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Does the accuracy of prehospital pelvic binder placement affect cardiovascular physiological parameters during rescue? A clinical study in patients with pelvic ring injuries

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Abstract

Introduction: Pelvic binders (PB) have become an established first–line treatment for on scene use in suspected pelvic ring injuries. A sustained incidence of incorrect placements was reported, usually above the trochanteric region. We examined if malplacement is associated with worse clinical parameters related to resuscitation.

Methods: Retrospective chart review, level 1 center over a 3–year period. Inclusion criteria: adult patients (18–69y/o), high–energy injury, presence of a pelvic binder on admission — patients without binders served as controls. Exclusions: geriatric patients (>70y/o), ground level falls. Malplacement of the binder was assessed and graded (grade 1:<5 cm above trochanter, grade 2:5–10 cm, grade 3 > 10 cm) from the initial computed tomography scan (3D reconstruction).

Results: Seventy–six patients were included. Males (72%), mean age 47years (range 18–91, SD 19.4). Mean Injury Severity Score was 22.3 points (range 1 –48, SD 10.4) and mean Glasgow Coma Score on arrival was 10.8 points (range 3–15, SD 5.3). Fifty-three percent presented with a pelvic ring injury (74% of them with a type B or C fracture). Mean PB distance from the trochanteric region was 56 mm (range 41–247 mm, SD 54.5). Fifty percent of PBs were moderately displaced, 21% showed severe misplacement (>100 mm). Physiological parameters were unchanged regardless of the accuracy of PB placement.

Conclusion: Incorrect placement of pelvic binders persists despite widespread implementation of the device. In our series, displacement was always cranially and had no effect on preclinical fluids received or parameters of resuscitation on arrival.

Level of Evidence: III

Keywords: CT scan, malplacement, pelvic binder, pelvic ring fracture, physiological changes

1. Introduction

Although pelvic fractures and traumatic pelvic ring disruptions are relatively rare, they can lead to life–threatening blood loss.[1,2] Bleeding can be arterial, but usually originates from the sacral venous plexus or from the fracture site itself.[3] Especially in case of increased pelvic volume with rotationally unstable pelvic ring injuries as seen with open-book type injuries, reduction and stabilization of the pelvic ring by a pelvic sheet or binder represents a key initial measure to help stop the bleeding,[4,5]

Pelvic binders have emerged as an effective tool to reduce and stabilize the pelvic ring.[6–8] In contrast to other measures, such as external fixators or c–clamp application, pelvic binders can safely be applied on scene and were described to reduce potential lifethreatening hemorrhage.[9] Moreover, the quality of reduction even led to reports of missed pelvic ring injuries if only plain films were used to assess the pelvic ring.[10–14]

The correct application of the pelvic binder is essential to allow for a good quality reduction.[15–17] Vaidya et al[18] have reported that numerous binders were placed too proximally, yet did not quantify how far off it was from being correctly placed. Bonner et al[17] documented that 39% of pelvic binders were inaccurately placed on conventional radiographs, most of them being applied too proximally as well.

In general, placement of the binder over the greater trochanter is advised, with the patient's legs crossed to allow for alignment and have good lever arms for reduction. Although positioning of the pelvic binder has previously been examined, its effect on patient resuscitation parameters has not been looked at in detail. The aim of this study was twofold:
to measure the incidence and magnitude of binder malplacement, and to assess whether binder position affects measurable resuscitation parameters in patients with unstable pelvic ring fractures.

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2. Methods

We performed a retrospective chart review and classified the pelvic ring fractures, the degree of hemorrhagic shock and the placement of binders via initial computed tomography (CT) scans. All patients admitted to our Emergency Department (January 1, 2016–December 31, 2019) were screened for eligibility. Ethical approval was granted by the institutional review board (application number: 2015-0223).

2.1. Definitions

Pelvic ring injuries were classified according to Young and Burgess.[19]

All injuries were classified by the force vector acting at the moment on injury and distinguishes lateral compressions (LC), anterior-posterior compression and vertical shear. LC- and anterior–posterior compression injuries are further graded by numerical values indicating increasing rotational and/or vertical instability of the pelvic ring. For this study, LC I fractures and isolated injuries to the crista or iliac spine without pelvic ring compromise were considered stable, whereas all other fractures were regarded as rotationally and/or vertically unstable.

Grading of malplacement of the binder was then assessed by initial CT scan (3D reconstruction) and we separated three degrees: Grade 1: ≤ 5 cm above the greater trochanter; Grade 2: 5 to 10 cm above the greater trochanter; Grade 3: > 10 cm above the greater trochanter.

An example is provided in Figure 1. It compares correct placement of large size binder (A) vs proximal malplacement of small size binder (B) in the initial 3D CT scan.

2.2. Inclusion/exclusion criteria

We included consecutive adult patients, when a pelvic binder was placed preclinically (either SAM–Sling [Sam Medical, Tualatin, Oregon] or T–POD [Teleflex, Morrisville, North Carolina]). Exclusion criteria were no pelvic binder, age <18 years, or rejection of use of data documented by failed patient consent.

2.3. Statistical analysis

Statistical analysis was done by SPSS for windows 25.0 (SPSS, Chicago, Illinois). Data is presented as frequencies and means with range and standard deviation (SD). The Shapiro–Wilk test was used to test for normality (n <2000). If data was normally distributed, means were compared using the Independent t test, if data was not normally distributed, the Mann–Whitney U test was conducted. The level of statistical significance was set at $P < .05$.

3. Results

Seventy-six patients were included in the study. Patient demographics and the quality of binder placement is documented in Table 1. The predominant sex was male (72%), the mean age was 47years (range 18–91, SD 19.4). The Sam-Sling pelvic binder could be identified in 82% of patients. Fifty-three percent presented with a pelvic ring injury of which 74% had either a rotationally and/or vertically unstable pelvic ring. The leading injury patterns were lateral compression type injuries; a more detailed depiction is provided in Figure 2. Mean Injury Severity Score (ISS) was 22.3 points (range 1 –48, SD 10.4) and mean Glasgow Coma Score on arrival was 10.8 points (range 3–15, SD 5.3).

3.1. Pelvic binder placement

The mean degree of malpositioning (distance from the optimal position) was 57.51 mm (41–247 mm, SD 54.5 mm). Exactly half of binders were moderately displaced whereas 21% showed severe misplacement >100 mm. The mean angle of application was –0.4° (range –17° to +10°, SD 5.4°).

3.2. Physiological status and response to resuscitation

The physiological resuscitation parameters associated with the degree of binder displacement are represented in Table 2. Systolic blood pressure, heart rate, hemoglobin, and hematocrit showed a normal distribution, while preclinically applied volume, lactate, base excess, and shock index did not. Overall, there was no difference in physiological parameters or preclinically applied volume between pelvic binders that were applied correctly (i.e., within a 5 cm range), when compared with moderate or severe displacement. Equal results were achieved when looking only at patients with a pelvic ring fracture. There was no significant difference in all of the parameters between the

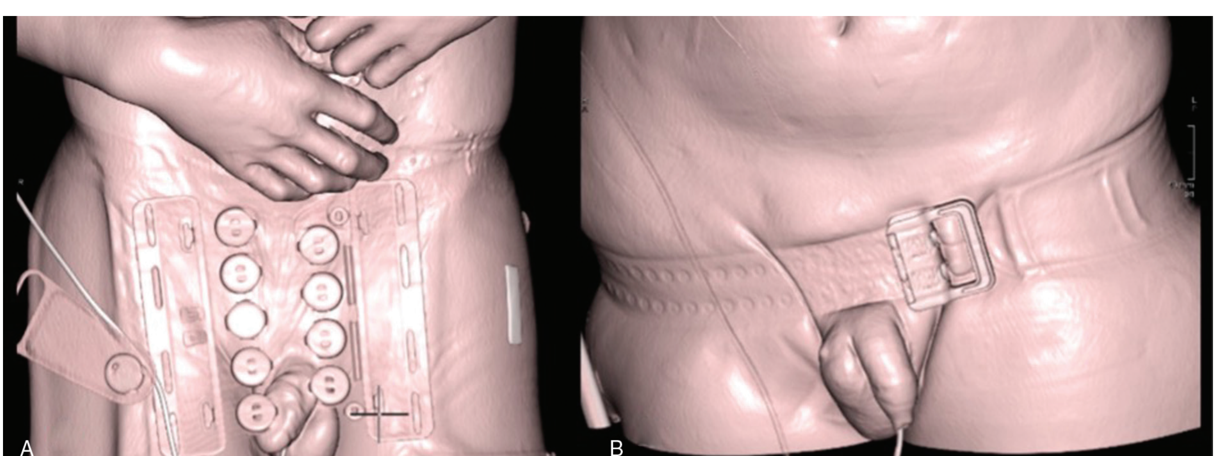

Figure 1. Correct placement of large size binder (A) vs cranial malplacement of small–size binder (B).

Table 1

Demographics and binder placement

Demographics and binder position	n	Mean (%)	Range	SD
Age (years)	76	47.02	18–91	19.4
Sex (male, %)	76	72.4		
ISS (Pts.)	76	22.32	1–48	10.4
GCS (Pts.)	75	10.81	3–15	5.3
>50 mm displacement (%)	76	50 00		
>100 mm displacement (%)	76	21.10		

GCS = Glasgow Coma Score; ISS = Injury Severity Score; SD = standard deviation.

Table 2

Effect of the degree of malplacement in unstable pelvic fractures (PFX) on hemodynamic parameters

Unstable PFX	n	Mean. 50 mm Sig., P value	100 m Sig.
RR sys (mm Hg)	26	95 mm Hg $P=.359$	$P=.483$
Heart rate (/min)	27	$P=.517$	$P=.895$
Shock index	26	$P=.516$	$P=.622$
Volume (mL)	23	$P=.576$	$P=.970$
Hemoglobin (g/L)	27	$P=.789$	$P=.756$
Hematocrit	27	$P=.909$	$P=.740$
Lactate (mmol/L)	26	$P=.877$	$P=.707$
Base excess (mmol/L)	25	$P=.430$	$P=.762$

different application results. In any kind of rotationally or vertically unstable pelvic ring injuries, no significant difference occurred regardless of the quality of application.

Table 3 shows a comparison of patients with or without binders (control group). Physiological parameters of resuscitation were not significantly different (data not shown).

Table 3

Hemodynamics in comparable pelvic injuries with and without pelvic binder application

Binder vs no binder	Correct binder	Binder/ no–binder	All binders	Binder/ no–binder
RR sys (mm Hg)	$P=.316$	15/17	$P=.440$	26/17
Heart rate (/min)	$P=.614$	15/19	$P=.488$	27/19
Shock index	$P=.533$	15/17	$P=.766$	26/17
Hemoglobin (g/L)	$P=.781$	15/19	$P=.763$	27/19
Lactate (mmol/L)	$P=.115$	14/18	$P=.112$	26/18
Base excess (mmol/L)	$P=.378$	13/18	$P=.140$	25/18

4. Discussion

Pelvic ring injuries represent major fractures in young patients with high–energy injuries. The degree of life–threatening hemorrhage and the amount of soft tissue injuries (e.g., Morel Lavalée lesions) require special attention, as they can cause local and systemic complications.

In this line, our study aimed at comparing the effects of placement of pelvic binders on resuscitation and physiological state on arrival at the Emergency Department. We found a high rate of incorrect placements, which seems to be in line with previous results that focus on the anatomical location of pelvic binders.[17,18] Our results are in line with previous studies in that incorrect placement exclusively occurred proximal to the greater trochanter region. Previous authors suggested that this may be associated with a high potential to jeopardize the soft tissue layer and adjacent nerves such as the femoral nerve. Fortunately, none of these complications was found in any of our cases, which may be due to the fact that all cases are submitted to early fixation of fractures. Therefore, none of our binders was removed after a 6-hour time point following admission (data not shown). Nevertheless, the high amount of proximally displaced binder positions matched our impression that drew the idea for this study.

While some studies have looked at changes in stability with different and incorrect positioning of the pelvic binder,[15,17] we are only aware of a single case report about improved hemodynamic stability after binder repositioning.[16] In contrast to our expectations, our study was unable to identify any significant difference in hemodynamic parameters of hemodynamic stability, or parameters of resuscitation. This is even more striking, when considering that more than a third of our patients presented with unstable pelvic ring injuries, out of which almost half had their binder placed too proximally.

Certain downsides of our study have to be considered. On one hand, the study design is limited by its inherited bias due to the retrospective design, especially in terms of the time points of resuscitation parameters. The timing of collection thus could not be determined in a standardized fashion. On the other hand, the relatively small sample size calls for a more detailed study that includes a larger sample size. Finally, the severity of injury has to be regarded as another confounding factor regarding the measurement of resuscitation effort. Our study collective showed a relatively high mean ISS above 20 points. We can therefore not rule out that other injuries have contributed to hemodynamic instability.

We feel that our study also has certain strengths, such as selecting precise inclusion and exclusion criteria, and ruling out complications by other life-threatening injuries. Inclusion of these might have resulted in much higher ISS scores, but also would render the hemodynamic changes less precise in terms of the sequelae of the pelvic ring injury. We feel that using a study population exclusively with isolated hemodynamically relevant high–energy pelvic ring injuries has been an adequate approach.[2,20]

We agree that further studies with larger sample sizes should look at comparing unstable pelvic ring injuries that arrive at the trauma bay without a pelvic binder with unstable injuries arriving with a displaced pelvic binder.

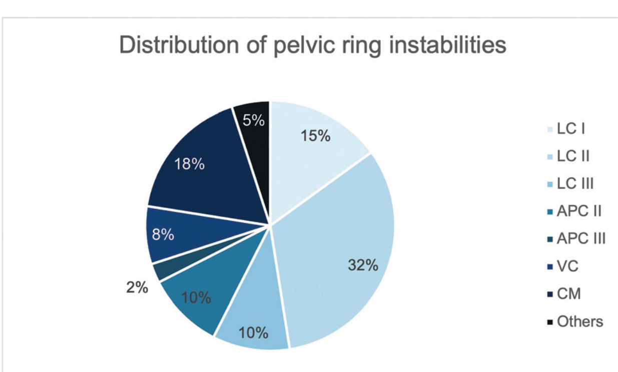

Figure 2. Distribution of pelvic ring injuries.

5. Conclusion

Incorrect placement of pelvic binders persists despite widespread implementation of the device and specific training performed for rescue personnel. According to our results, displacement frequently occurs proximal to the greater trochanter. Despite this radiographic finding, no association with indicators of hemorrhage, such as requirement of preclinical volume replacement, or other parameters of resuscitation on arrival, was detected. Further study should include larger patient numbers and further parameters, such as subclinical inflammatory parameters.

References

1. Hak DJ, Smith WR, Suzuki T. Management of hemorrhage in lifethreatening pelvic fracture. J Am Acad Orthop Surg 2009; 17:447–457.
2. Balogh Z, King KL, Mackay P, et al. The epidemiology of pelvic ring fractures: a population-based study. J Trauma 2007; 63:1066–1073.
3. Tile M. Pelvic ring fractures: should they be fixed? J Bone Joint Surg Br 1988; 70:1–12.
4. FitzPatrick MK. A new tool for initial stabilization of pelvic fractures: the TPOD—trauma pelvic orthotic device. J Trauma Nurs 2002; 9:20–21.
5. Simpson T, Krieg JC, Heuer F, et al. Stabilization of pelvic ring disruptions with a circumferential sheet. J Trauma 2002; 52:158–161.
6. DeAngelis NA, Wixted JJ, Drew J, et al. Use of the trauma pelvic orthotic device (T-POD) for provisional stabilisation of anterior-posterior compression type pelvic fractures: a cadaveric study. Injury 2008; 39:903–906.
7. Krieg JC, Mohr M, Ellis TJ, et al. Emergent stabilization of pelvic ring injuries by controlled circumferential compression: a clinical trial. J Trauma 2005; 59:659–664.
8. Tan EC, van Stigt SF, van Vugt AB. Effect of a new pelvic stabilizer (T-POD(R)) on reduction of pelvic volume and haemodynamic stability in unstable pelvic fractures. Injury 2010; 41:1239–1243.
9. Knops SP, Schep NW, Spoor CW, et al. Comparison of three different pelvic circumferential compression devices: a biomechanical cadaver study. J Bone Joint Surg Am 2011; 93:230–240.
10. Swartz J, Vaidya R, Hudson I, et al. Effect of pelvic binder placement on OTA classification of pelvic ring injuries using computed tomography. Does it mask the injury? J Orthop Trauma 2016; 30:325–330.
11. Fletcher J, Yerimah G, Datta G. The false security of pelvic binders: 2 cases of missed injuries due to anatomical reduction. J Orthop Case Rep 2016; 6:44–47.
12. Beaven A, Toman E, Cooper J. Post binder radiography in pelvic trauma. BMJ Cae Rep 2016; 2016:
13. Bayer J, Hammer T, Maier D, et al. Emergency radiological examination of the externally stabilized pelvis—there is a catch to it: lessons learned from two cases with symphyseal disruption despite initial inconspicuous computed tomography. BMC Surg 2016; 16:11.
14. Clements J, Jeavons R, White C, et al. The concealment of significant pelvic injuries on computed tomography evaluation by pelvic compression devices. J Emerg Med 2015; 49:675–678.
15. Prasarn ML, Small J, Conrad B, et al. Does application position of the T-POD affect stability of pelvic fractures? J Orthop Trauma 2013; 27:262–266.
16. Fleiter N, Reimertz C, Lustenberger T, et al. Importance of the correct placement of the pelvic binder for stabilisation of haemodynamically compromised patients. Z Orthop Unfall 2012; 150:627–629.
17. Bonner TJ, Eardley WG, Newell N, et al. Accurate placement of a pelvic binder improves reduction of unstable fractures of the pelvic ring. J Bone Joint Surg Br 2011; 93:1524–1528.
18. Vaidya R, Roth M, Zarling B, et al. Application of circumferential compression device (binder) in pelvic injuries: room for improvement. West J Emerg Med 2016; 17:766–774.
19. Burgess AR, Eastridge BJ, Young JW, et al. Pelvic ring disruptions: effective classification system and treatment protocols. J Trauma 1990; 30:848–856.
20. 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.