Air Medical Journal 38 (2019) 294–297

Contents lists available at ScienceDirect

Air Medical Journal

journal homepage: http://www.airmedicaljournal.com/

Original Research

Clinical Examination of the Pelvic Ring in the Prehospital Phase

Eelco A.P. van Leent, BSc [1,*], Bas van Wageningen, MD [1,3], Özcan Sir, MD [2], Erik Hermans, MD, PhD [1], Jan Biert, MD, PhD [1,3]

[1] Department of Surgery, Division of Trauma Surgery, Radboud University Medical Center Nijmegen, Nijmegen, the Netherlands
[2] Department Emergency Medicine, Radboud University Medical Center Nijmegen, Nijmegen, the Netherlands
[3] Helicopter Emergency Medical Service, Radboud University Medical Center Nijmegen, Nijmegen, the Netherlands

A B S T R A C T

Introduction: Instable pelvic fractures are associated with significant hemorrhage and shock. Instability of the pelvic ring should be tested with the manual compression test (MCT) and instable pelvic ring fractures should prompt mechanical stabilization. However, the accuracy of the prehospital MCT in patients, that sustained a high energetic trauma, is still unknown.

Setting: Radboudumc Nijmegen, level 1 trauma center, the Netherlands.

Methods: This prospective blind observational study included all patients after a high impact blunt trauma treated by an experienced Helicopter Emergency Medical Service (HEMS) physician. Nominal arranged questionnaires were filled in by the HEMS physician prior to the radiological examination of the patient.

Results: We included 56 patients of which 11 sustained a pelvic ring fracture. 13 patients were treated with pelvic compression devices, of which only five patients had a pelvic ring fracture. Prehospital performed clinical examination by the HEMS physicians had an overall sensitivity of 0.45 (95% CI 0.16-0.75) and a specificity of 0.93 (95% CI 0.29-0.96).

Conclusion: Pelvic ring instability cannot accurately be diagnosed in the prehospital setting, based on the MCT. The use of the pelvic binder should standard in high impact blunt trauma patients, independently of the MCT or trauma mechanism.

After the introduction of Advanced Trauma Life Support in 1980, clinical examination of pelvic ring stability is warranted in the primary survey.[1,2] In patients with injuries after blunt trauma, 5% to 16% sustain pelvic ring injuries, which results in a mortality rate of 5% to 50%.[2-5] This is primarily caused by hemorrhagic shock.[3,5] Theoretically, reduction and stabilization of the pelvic ring can reduce the volume of the small pelvis and thereby improve the tamponade effect on the hemorrhage arising from the bone or the venous plexus.[3,5-7] The sooner the bleeding is controlled, the greater the chance of avoiding hypothermia, coagulopathy, and acidosis associated with trauma patients.[2,5]

Pelvic ring stability is assessed by manual compression of the iliac crest.[4,8,9] If no instability is found, manual distraction of the pelvis is performed by pushing the iliac crest outward with both hands.[4] Instability is suspected when the patient complains of pain on compression or when movement of the pelvic ring is detected. However, it is proven to be difficult to assess pelvic stability in polytraumatized patients, especially in the unconscious patient.[8-10] A potential dangerous complication of manipulating the pelvis is that formed blood clots can be dislocated, resulting in further blood loss.[11,12]

In the prehospital setting, acute management of instable pelvic ring fractures consists of emergency reduction by circumferential pelvic binding devices.[11,13] Circumferential pelvic binding devices are fast, safe, simple, and also proven to be effective in reducing the pelvic volume and thereby improving hemodynamics.[3,14-16] A binding device is standard equipment on ambulances and the helicopter emergency medical service (HEMS) throughout the Netherlands. The application of a pelvic binder has become standard care for trauma patients with suspected pelvic fractures.[5] However, a previous study showed that a prehospital pelvic binder was applied in only 16% (87/537) of patients with a pelvic ring fracture.[7]

The present prospective study aims to establish the diagnostic accuracy of the prehospital clinical examination of the pelvic ring by a HEMS physician, guiding for therapeutic intervention by a pelvic binder.

Methods

This prospective observational study was conducted in the Radboud University Medical Center Nijmegen, a level 1 trauma center in

* Address for correspondence: Eelco A.P. van Leent, BSc, Department of Surgery, Division of Trauma Surgery, Radboud University Medical Center Nijmegen, Geert Grooteplein Zuid 10, 6525 GA Nijmegen, The Netherlands.
E-mail address: eelco.vanleent@radboudumc.nl (E.A.P. van Leent).

1067-991X/$36.00

https://doi.org/10.1016/j.amj.2019.04.004

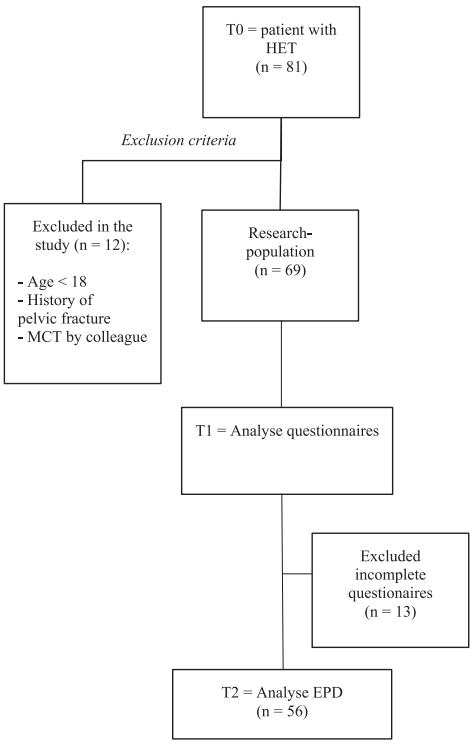

Figure 1. Flowchart showing inclusion of patients for analysis.

the Netherlands. Patients were enrolled from May 2015 until December 2016. Data were collected using nominal questionnaires that were completed by the attending HEMS physician after transferring a patient to the emergency department (ED). A total of 56 patients took part in this study.

All included patients sustained a high-energy blunt trauma and had an Injury Severity Score > 16. An on-scene examination of the pelvic ring was conducted by the attending HEMS physician in all patients. All included patients were ≥ 18 years and had an indication for radiologic examination of the pelvis. In all patients, a computed tomographic (CT) scan of the pelvic ring was obtained. After presentation at the ED, the HEMS physician completed the questionnaire concerning his prehospital clinical examination before a pelvic CT scan or pelvic x-ray was made.

Patients were excluded if they were under the age of 18 years, had a history of pelvic fracture(s), or had no indication for CT imaging. Also, patients were excluded when the HEMS physician did not examine the patient by himself or when the HEMS physician knew the radiologic examination outcome before completing our questionnaire. Lastly, incomplete questionnaires were excluded as well (Fig. 1), resulting in a diverse population with a high level of suspicion for pelvic ring fractures.

All patients gave (indirect) informed consent. The nominal arranged questionnaires contained information on the trauma mechanism, vital and neurologic parameters (clinical classification of hemodynamic instability, Glasgow Coma Scale [GCS], and Alert, Verbal, Pain, Unresponsive [AVPU] scale), the manual compression test (MCT), and the use of a pelvic binder. The MCT was considered to be positive when pain and/or instability of the pelvis was found and a pelvic ring fracture was suspected. Neurologic impairment was defined as GCS ≤ 13 and/or AVPU scored verbal or lower. Hemodynamic instability was scored with clinical signs of shock based on heart rate (> 100 beats/min) and/or systolic blood pressure (< 90 mm Hg). Furthermore, for the purpose of this study, pelvic ring fracture was classified according to Tile.

The decision to apply the pelvic binder (T-POD; Pyng Medical, Richmond, BC, Canada), was made by the HEMS physician prehospitally based on clinical examination and/or the mechanism of trauma. Clinical examination was performed conforming to the Advanced Trauma Live Support guidelines (Trauma Programs, Chicago, IL) and included the MCT. If needed, additional information including patient characteristics, neurologic status, and the conclusions of the CT scan were collected from our electronic patient files.

The statistical analysis was performed using SPSS 25.0 (IBM Corp, Armonk, NY). The diagnostic accuracy was determined by calculating the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) and their 95% confidence interval (CI). This study was approved by the local medical ethics committee.

Results

From May 2015 until December 2016, 56 patients enrolled in this study. Patient characteristics are listed in Table 1. The mean age was 49.3 (standard deviation = 20.1) years, and 70% of the included patients were men. Thirteen patients died after admission in the

Table 1
Patient Characteristics

		Fracture		No fracture				
	n		Mean	n	Mean	n	Mean	*P* Value[a]
Sex	Female	3		14		17		
	Male	8		31		39		
								1.00
Age (years)			41.9 (SD = 22.6)		51.1 (SD = 19.2)	0	49.3 (SD = 20.1)	.18
Trauma mechanism	Traffic accident	8		27		35		
	Fall from height	1		15		16		
	Crush	2		0		2		
	Sport	0		3		3		
								.03
Pelvic binder	Yes	5		8		13		
	No	6		36		42		
	Unknown	0		1		1		
								0.17
Tile classification	Tile A	4 (2[b])						
	Tile B	5 (3[b])						
	Tile C	2 (1[b])						

[a] *P* value calculated with the Fisher exact test.
[b] Undiagnosed pelvic fractures during clinical examination.

Table 2
The influence of trauma-related characteristics on pelvic ring fracture suspicion

			Pelvic fracture			Sensitivity	Specificity	PPV	NPV
			Yes		No				
Clinical examination		Fracture suspected	Yes	5	3				
			No	6	42				
		Total				0.45 (95% CI, 0.16-0.75)	0.93 (95% CI, 0.86-1.01)	0.63 (95% CI, 0.29-0.96)	0.88 (95% CI, 0.78-0.97)
MCT[a]		Fracture suspected	Yes	3	1				
			No	7	43				
		Total				0.30 (95% CI, 0.02-0.58)	0.98 (95% CI, 0.93-1.02)	0.75 (95% CI, 0.33-1.17)	0.86 (95% CI, 0.76-0.96)
GCS[a]	≤ 13	Fracture suspected	Yes	3	2				
			No	2	26				
		Total				0.60 (95% CI, 0.17-1.02)	0.93 (95% CI, 0.83-1.02)	0.60 (95% CI, 0.17-1.02)	0.93 (95% CI, 0.83-1.02)
	> 13	Fracture suspected	Yes	2	1				
			No	3	15				
		Total				0.40 (95% CI, −0.03 to 0.83)	0.94 (95% CI, 0.82-1.06)	0.67 (95% CI, 0.13-1.20)	0.93 (95% CI, 0.66-1.01)
AVPU	Unresponsive	Fracture suspected	Yes	1	0				
			No	3	16				
		Total		4	16	0.25 (95% CI, −0.17 to 0.67)	1.0 (95% CI, 1.00)	1.0 (95% CI, 1.0)	0.84 (95% CI, 0.68-1.01)
	Alert, verbal, or pain	Fracture suspected	Yes	3	3				
			No	3	26				
		Total				0.50 (95% CI, 0.10-0.90)	0.90 (95% CI, 0.79-1.0)	0.50 (95% CI, 0.10-0.90)	0.90 (95% CI, 0.79-1.01)
HD instability[a]	Yes	Fracture	Yes	4	2				
			No	4	7				
		Total				0.50 (95% CI, 0.15-0.85)	0.78 (95% CI, 0.50-1.04)	0.67 (95% CI, 0.29-1.04)	0.63 (95% CI, 0.87-1.02)
	No	Fracture	Yes	1	1				
			No	2	33				
		Total				0.33 (95% CI, −0.20 to 0.87)	0.97 (95% CI, 0.91-1.03)	0.50 (95% CI, −0.19 to 1.19)	0.94 (95% CI, 0.83-1.02)

AVPU =; CI = confidence interval; GCS = Glasgow Coma Scale; HD = hemodynamic; MCT = manual compression test; NPV = negative predictive value; PPV = positive predictive value.
[a] Values scored as "unknown" are not presented and calculated in the 2 × 2 table.

hospital, mostly because of traumatic brain injury. Only 3 deceased patients had a pelvic ring fracture.

Of the included 56 patients, 11 (20%) patients had a pelvic ring fracture. Classification according to Tile resulted in 4 Tile A–, 5 Tile B– (all Tile B2), and 2 Tile C–type fractures. Thirteen patients were treated with a pelvic binder in the prehospital phase; only 5 patients acutely sustained a pelvic ring fracture. Of the 5 patients with a pelvic ring fracture and a pelvic binder applied, only 1 had on-scene signs of a pelvic ring fracture like a Morel-Lavallée lesion and/or a genital hematoma. The MCT was positive in only 3 of these patients.

The overall accuracy of the prehospital clinical examination showed a sensitivity of 0.45 (95% CI, 0.16-0.75) and a specificity of 0.93 (95% CI, 0.86-1.01). The PPV was 0.63 (95% CI, 0.29-0.96), and the NPV was 0.88 (95% CI, 0.78-0.97) (Table 2).

A positive MCT was found in 4 of 56 patients, 3 of whom had a pelvic fracture, and in 7 patients with a pelvic ring fracture, the MCT was negative. The reliability of the on-scene MCT showed a sensitivity of 0.30 (95% CI, 0.02-0.58) and a specificity of 0.98 (95% CI, 0.93-1.02). The PPV was 0.75 (95% CI, 0.33-1.17), and the NPV was 0.86 (95% CI, 0.76-0.96) (Table 2). The sensitivity, specificity, PPV, and NPV of the clinical examination in patients who were hemodynamically unstable, neurologically impaired (GCS ≤ 13), or unresponsive are also listed in Table 2. Forty-nine percent of the patients with a GCS ≤ 13 were also unresponsive.

A pelvic binder was applied prehospitally in 13 patients (23.2%). In 6 out of 13 patients (46.2%), there was a clinical suspicion of a pelvic fracture based on the MCT and/or the trauma mechanism. Seven patients were in evident hemorrhagic shock and were treated with a pelvic binder preemptively.

Discussion

This blinded prospective study was conducted to establish the value of physical examination of the trauma patient after a high-impact blunt trauma and to accurately diagnose a pelvic ring fracture. The blinding of the attending physician makes this study unique and shows the substantiated limitations of on-scene physical examination.

Based on our results, it is apparent that it is difficult to rule out a pelvic fracture at the accident scene in patients with a high-impact blunt trauma with high suspicion of a pelvic ring fracture on physical examination alone. In contrast to the meta-analysis conducted by Sauerland et al,[9] this study was performed on scene with neurologic- and/or hemodynamic-impaired patients. This study surprisingly showed a higher sensitivity of the MCT in patients with neurologic impairment (GCS ≤ 13). History taking is complicated in polytraumatized patients because of concomitant head injury or distracting injury. Therefore, we separately calculated the results in unresponsive patients because these patients cannot give an indication of pain during the MCT. Then, we saw that the sensitivity and NPV, compared with the overall results, were lower in these unresponsive patients. Based on these results (Table 2), it can be concluded that clinical examination of the pelvic ring is further obscured in patients with neurologic deficit but to a lesser extent in patients with hemodynamic deficit.

Furthermore, we concluded that a negative MCT does not rule out a pelvic fracture. This warrants the conclusion that pelvic binders should be standard care after high-energy blunt trauma regardless of MCT, which corresponds with the study of Yong et al.[8] The low accuracy of the MCT and the potential risks of it also confirmed that we should use the pelvic binder with a low threshold.[8,11,12]

This study had several strengths and limitations. First, there was a small population of only 56 patients included in this study. However, our study represents a heterogeneous population of different kinds of blunt trauma and shows the dilemma of decision making of the HEMS physician in the prehospital phase. Second, because of the urgency for the primary survey at the ED in this level 1 trauma center and our strict inclusion and exclusion criteria, HEMS physicians could not fill in all of the questionnaires. Despite these missing blunt trauma patients, we believe that the included patients were a representable small group of the blunt trauma patient because the a priori chance for a pelvic ring fracture was still 20%. This incidence was in agreement with previous studies in high-impact blunt trauma patients.[5] Third, because of the small population, the resulting low sensitivity is possibly a sign of undertriage and the high specificity a

sign of overtriage. Also, 2 patients (3.6%) were scored as unknown during hemodynamic instability and MCT; these data were excluded from the final analysis.

In summary, we can conclude that diagnosing a pelvic ring fracture in the prehospital phase based on the MCT is not reliable. In this study, we found a low sensitivity and PPV and a high specificity and NPV for the clinical examination. We advise that every severely injured trauma patient, independent of the trauma mechanism, should be given a pelvic binder to prevent ongoing bleeding from an undiagnosed pelvic ring fracture. Manual testing of the pelvis is not reliable and potentially dangerous and should therefore be abandoned in the prehospital phase. Further research is needed to find out the accuracy of the MCT in only unstable pelvic ring fractures in the prehospital phase because these fractures are high risk for hemodynamic instability and shock and could strengthen our presented results.

Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amj.2019.04.004.

References

1. Wong AT, Brady KB, Caldwell AM, Graber NM, Rubin DH, Listman DA. Low-risk criteria for pelvic radiography in pediatric blunt trauma patients. *Pediatr Emerg Care*. 2011;27:92–96.
2. Katsoulis E, Giannoudis PV. Impact of timing of pelvic fixation on functional outcome. *Injury*. 2006;37:1133–1142.
3. Tan EC, van Stigt SF, van Vugt AB. Effect of a new pelvic stabilizer (T-POD??) on reduction of pelvic volume and haemodynamic stability in unstable pelvic fractures. *Injury*. 2010;41:1239–1243.
4. den Boer TA, Geurts M, van Hulsteijn LT, et al. The value of clinical examination in diagnosing pelvic fractures in blunt trauma patients: a brief review. *Eur J Trauma Emerg Surg*. 2011;37:373–377.
5. Hsu S, Chen C, Chou Y, Wang S, Chan D. Effect of early pelvic binder use in the emergency management of suspected pelvic trauma: a retrospective cohort study. *Int J Environ Res Public Health*. 2017;14:1–9.
6. Sierink JC, Saltzherr TP, Beenen LFM, et al. A multicenter, randomized controlled trial of immediate total-body CT scanning in trauma patients (REACT-2). *BMC Emerg Med*. 2012;12:4.
7. Hermans E, Biert J, Edwards MJR. Epidemiology of pelvic ring fractures in a level 1 trauma center in the Netherlands. *Hip Pelvis*. 2017;29:253.
8. Yong E, Vasireddy A, Pavitt A, Davies GE, Lockey DJ. Pre-hospital pelvic girdle injury: Improving diagnostic accuracy in a physician-led trauma service. *Injury*. 2016;47:383–388.
9. Sauerland S, Bouillon B, Rixen D, Raum MR, Koy T, Neugebauer EA. The reliability of clinical examination in detecting pelvic fractures in blunt trauma patients: a meta-analysis. *Arch Orthop Trauma Surg*. 2004;124:123–128.
10. Habib N, Filardo G, Delcogliano M, Arigoni M, Candrian C. An algorithm to avoid missed open-book pelvic fractures. *Eur Rev Med Pharmacol Sci*. 2018;22:2973–2977.
11. van Stigt SF, Tan EC, van Vugt AB. Acute behandeling van bekkenfracturen. *Nederland Tijdschrift voor Geeskunde*. 2009;153:1–7.
12. Lee C, Porter K. The prehospital management of pelvic fractures. *Emerg Med J*. 2007;24:130–133.
13. Papakostidis C, Giannoudis PV. Pelvic ring injuries with haemodynamic instability: efficacy of pelvic packing, a systematic review. *Injury*. 2009;40(suppl 4):S53–S61.
14. Auston DA, Simpson BR. Initial Treatment of “Pelvic Injuries” with Commercially Available Pelvic Binders Results in Displacement of Acetabular Fractures: A Report of Three Cases. *J Bone Joint Surg Case Connect*. 2015;5(1):e4–e20.
15. Bakhshayesh P, Boutefnouchet T, Tötterman A. Effectiveness of non invasive external pelvic compression : a systematic review of the literature. *Scand J Trauma Resusc Emerg Med*. 2016;24:1–9.
16. Pizanis A, Pohlemann T, Burkhardt M, Aghayev E, Holstein JH. Emergency stabilization of the pelvic ring: clinical comparison between three different techniques. *Injury*. 2013;44:1760–1764.