	32.9 ± 12.0	0.329
Type of injury, n, (%)				
Fall from height	12 (41.4%)	3 (23.1%)	9 (56.2%)	0.098
MVA	17 (58.6%)	10 (76.9%)	7 (43.8%)	
PMH, n (%)				
Cardiovascular	7 (24.1%)	2 (15.4%)	5 (31.3%)	0.292
Cerebrovascular	2 (6.9%)	1 (7.7%)	1 (6.3%)	0.704
Blood thinners	4 (13.8%)	3 (23.1%)	1 (7.1%)	0.110
Asthma/COPD	2 (6.9%)	2 (15.4%)	0 (0%)	0.192
Smoking	8 (27.6%)	6 (46.2%)	2 (16.7%)	0.125
Mental disease	9 (31%)	4 (30.8%)	5 (31.3%)	0.647
GCS in the field	7.5 ± 5.2	4.2 ± 2.3	10.2 ± 5.4	0.001
GCS on arrival	7.1 ± 5.0	4.1 ± 1.9	9.6 ± 5.4	0.001
MAP before packing	49.9 ± 22.8	44.7 ± 23.5	54.3 ± 22.2	0.298
Pulse before packing	112.4 ± 28.6	115.3 ± 21.0	110.3 ± 33.6	0.645

COPD = chronic obstructive pulmonary disease, ED-EPP = emergency department extra peritoneal packing, GCS = Glasgow Coma Scale, MAP = mean arterial pressure, OR-EPP = operative room extra peritoneal packing, MVA = motor vehicle accident, PMH = past medical history, SD = standard deviation

An increase of 30 ± 27.5 mmHg in MAP was documented following EPP in both groups. The MAP following packing was significantly higher (78.00 ± 22.65) than the initial MAP on arrival, before the procedure (48.04 ± 24.37 mmHg, $P < 0.001$) [Figure 2]. Patients who underwent EPP in the ED showed a significant higher change in MAP (40.69 ± 22.90) than the OR-EPP patients (20.00 ± 28.34, $P = 0.0458$). However, the overall mortality (27.5%) was similar between the OR-EPP and ED-EPP in all age groups.

Hemodynamic stability (MAP > 65) was successfully achieved in 25 of 29 patients (86.2%). In the ED-EPP, 11 of 13 patients (84%) were stable enough to undergo CT scan following the packing. Of those who did not achieve hemodynamic stability following the procedure, one patient died in the ED and the other was taken for urgent laparotomy and splenectomy but eventually succumbed. Following the total body CT scan, three patients were found with major head trauma and were transported to the OR for craniotomy or intracerebral pressure monitor insertion and three patients underwent further laparotomy due to mesenteric and splenic hemorrhage.

The average number of blood products provided to all patients in the cohort during 24 hours following injury was 12.89 ± 11.94, mean 8.07 ± 8.26 for PRBC, and 5.69 ± 5.00 for FFP.

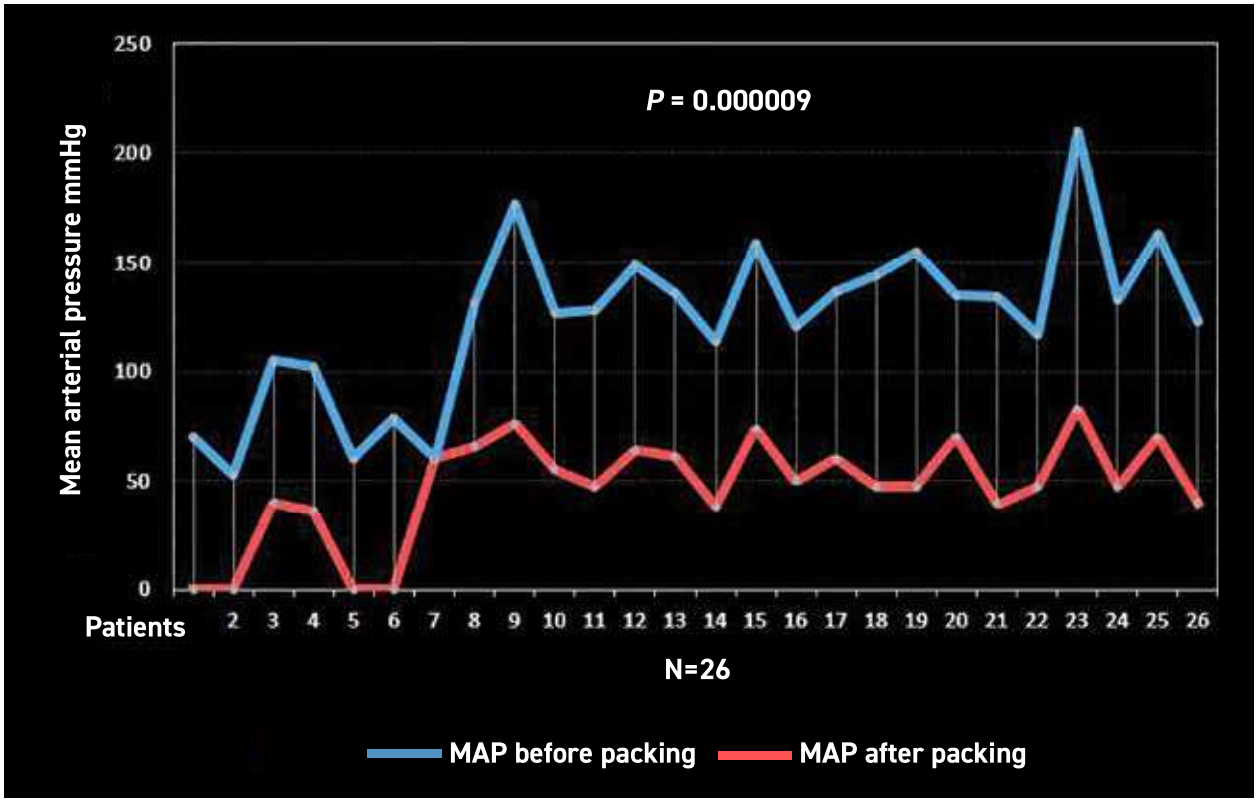
No differences were found between ED-EPP and OR-EPP ($P = 0.439$) in the amount of transfused blood products.

Eight patients (27.5%) died during the first week after injury. Three patients in the ED group and five in the OR group ($P = 0.345$). The mean age of the succumbed patients was 60.75 ± 20.5 years, higher than the whole cohort mean age, which was 45.5 ± 22 years ($P = 0.0178$). Their median MAP before packing was 36 mmHg, which was significantly lower than the overall median MAP ($P = 0.0005$). Four patients died in the ED or OR after EPP due to fatal head trauma or extra-pelvic refractory bleeding with secondary multi-organ failure. Another four patients did not survive the first week due to bowel necrosis and brain death. All eight patients who died during the first week after injury were excluded from analysis regarding LOS, deep vein thrombosis (DVT), and surgical site infection.

The mean overall LOS in the cohort was 93.71 ± 55.16 days. The average LOS in the ICU was 20.8 ± 14.3 days. Both were similar between the ED-EPP and OR-EPP groups ($P = 0.159$ and 0.149, respectively).

Figure 2. Mean arterial pressure before and after extra peritoneal packing

MAP = mean arterial pressure



Surgical site infection (SSI) rate was 38% (8/21), with no significant difference between the ED-EPP group (40%) and the OR-EPP (36.3%) group ($P = 0.864$) [Figure 3]. This rate included SSI with or without bacterial growth and pelvic collections. No definite correlation was found between SSI rate and age, weight, ISS, GCS, and MAP.

Six patients (28.5%) presented with pelvic DVT following the injury and after undergoing EPP. All DVT situations were diagnosed in-house using venous duplex ultrasound by a certified radiologist. The patients who underwent EPP in the ED were more prone to develop DVT: incidence of 50% (5/10) in the ED EPP group vs. 9% (1/11) in the OR EPP group ($P = 0.038$) [Figure 3]. No events of pulmonary embolism were documented in this series.

DISCUSSION

The main goal of this study was to examine whether the practice of performing EPP in the ED is as safe and effective as in the OR.

Previous studies showed that EPP is an effective first-line treatment for critical trauma patients with exsanguinating pelvic bleeding [2,10,12]. However, current evidence is mainly based on case series. In the absence of evidence-based controlled trials studies, the EPP procedure is still controversial [13]. Moreover, most surgeons have limited experience with this procedure, especially when performed in suboptimal environment such as the ED.

The most important factor in the survival of patients with pelvic hemorrhage is the achievement of immediate hemostasis [14]. However, all current interventional options necessitate transfer of hemodynamically unstable patients either to the OR or to the interventional radiology suite.

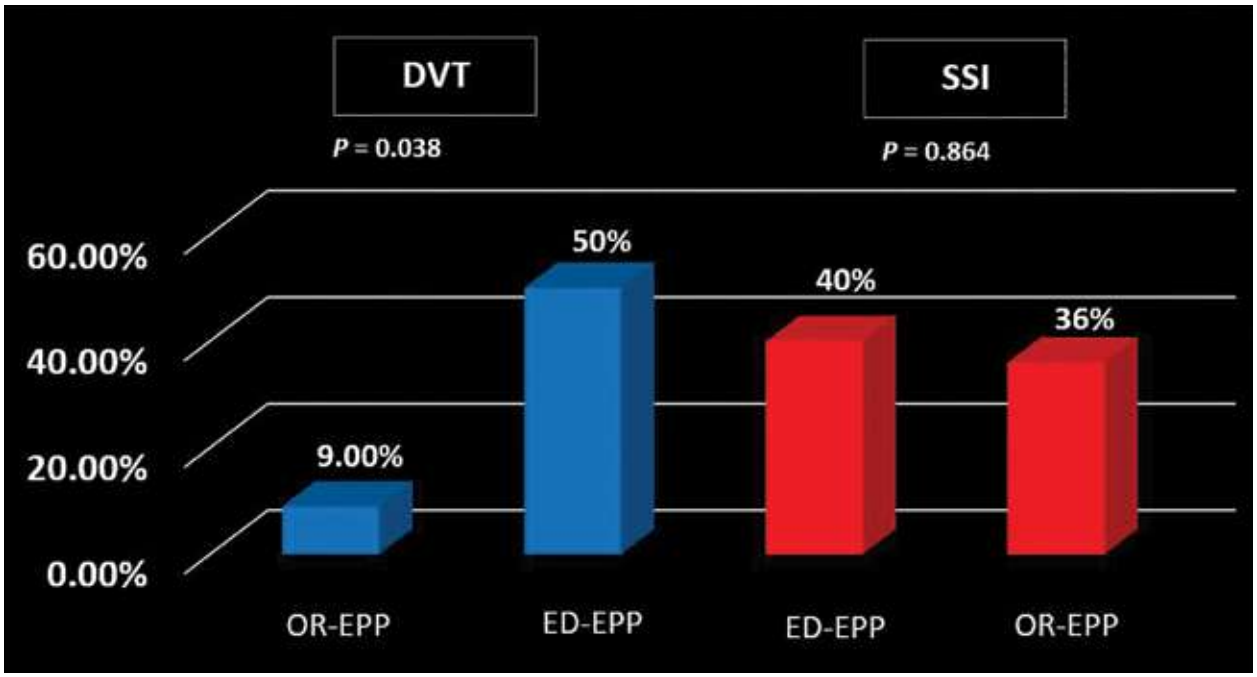
Previous articles mentioned the feasibility of EPP performance in the ED [4,10]; however, a systematic analysis and comparison between ED-EPP and OR-EPP procedures has never been performed, to the best of our knowledge. Our findings suggest that it is indeed feasible to perform EPP in the ED and its effectiveness and safety are similar to the same procedure performed in the OR.

It is highly important to achieve fast hemodynamical stability in multi-trauma patients. The obvious clinical advantage is that it allows the team to perform a CT scan and better appreciate the complexity and extent of the injuries. In our cohort, 61.5% (8/13) of the patients had major extra-pelvic injuries such as splenic lacerations, intracranial bleeding, and pneumothorax and bladder injuries, which benefited from the ability to perform CT before entering the OR.

In this cohort, EPP was used as the initial and sole surgical management for the patients who did not respond to initial resuscitation with two units of PRBC and FFP. No attempts for angioembolization were performed during the initial treatment in the ED. Previous reports have shown that direct pelvic pack-

Figure 3. Deep vein thrombosis and surgical site infection rate after extra peritoneal packing

DVT = deep vein thrombosis, ED-EPP = emergency department extra peritoneal packing, OR-EPP = operative room extra peritoneal packing, SSI = surgical site infection



ing is faster and more effective than early pelvic angiography in unstable patients with pelvic bleeding [15,16]. In addition, EPP may control both venous and arterial bleeding [4.17].

The mean ISS in the cohort was 34.9 ± 11.8, higher than the reported score in the American multi-institutional trial on management of severe pelvic traumas [18,19] and another Israeli report regarding pelvic fractures [20].

The 21 patients (72.5%) post-EPP who survived the first week after injury were eventually successfully discharged from the hospital. All patients who succumbed had other severe extra-pelvic injuries, including grade 4 liver hemorrhage, intracranial herniation, and sepsis secondary to bowel necrosis. None of the patients died from isolated pelvic exsanguination.

The method of the surgical technique used in this study was slightly modified from the version originally described by Pohlemann et al. [6]. The EPP was performed with pelvic tamponade using laparotomy pads. The anterior fascia was left open and the temporary wound closure was performed only with skin on top of the pads as in damage control laparotomy. In our experience, this method allows better pelvic tamponade for bleeding control as it allows insertion of more pads to the pelvic cavity. Those pads are held tight with the skin closure on top. In addition, it may allow better preservation of the fascia as it is not reopened during a de-packing procedure.

The rate of surgical site infections in patients with pelvic ring fractures undergoing angiographic embolization ranges from 3% [4] to 9% [18]. One of the disadvantages of EPP, is that it carries a higher risk for infections. In our study, the infection rate was 38% (8/21), with no marked difference between ED and OR EPP groups. This infection rate is similar to 33% rate reported by Tötterman et al. [12] but higher than 12% and 20% described by Burlew et al. [9] and Shim et al. [21], respectively. It is also quite similar to the surgical site infection rate after external fixation of unstable pelvic fractures without packing (36.0%) [22].

All patients received prophylactic intravenous (IV) antibiotic treatment; however, the patients who underwent EPP in the ED received the antibiotics only after the procedure. Active postoperative surgical site infections were treated with IV antibiotics, daily irrigations, and surgical debridement when necessary. None of the patients developed pelvic osteomyelitis and none necessitated orthopedic hardware removal. No death was attributed to pelvic infection.

The rate of thromboembolic complications in patients with pelvic fractures is estimated to be 33–60% [19-21]. It varies according to the type of injury, the method of detection, and the use of prophylaxis. In our study, 28.5% (6/21) of the patients presented with deep vein thrombosis, most in the ED-EPP group (50%). The exact reasons behind higher prevalence of DVT in the ED-EPP group are out of scope of this manuscript. Although we do speculate that the pelvic packing itself may cause pressure on the iliac veins and predispose to DVT, the packing technique was similar in the ED-EPP and OR-EPP groups, which does not explain the difference between the groups in this issue. We plan to examine those findings in more detail in further studies.

All patients in the study were treated with low-molecular-weight-Heparin (Lovenox) starting 24 hours after their injury. We did not use any routine screening measures for DVT or PE detection as there is no current consensus regarding routine screening for venous thromboembolism of high-risk asymptomatic trauma patients [22]. In addition, the patients underwent inferior vena cava (IVC) filter insertion prior to de-packing as part of the de-packing routine in the IR suite. We found it necessary due to the very high rate of DVT concurrent with inability to provide proper prophylaxis when there is still concern for bleeding. In addition, IVC filter insertion before de-packing may prevent clot dislodgment from a secondary DVT caused by the packing itself. Indeed, despite the high DVT rate, no events of pulmonary embolism were noted. This unique de-packing protocol has been in use for more than 10 years in our institution following two cases of massive pulmonary embolism immediately after de-packing. The packing and de-packing techniques with routine use of angiography and IVC insertion is the local practice at Sheba Medical Center based on the experience of the principal investigator (Y.K.). It is not a common practice and has not yet been described in the literature in an evidence-based manner.

LIMITATIONS

A major limitation of this study is that it is a retrospective case series study with no control group. It also contains a relatively small number of patients, which makes it under-powered. Despite other studies exploring EPP, we focused on the MAP values of the blood pressure. This criterion may add further difficulties in comparing our findings to previously published literature.

In addition, it is important to mention that patient selection was based on the performance of the EPP procedure itself and not on the original intention to treat.

As this study was planned to characterize the safety and efficacy of the ED-EPP compared to OR-EPP, the cohort had to be divided in this manner. This division was done artificially, despite the differences between the groups, as the patients brought to the OR usually had an extra-pelvic bleeding site.

Considering these limitations, we believe this study adds valuable data regarding EPP procedures conducted in an ED setting with reference to the procedures performed in the OR. It also adds new information regarding the effectivity and postoperative complications of EPP as a lifesaving salvage procedure. Our study is the first to systematically address and present the feasibility to perform EPP in the ED and to shed light on our modified EPP technique and the unique de-packing protocol.

CONCLUSIONS

ED-EPP is a feasible and lifesaving procedure. Based on the current data, EPP is equally effective when performed in the ED or OR with similar surgical site infection rates.

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Capsule

Ozanimod as induction and maintenance therapy for ulcerative colitis

Ozanimod, a selective sphingosine-1-phosphate receptor modulator, is under investigation for the treatment of inflammatory bowel disease. **Sandborn** and colleagues conducted a phase 3, multicenter, randomized, double-blind, placebo-controlled trial of ozanimod as induction and maintenance therapy in patients with moderately to severely active ulcerative colitis. In the induction period, 645 patients were included in cohort 1 and 367 in cohort 2; a total of 457 patients were included in the maintenance period. The incidence of clinical remission was significantly higher among patients who received ozanimod than among those who received a placebo during both induction (18.4% vs. 6.0%, $P < 0.001$) and maintenance (37.0% vs. 18.5% among patients with a response at week 10, $P < 0.001$). The incidence of clinical response was also significantly higher with ozanimod than with placebo during induction (47.8% vs. 25.9%, $P < 0.001$) and maintenance (60.0% vs. 41.0%, $P < 0.001$). All other key secondary endpoints were significantly improved with ozanimod as compared with placebo in both periods. The incidence of infection of any severity with ozanimod was similar to that with placebo during induction and higher than that with placebo during maintenance. Serious infection occurred in less than 2% of the patients in each group during the 52-week trial. Elevated liver aminotransferase levels were more common with ozanimod.

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