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Use of the trauma pelvic orthotic device (T-POD) for provisional stabilisation of anterior—posterior compression type pelvic fractures: A cadaveric study

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Summary

Objective: To demonstrate that a commercially available pelvic binder the trauma pelvic orthotic device (T-POD) is an effective way to provisionally stabilise anterior—posterior compression type pelvic injuries.
Methods: Rotationally unstable pelvic injuries were created in 12 non-embalmed human cadaveric specimens. Each pelvis was then stabilised first with a standard bed sheet wrapped circumferentially around the pelvis and held in place with a clamp. After recreating the symphyseal diastasis, the pelvis was stabilised with the T-POD. Reduction of the symphyseal diastasis was assessed by comparing measurements obtained via pre- and post-stabilisation AP radiographs.
Results: The mean symphyseal diastasis was reduced from 39.3 mm (95% CI 30.95—47.55) to 17.4 mm (95% CI −0.14 to 34.98) with the bed sheet, and to 7.1 mm (95% CI −2.19 to 16.35) with the T-POD.

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Conclusions: Although both a circumferential sheet and the T-POD were able to decrease symphyseal diastasis consistently, only the T-POD showed a statistically significant improvement in diastasis when compared to injury measurements. In 75% of the cadaveric specimens (9 of 12), the T-POD was able to reduce the symphysis to normal (<10 mm diastasis). Both a circumferential sheet and the T-POD are effective in provisionally stabilising Burgess and Young anterior–posterior compression II type pelvic injuries, but the T-POD is more effective in reducing symphyseal diastasis.

Introduction

High energy forces are required to injure the pelvic ring. As a result, patients with pelvic fractures often have associated injuries and may be haemodynamically unstable.[7] In the Burgess and Young classification, anterior–posterior compression type (APC) pelvic injuries are associated with large amounts of blood loss.[10] In the setting of a vertical shear injury to the pelvis, patients presenting with hypotension were significantly more likely to die than those who were normotensive (44% versus 17%).[7] In patients presenting with an unstable pelvic fracture pattern and haemorrhagic shock, mortality over 50% has been reported.[8] Among all pelvic trauma patients, haemorrhage is the major reversible contribution to mortality in 42%.[9]

Provisional control of APC pelvic injuries in the emergency room can be an important component in the resuscitation and treatment of a haemodynamically unstable patient.[9,10] The AP pelvic radiograph taken in the trauma bay, along with physical examination, can be used to assess pelvic stability and initially classify pelvic fractures. Before patient transfer, one of several techniques, including bed sheets, pelvic binders, pelvic clamps, or external fixation, should be employed to temporarily stabilise pelvic injuries.[1,6]

Among these options, bed sheets and commercially available pelvic binders such as the trauma pelvic orthotic device (T-POD) each offer the advantages of timely, simple, non-invasive application while still allowing access to the abdomen and lower extremities.[6,14] The T-POD has been shown to provide significant stabilisation of open-book pelvic injury variants in human cadavers.[4,5] A clinical trial by Kreig et al.[11] suggests that the device is able to significantly reduce externally rotated pelvic fractures in an emergency setting.[12] We hypothesise that the T-POD is superior to simple bed sheet in reducing symphysis diastasis.

Materials and methods

Rotationally unstable pelvic injuries (Burgess and Young APC II, or Tile B1) were created in 12 non-embalmed human cadaveric specimens by sectioning the pubic symphysis and the anterior sacroiliac, sacrospinous, and sacrotuberous ligaments on the left side of the pelvis. Surgery was completed through an anterior approach to the symphysis for symphyseal sectioning and through the first window of the ilioinguinal approach for sectioning of the remaining ligamentous structures. All operations were performed by the same orthopaedic surgeon.

Pre-operative X-rays were obtained and none of the specimens had evidence of previous pelvic trauma. Following surgery, an AP pelvic radiograph was obtained and the symphyseal diastasis was measured. A ruler was used to position and standardise the X-ray bucky 40 cm from the pubic symphysis. This was done to ensure no magnification, thereby, producing radiographs exactly to scale. A magnification marker was used to confirm the scale and direct measurements were made from the AP radiographs. After images were obtained, the pelvis was stabilised in two manners. First, a standard bed sheet folded to a width of approximately 8 in. was wrapped circumferentially around the pelvis and greater trochanters, the symphysis was reduced, and the sheet was held in place with a clamp. The sheet was then removed, the symphyseal diastasis was recreated, and the symphysis was then reduced using the T-POD according to the instructions provided by the manufacturer (Fig. 1).

Reduction with each technique was guided by direct palpation of the symphysis. Each reduction was evaluated with an AP pelvic radiograph and measurement of the remaining symphyseal diastasis.

Results

The injury created in the cadaveric specimens resulted in a mean symphyseal diastasis of 39.3 mm with a range of 33–46 mm (95% CI 30.95–47.55). On average, use of the bed sheet reduced the symphyseal diastasis to 17.4 mm (range 3–38 mm, 95% CI −0.14 to 34.98), while the T-POD reduced the symphyseal diastasis to 7.1 mm (range 1–19 mm, 95% CI −2.19 to 16.35) (Table 1). In 75% of the cadaveric specimens (9 of 12), the T-POD was able to reduce the symphysis to normal (<10 mm

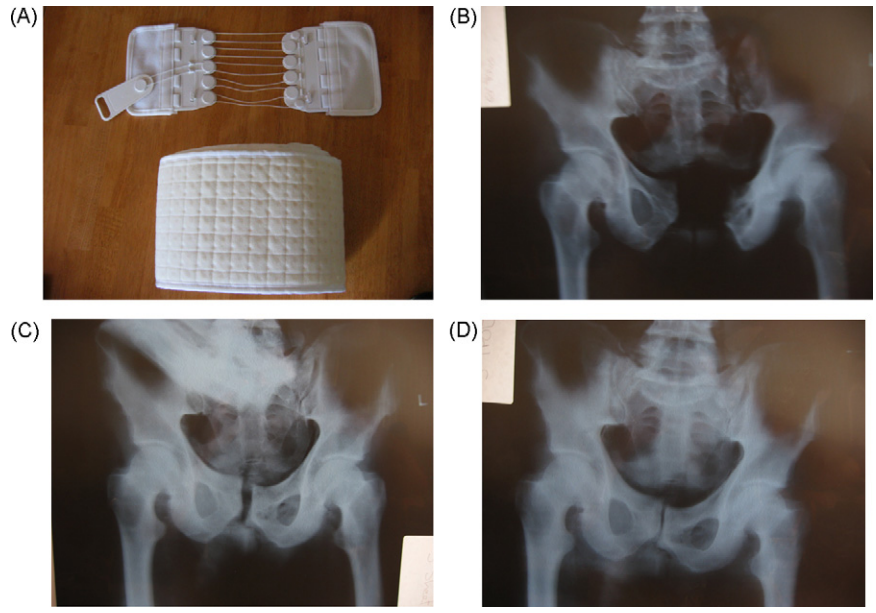

Figure 1 A picture of the T-POD (A), and an example of AP pelvic radiographs after creation of an APC injury (B), application of a sheet (C), and application of the T-POD (D).

diastasis). The symphysis was reduced to normal in 17% of the cadaveric specimens (2 of 12) using the bed sheet.

Discussion

The patient with an unstable pelvic fracture faces serious risk of death via haemorrhage. As part of the initial management of these patients, circumferential pelvic compression is typically applied to provide both tamponade and stabilisation of the bony elements.[1,6] As a result of this manoeuvre, the rate of haemorrhage from pelvic vessels is reduced, and the risk of further vascular injury secondary to mobile bony fragments is diminished. While the benefits of provisional pelvic stabilisation are well accepted, a consensus has yet to be agreed upon to distinguish among non-invasive techniques.

Past researchers have touted anterior pelvic external fixation as a routine intervention in even stable patients with pelvic fractures.[13] More recent protocols now call for non-invasive means of pelvic stabilisation to reduce the risks to patients during the initial resuscitative period and prior to operative stabilisation or angiography.[3] As opposed to external fixation, non-invasive pelvic stabilisation has been declared a safer, more time-effective, technically simpler method of effectively bridging the gap until definitive stabilisation.[9]

Table 1 Average symphyseal displacement of diastasis in the setting of injury, treatment with a circumferential sheet, or T-POD

	Average symphyseal diastasis (mm)	Range (mm)	95% Confidence intervals
Injury	39.3	33—46	30.95—47.55
Sheet	17.4	3—38	−0.14 to 34.98
T-POD	7.1	1—19	−2.19 to 16.35

A number of techniques of provisional pelvic stabilisation have been proposed and attempted with varying levels of acceptance. Pneumatic trousers and other inflatable garments have been associated with compartment syndrome and also restrict access to the abdomen and lower extremities.[14,15] Commercially available bean bags, straps, and binders have been limited due to their high cost and need for cleaning or replacement.[14,15] Because of their technically difficult application, pelvic C-clamps have been associated with numerous complications including perforation of the ilium, fracture fragment displacement, dislodgement of pins into the greater sciatic notch, and haemorrhage secondary to haematoma release, though a modified technique may reduce the incidence of such complications.[2] A standard bed sheet wrapped around the trochanters and held in place with clamps has been associated with necrosis of the underlying skin.[14,15,11]

The T-POD is a commercially available pelvic circumferential compression device that has been shown to provide pelvic stability comparable to the pelvic C-clamp and closely reapproximate the sym-

physeal diastasis.[4,5] Like the bed sheet, it can be applied more rapidly than external fixators, and requires no special training for proper placement.[4,13] While not as readily available as the ubiquitous bed sheet, the T-POD is not prohibitively expensive nor difficult to obtain. In the orthopaedic trauma literature, no distinction has been drawn between the two techniques.

Our results show that a commercially available pelvic binder reduces the symphyseal diastasis in APC type pelvic fractures more effectively than a circumferential bed sheet. Since both techniques are similarly easy to apply, inexpensive, and have low complication rates, commercially available pelvic binders may be a better choice for temporary pelvic stabilisation in the setting of an appropriate pelvic fracture pattern.

Our methodology is limited in some respects. In particular, it is possible that because we applied the sheet first and the T-POD second in all cases, the improvement in reduction seen with the T-POD is because the previous attempt at reduction facilitated symphyseal closure. In cadaveric specimens, however, there would be no haematoma or intervening soft tissue, which the first attempt could displace. The deformity was recreated and confirmed between attempts; furthermore, in a static situation such as embalmed cadaveric specimens the most likely conclusion would be that the force applied by the T-POD is simply greater than can be applied with simple sheeting.

Future work should clearly establish an association between pelvic stabilisation and favourable patient outcomes, such as decreased mortality and transfusion rates. Furthermore, since force only slightly in excess of that which is necessary to provide adequate stabilisation of the pelvis may induce skin breakdown,[14] close attention should be paid to potential complications associated with commercially available binders, such as pressure-induced necrosis of the skin.

Conclusions

Although both a circumferential sheet and the T-POD were able to reduce symphyseal diastasis consistently, only the T-POD showed a statistically significant improvement in diastasis when compared to injury measurements.

Both a circumferential sheet and the T-POD are effective in provisionally stabilising Burgess and Young anterior—posterior compression II type pelvic injuries; however, the T-POD is more effective in reducing symphyseal diastasis.

Conflict of interest statement

There are no conflicts of interest in this study and none of the authors received any financial contributions.

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