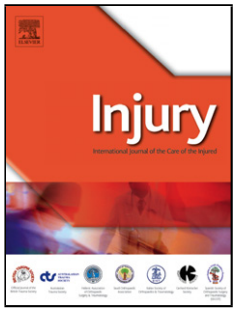

Title: Straight Leg Elevation to Rule out Pelvic Injury

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Straight Leg Elevation to Rule out Pelvic Injury

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Keywords: Pelvic fracture; Straight leg raise; trauma.

Abstract:

Objective: Pelvic x-ray is frequently used as a screening tool during initial assessment of injured patients. However routine use in the awake and alert blunt trauma patient may be questioned due to low yield. We propose a clinical tool that may avoid unnecessary imaging by examining whether the ability to straight leg raise, without pain can rule out pelvic injury.

Methods: We conducted a prospective cohort study with the exposure variables of ability to straight leg raise and presence of pain on doing so, and presence of pelvic fracture on x-ray as the primary outcome variable.

Results: Of the 328 participants, 35 had pelvic fractures, and of these 32 were either unable to straight leg raise, or had pain on doing so, with a sensitivity of 91.43% (95% CI: 76.94 – 98.2%) and a negative predictive value of 98.57% (95% CI: 95.88 – 99.70%). The 3 participants with a pelvic fracture who could straight leg raise with no pain, all had a GCS of less than 15, and therefore, among the sub-group of patients with GCS15, a 100% sensitivity and 100% negative predictive value for straight leg raise with no pain to rule out pelvic fracture was demonstrated.

Conclusion: Among awake, alert patients, painless straight leg raise can exclude pelvic fractures and be incorporated into initial examination during reception and resuscitation of injured patients.

Introduction:

Keywords: Clinical Decision-making; Diagnostic techniques & procedures; radiography; computer tomography; multiple trauma; shock, traumatic; fractures; pelvis; pelvic bones; leg; whole body imaging; physical examination; fractures, pelvis.

Fractures of the bony pelvis commonly result in injury to multiple large blood vessels and the resulting haemodynamic instability is associated with substantial morbidity and mortality. Trauma patients with haemodynamic instability have improved outcomes with early access to definitive management, best provided in centralised trauma centres [1]. Early recognition of haemorrhage and definitive management is important to improve outcomes [2,

3]. On arrival to a trauma centre, the American College of Surgeons Advanced Trauma Life Support (ATLS) recommends antero-posterior pelvic x-rays on all patients after blunt torso trauma for early detection of fractures that may be a potential source of haemorrhage.

The sensitivity of radiographs for pelvic fracture is low, reported at between 74 – 78%, but can be as low as 53% if posterior fractures only are present [4, 5, 6,], but they remain a routine investigation in trauma patients in many centres. The cost-effectiveness of a policy for routine pelvic radiography in the awake and alert blunt trauma patient may be questioned. Time costs during trauma resuscitation, potential adverse effects of additional radiation exposure and financial costs should be considered against utility of this practice [7-9]. Multiple clinical symptoms and examination techniques to exclude a pelvic fracture have been previously suggested. These include patient complaint of pelvic pain, pain on hip rotation, pain on pubic symphysis compression, pain on inward iliac compression, pain on posterior iliac compression, blood at penile meatus, perineal or scrotal hematoma and gross blood on rectal exam [10]. Clinical examination has been shown to be as sensitive as x-ray in diagnosing pelvic fracture [11, 12], however variations in examination techniques limit its utility in screening for pelvic trauma.

The act of straight leg raise (SLR) is a simple and objective method of clinical assessment, and we propose to investigate whether the ability of a patient to actively and painlessly straight leg raise during the primary survey rules out significant pelvic trauma. This would aid early clinical decision making regarding definitive management and disposition, and avoiding unnecessary investigation. The muscles involved with SLR (namely iliacus, iliopsoas, psoas major, sartorius and rectus femorus) all have their proximal attachments in the pelvis (except psoas major), mainly the iliac crest and iliac spine [13]. We hypothesise that attempting to painlessly utilise the muscles responsible for hip flexion and SLR in the presence of major pelvic bony injury will not be possible.

Methods:

Setting: The Alfred Hospital is a designated adult Major Trauma Service (MTS) in Melbourne, Australia. Prehospital major trauma triage guidelines direct 85% of major

trauma patients to one of two MTS for definitive treatment. Patients that meet trauma call-out criteria are received and undergo standardized trauma reception investigations that include a routine pelvis x-ray.[14]

Design: We conducted a prospective cohort study using convenience sampling. The ability to SLR whilst supine and presence of pain on doing so (in right and left leg) were the exposure variables being assessed. A pelvis fracture, as diagnosed by a radiologist on x-ray of the pelvis, was the primary outcome variable. Pelvic fractures were classified using the Young-Burgess classification, using LC (lateral compression) type 1, 2, 3, APC (Anterior posterior compression) type 1, 2, 3 and VS (vertical shear) (10). Ethical approval was obtained from The Alfred Hospital Research and Ethics Committee, and a waiver for informed consent granted.

Inclusion & Exclusion criteria: All patients who presented to the Emergency & Trauma Centre after a blunt mechanism of injury and were investigated with a pelvis x-ray were eligible for inclusion (including patients who did not fit trauma call-out criteria). The exclusion criteria were a presenting Glasgow Coma Scale score of <13, age 15 years or younger, evidence of spinal injury with sensory and/or motor level and presence of lower limb injury affecting ability to SLR.

Recruitment: Patients were recruited by the treating doctor if a pelvic x-ray was requested and the patient satisfied inclusion and exclusion criteria. Data were contemporaneously recorded by the treating doctor documenting ability to actively straight leg raise, and presence of pain on doing so in either leg (Appendix 1). The ability to straight leg raise was defined as the ability of the patient to actively raise their foot to any degree, off the bed. Demographic data and radiology findings were retrospectively extracted from electronic medical records.

Statistical analysis: Discrete numerical data were presented as counts with proportions, with significance of differences assessed using the chi-squared test or if value in a cell was <5, the Fisher Exact test was used. Continuous data were summarised using medians with interquartile ranges. Diagnostic ability of the ability to SLR without pain for pelvic fractures were presented using specificity, sensitivity, positive and negative predictive values with 95% confidence intervals. A p-value of <0.05 was considered to be statistically significant. The sample size required was calculated using an estimated prevalence of pelvic fracture of 15% among included patients and with 95% confidence to detect at least 99% of all diagnosed fractures. The estimated number of patients required to test our hypothesis was 340. All analyses were performed using Stata v. 11.3 (College Station, Texas, USA).

Results:

There were 367 patients recruited into the study. Of these, 31 were excluded due to the presence of lower limb trauma that would have affected their ability to SLR (Figure 1). A further 8 patients were excluded as although pelvis imaging was initially planned at the time of recruitment, this did not occur. This left a total of 328 participants for analysis.

The characteristics of the study participants are summarised in Table 1. The median age of participants was 46 years (IQR 29-68 years). Most of the participants were male (64%). The most common mechanism of injury was a fall of less than 3 metres or a motor vehicle crash of less than 100kph.

Of the 328 participants, 118 (36%) were either unable to SLR, or had pain on SLR. A pelvic fracture was present in 35 of the 328 participants (10.7%), and Table 4 describes these fractures using the Young-Burgess classification. Of these 35 fractures, 32 were either unable to SLR, or had pain on SLR (91.4%). Of the 3 participants who had a pelvic fracture and were able to SLR without pain, all three had a GCS of less than 15/15, and one was documented as having fentanyl in the ambulance prior to arriving.

Of the 328 participants, 272 had a GCS of 15/15, and 28 of these had a pelvic fracture. In a sub-group analysis of these patients, none of the participants with a GCS of 15/15 and a pelvic fracture were able to SLR without pain, giving 100% sensitivity.

Discussion

Among the sub-group of participants with a GCS of 15 all patients with a pelvic fracture, regardless of severity, were SLR without pain. These findings suggest that, in trauma patients presenting with a GCS of 15, painless SLR may be used as a screening tool to avoid routine pelvis x-ray. Performance among patients presenting with a GCS <15, or those who received opiates, was inadequate and this rule cannot be applied to such patients.

In the haemodynamically unstable patient, door to theatre time is critical for improved outcomes. [3] Efficient assessment can assist in minimising such times and recent amendments suggested to routine assessment include limited log roll examination among obtunded patients and delayed bladder decompression among patients with suspected pelvic haemorrhage.[15, 16] A bedside tool that allows physicians to make safe assessments regarding pelvic instability would be useful and minimise urgent

imaging. Painless straight leg raise in the alert trauma patient would exclude major pelvic fracture quickly, without the need for imaging, and aid time critical decision making regarding definitive management of other injuries. In the awake trauma patient, in the setting of haemodynamic stability, the pelvis x-ray may be at least delayed until clinical assessment of the pelvis through axial loading and mobilisation is possible.

Minimising radiation exposure to trauma patients is an important element to management, and is especially relevant following recent debate on the use of whole body CT [17]. While radiation exposure for pelvic x-ray is low, CT of the pelvis can be as high as 9mSv and whole body CT up to 28 mSv [18], and any reduction in the cumulative exposure of patients is beneficial, especially as many trauma patients receive imaging of more than one body region (e.g. CXR and pelvic x-ray), or serial imaging of a region. The ability to painlessly SLR would eliminate the need for pelvic imaging, and therefore substantially decrease the overall radiation exposure of trauma patients.

This study was adequately powered for it's primary hypothesis, but failed to disprove the null hypothesis among the proposed inclusion criteria of patients with GCS≥13. The findings do raise the hypothesis for further assessment of SLR to exclude pelvic fractures. Enrolment of patients was dependent on their treating physicians, and was thus limited by work load and physician awareness of the study. There was also potential bias in the data collection as physicians documenting ability to SLR were not blinded to the x-ray results (although it is likely that few were aware of the x-ray report at the time of data collection, only the x-ray itself). We limited the effect of confounders on the results by excluding participants with injuries that would limit their ability to SLR such as lower limb trauma, and spinal injury with a motor or sensory level. We also excluded those with a GCS that might affect their ability to either SLR or report pain. Analgesia given to participants may have increased their ability to SLR and may have been a confounding factor in the 3 patients with a pelvic fracture who could SLR with no pain. Also, as a screening tool, SLR is not specific, as indicated by the 86 participants (29.3%) who were unable to painlessly straight leg raise who did not have pelvic fractures.

Future directions for further study could include a larger study, possibly multi-centre, looking at the same end-points, using the more sensitive modality of CT as a comparison (sensitivity for pelvic fracture can approach 100% (19), which would test the validity of the SLR and presence of pain as a clinical test for pelvic fracture. As well as aiding quick clinical decisions in the unstable trauma patient, it may prove to

be a clinical device, similar to the NEXUS or Canadian C-spine rules in c-spine fracture, which could avoid unnecessary imaging in a population with low mechanism injuries.

Conclusion

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Conflict of Interest

On behalf of all authors I state that there is no conflict of interest to declare.

Dr Caroline Bolt

Corresponding author

Among awake, alert patients without spinal or lower limb injury, painless straight leg raise can exclude pelvic fractures and be incorporated into initial examination during reception and resuscitation of injured patients. This may reduce radiographic imaging and aid quick decision making when identifying a source of bleeding in trauma patients.

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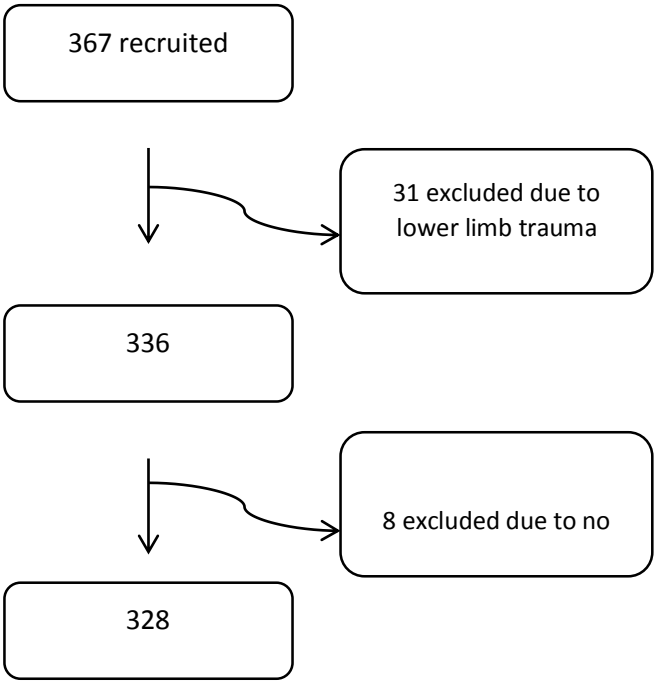
Figure Caption

Figure 1 : Flow of participants

Appendix 1 : Data collection sheet

Figure 1: Flow of Participants



Appendix 1 – Data collection sheet

SLERPIT trial – Straight Leg Elevation to Rule out Pelvic Injury in Trauma
4.10 project Dr Caroline Bolt

If you have ordered a pelvic x-ray please fill in the details below & place in the box in the trauma centre:

Patient sticker:

Is patient able to straight leg raise? (actively raise posterior knee and foot from bed)

Right leg:
Yes ☐ No ☐
Pain present? Yes ☐ No ☐

Left leg:
Yes ☐ No ☐
Pain present? Yes ☐ No ☐

Table 1: Patient demographics and presenting clinical features

Variable	Painless bilateral straight leg raise (n=210)	Pain or inability to straight leg raise (n=118)	p-value
Age (years)			0.50
• **16 – 24**	34 (16.2%)	20 (16.9%)	
• **25 – 34**	33 (15.7%)	20 (16.9%)	
• **35 – 44**	26 (12.4%)	23 (19.5%)	
• **45 – 54**	28 (13.3%)	10 (8.5%)	
• **55 – 64**	28 (13.3%)	11 (9.3%)	
• **65 +**	61 (29.1%)	34 (28.8%)	
Male sex	137 (65.2%)	74 (62.7%)	0.65
GCS			0.07
• **13**	4 (1.9%)	1 (0.9%)	
• **14**	38 (18.1%)	13 (11.0%)	
• **15**	168 (80.0%)	104(88.1%)	
Intoxicated	27 (12.8%)	3 (2.5%)	0.001
Mechanism of trauma			0.32
• **MVC**	67 (31.9%)	35 (29.7%)	
• **MBC**	23 (10.9%)	16 (13.6%)	
• **Fall >3m**	12 (5.7%)	9 (7.6%)	
• **Fall≤3m**	60 (28.6%)	33 (27.9%)	
• **Assault**	4 (1.9%)	4 (3.4%)	
• **Other**	44 (21.0%)	21 (17.8%)	
Thoraco-lumbar spine trauma	27 (12.8%)	30 (25.4%)	0.004

Table 2 – Primary outcomes

Exposure	Pelvic fracture N=35	No pelvic fracture N=293
Able to straight leg raise & no pain	3 (8.6%)	207 (70.6%)
Unable to straight leg raise, or pain present	32 (91.4%)	86 (29.3%)

Table 3 Performance of SLR & pain on SLR

Statistic	Value	95% CI
Sensitivity	91.43%	76.94 – 98.2%
Specificity	70.65%	65.07– 75.80%
Positive predictive value	27.12%	19.35 – 36.08%
Negative predictive value	98.57%	95.88 – 99.70%

Table 4 Young-Burgess classification of the 35 pelvic fractures

Patient ID	Young-Burgess Classification of pelvic fracture
283	LC1
194	LC1
323	LC1
216	LC1
309	LC1
365	LC1
40	LC1
56	LC1
69	LC1
8	LC2
5	LC2
13	LC1
319	LC1
58	LC1
57	LC1
43	LC2
36	APC2
162	APC2
128	LC1
75	LC1
113	LC1
117	LC1
157	LC1
154	LC1
153	LC1
192	LC2
181	LC2
242	LC1
328	LC2
305	LC1
359	LC1
356	LC2
348	APC2
343	LC2

Table 5 – Patients with pelvic fracture able to SLR with no pain (false negatives)

Patient ID	Young-Burgess Clasasification	GCS	Analgesia prior to exam
117	LC 1	14	Not documented
242	LC 1	14	Not documented
309	LC 1	14	Yes

Table 6 – Sub-group analysis: patients with GCS 15/15

Exposure	Pelvic fracture (%)	No pelvic fracture (%)
Able to straight leg raise & no pain	0 (0%)	168 (68.9%)
Unable to straight leg raise, or pain present	28 (100%)	76 (31.1%)

Table 7 – Performance of straight leg-raise to exclude pelvis fracture among patients with GCS=15

Statistic	Value	95% CI
Sensitivity	100%	87.66 – 100.00%
Specificity	68.85%	62.63 – 74.61%
Positive predictive value	26.92%	18.69 – 36.51%
Negative predictive value	100%	97.83 – 100.00%