Injury, Int. J. Care Injured 49 (2018) 284–289

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

The value of 'binder-off' imaging to identify occult and unexpected pelvic ring injuries

James A.C. Fagg[a,b,*], Mehool R. Acharya[a], Tim J.S. Chesser[a], Anthony J. Ward[a]

[a] Pelvic and Acetabular Reconstruction Unit, Department of Trauma and Orthopaedic Surgery, Southmead Hospital, Southmead Way, Bristol BS10 5NB, United Kingdom
[b] Department of Trauma and Orthopaedic Surgery, Royal United Hospital, Bath BA1 3NG, United Kingdom

ARTICLE INFO

Keywords:
Pelvic ring
Pelvis fracture
Pelvic x-ray
Computed tomography
Pelvic binder
Trauma
Missed injury

ABSTRACT

Aims: To determine the effectiveness of 'binder-off' plain pelvic radiographs in the assessment of pelvic ring injuries.
Patients and methods: All patients requiring operative intervention at our tertiary referral pelvic unit/major trauma centre for high-energy pelvic injuries between April 2012 and December 2014 were retrospectively identified. Pre-operative pelvic imaging with and without pelvic binder was reviewed with respect to fracture pattern and pelvic stability. The frequency with which the imaging without pelvic binder changed the opinion of the pelvic stability and need for operative intervention, when compared with the computed tomography (CT) scans and anteroposterior (AP) radiographs with the binder on, was assessed.
Results: Seventy-three percent (71 of 97) of patients had initial imaging with a pelvic binder in situ. Of these, 76% (54 of 71) went on to have 'binder-off' imaging. Seven percent (4 of 54) of patients had unexpected unstable pelvic ring injuries identified on 'binder-off' imaging that were not identified on CT imaging in binder.
Conclusions: Trauma CT imaging of the pelvis with a pelvic binder in place is inadequate at excluding unstable pelvic ring injuries, and, based on the original findings in this paper, we recommend additional plain film 'binder-off' radiographs, when there is any clinical concern.

Introduction

Pelvic fractures occur in 5–16% of patients with blunt trauma and can cause life-threatening haemorrhage [1–4]. A number of different pelvic binder devices are now commercially available and pelvic binders are becoming a routine part of the initial pre-hospital management of trauma patients with suspected pelvic fractures in the United Kingdom and other countries [5]. The National Institute for Health and Care Excellence now recommends their use in all patients in whom active bleeding is suspected from a pelvic fracture following blunt high-energy trauma [6]. They are often placed by paramedics at the scene, or immediately on arrival in the Emergency Department. Binders function by closing down the pelvic volume by reducing the pelvic ring with circumferential pressure, stabilizing the pelvic bone fragments, and helping with clot stabilisation [7,8]. Recent major trauma protocols advise that patients undergo emergent computed tomography (CT) shortly after entering the emergency department, to identify any life-threatening injuries. This has taken the place of more traditional radiographs [9].

Numerous reports have confirmed that serious pelvic injuries may be missed or not fully appreciated in the presence of a pelvic binder that has been applied and has anatomically reduced the pelvic ring [10–17]. This is particularly true for Young and Burgess anteroposterior compression (APC) injuries [18], which are associated with the largest requirement for transfusion of all the pelvic fracture types, and can be purely ligamentous injuries. It is also possible for the APC injuries to become over-reduced, taking the appearance of lateral compression (LC) injuries. For this reason our department now performs additional pelvic imaging following removal of the pelvic binder where there is still suspicion of a pelvic injury (e.g. mechanism of injury, clinical signs of pain, distracting injury, tenderness and bruising around the pelvis, or history of haemodynamic instability). We perform a plain anteroposterior (AP) radiograph of the pelvis with the binder released, with immediate replacement of the binder if there are ongoing concerns. The intention of this study was to ascertain if

* Corresponding author at: Department of Trauma and Orthopaedic Surgery, Royal United Hospital, Bath BA1 3NG, United Kingdom.
E-mail address: jamesfagg@doctors.org.uk (J.A.C. Fagg).

https://doi.org/10.1016/j.injury.2017.11.023
0020-1383/

and how often the initial CT and AP pelvis imaging with a pelvic binder in place fails to identify unstable pelvic ring injuries. The Null Hypothesis was therefore that there is no difference in the interpretation of pelvic stability or need for surgical stabilisation following review of 'binder-off' radiographs when initial imaging has been performed in binder.

Patients and methods

Using prospective electronic records we identified all patients who underwent pelvic fixation in our tertiary pelvic referral unit between April 2012 and December 2014. We included all patients who underwent surgical stabilisation of OTA/AO 61 injuries [19] with open reduction and internal fixation, percutaneous screw fixation, anterior internal fixation or external fixation. We excluded patients with low energy fragility or pathological fractures. A total of 97 patients met these criteria. We then assessed the digital imaging of these patients for the presence of a pelvic binder on their initial pelvic imaging (n = 71, 73%), and then for the availability of subsequent pre-operative imaging without the pelvic binder (n = 54, 76%).

The initial images were reviewed by a single author not previously involved in the management of these patients (JF). The pelvic injury was classified according to fracture pattern (Young and Burgess Classification[18]) and stability (OTA/AO Classification [19]). The same author then reviewed the 'binder-off' imaging, assessing for any change to their previous interpretation. These cases were then discussed amongst the remaining authors (experienced pelvic and acetabular surgeons) for consensus opinion. Interpretation of stability was based on injury pattern and displacement patterns, rather than on any measured degree of displacement below or above which surgical treatment would or would not have been indicated. This more closely reflects our clinical decision-making.

The demographics (age and gender) and Young and Burgess classification were assessed for any statistically significant difference between those patients who had a 'binder-off' radiograph and the full cohort of operated patients. A 2-tailed Mann-Whitney *U* test was used to identify age bias and Pearson's Chi-squared test was used to identify gender bias and fracture pattern bias. A p value of <0.05 was considered significant.

Results

The radiographs of 97 patients were reviewed, of which 73% (71) had initial pelvic imaging with a pelvic binder in place. Of these 71 patients, 54 (76%) had 'binder-off' imaging.

The patient demographics are shown in Table 1. There was no statistically significant difference between the 'binder-off' group compared with the total group of patients with respect to the ages of the patients (p = 0.41), the gender of the patients (p = 0.61) or the mechanisms of injury, as per the Young and Burgess classification (p = 0.80).

The commonest injury pattern was LC (n = 28), followed by APC (n = 12), combined mechanism (CM, n = 6), and vertical shear (VS, n = 5). Three injuries could not be classified according to the Young and Burgess classification prior to the 'binder-off' radiograph. Two of these were subsequently classified as APC type 3 injuries (Table 2).

The most common injury according to the OTA/AO classification was the 61-B injury, most commonly of the B2 sub-type (Table 3). Six patients (11%) had concomitant acetabular fractures, bilateral in two patients. Two occurred in patients with 61-B1.1 injuries, three in patients with 61-B2.1 injuries and one in a patient with a 61-C3.1 injury.

Seven patients (13%) had significant anterior or posterior injuries (injuries that required or influenced surgical fixation) identified on the 'binder-off' radiograph that were not appreciated on the imaging in binder.

Four patients (7%) had injuries identified on 'binder-off' imaging which required surgical stabilisation, where imaging in binder had suggested non-operative management. Two of these patients (4%) had no pelvic abnormality detected on CT in binder, but had APC 3 injuries identified on 'binder-off' radiographs (Fig. 1a-f), with both symphyseal and sacroiliac joint (SIJ) disruption. Two patients had appearances suggestive of stable LC 1 injuries, one of which was revealed to be an LC 3 injury and the other an over-reduced APC 3 injury (Fig. 2a–b).

Three patients (6%) had injuries identified on imaging in binder that would have prompted operative intervention, or at least examination under anesthesia, but had previously unrecognized components of their injury identified on 'binder-off' imaging. One of these patients had an SIJ disruption and two had symphyseal diastases unmasked on binder-off imaging. The identification of the additional injuries with the 'binder-off' radiograph aided pre-operative planning in these three cases.

Discussion

Trauma CT has become a mainstay of investigating trauma patients in major trauma centres and other units [20]. It is generally considered to be more sensitive than plain radiographs for detecting pelvic injuries and early surgical planning is based on these findings [21]. The increased use of pre-hospital and 'on arrival' pelvic binder devices is effective in closing the pelvic volume providing mechanical stability and aiding resuscitation [7,8]. Computed tomography reveals a static image of the pelvis in the position it is held within the binder, and anecdotal reports exist of CT missing ligamentous pelvic ring injuries when performed with a pelvic binder in situ [14,15,17]. It has been shown that, even

Table 1
Patient demographics. Comparison of total number of operated patients and 'binder-off' patients.

	All Patients (N = 97)	'Binder-off' Group (N = 54)	P value
Gender (number, %)			0.61
• *Male*	57 (59%)	34 (63%)	
• *Female*	40 (41%)	20 (37%)	
Age (mean average, range)	40.53 (14–86)	37.33 (16–86)	0.41
Young & Burgess Classification (number, %)			
• *LC*	55 (57%)	28 (52%)	0.8
• *APC*	17 (18%)	12 (22%)	
• *VS*	6 (6%)	5 (9%)	
• *Combined*	15 (15%)	6 (11%)	
• *N/A*	4 (4%)	3 (6%)	