

P C S L I N G

Pelvic fractures are among the most devastating musculoskeletal injuries. They often cause life-threatening internal blood loss. Similar to cervical spine fractures, pelvic fractures require emergent stabilization, if possible, before patient transport.

In the past, EMS providers had few options to stabilize pelvic fractures in the field. Now, however, a study sponsored by the U.S. Office of Naval Research has led to the development of a device for the reliable, safe and effective stabilization of pelvic fractures. As a result, EMS personnel will soon be able to apply the newly developed Pelvic Sling in the field.

This article provides a brief review of pelvic fractures, describes research that led to the development of the new device and explains how EMS providers can easily apply the Pelvic Sling.

Pelvic ring fractures

Fractures of the pelvic ring can result from falls from height, crush-type injuries or forceful blows sustained during motor vehicle accidents. In general, the pelvic ring either collapses, causing a lateral compression fracture, or expands, causing an "open book" fracture (as shown in Figure 1, p. 86). In both scenarios, the pelvic ring typically breaks in the front through the pubic bone, or symphysis pubis, and/or in the back at the sacroiliac joint.

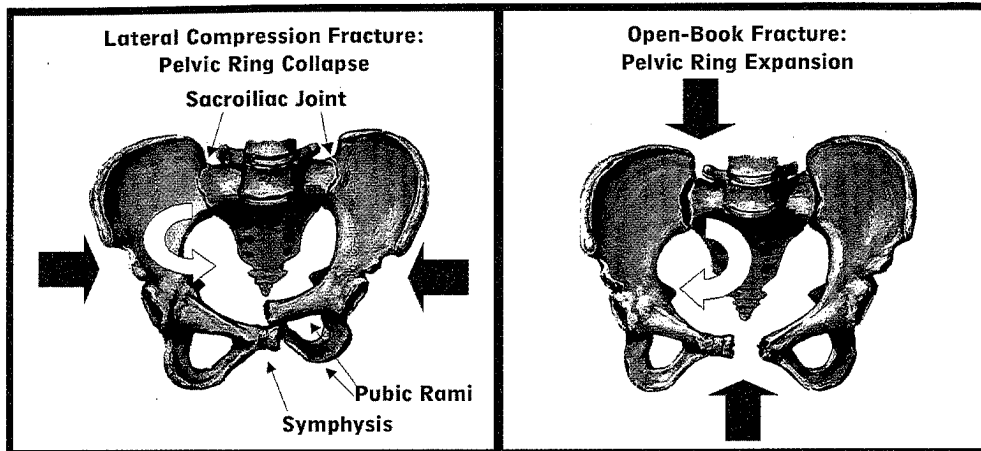
With an unconscious patient, providers can have difficulty recognizing a pelvic ring fracture on scene at an incident. Although blood loss may not be visible, massive internal bleeding from the venous plexus often occurs. This internal hemorrhage is the leading cause of death in patients with pelvic ring fractures.

Pelvic stabilization saves lives

Pelvic fracture stabilization in the field within the golden hour is most effective for controlling pelvic hemorrhage. Pelvic stabilization is especially important during patient

PELVIC SLING |

Figure 1: Common Types of Pelvic Ring Fractures



rescue and transport. Any motion between the torso and lower limbs can cause severe shifting of a fractured pelvis, jeopardizing coagulation and blood clot formation.

To stabilize a fractured pelvis before patient transport, Military Antishock Trousers (MAST) have been used, but complications and uncertain efficacy now contraindicate their use. Therefore, the

American College of Surgeons Advanced Trauma Life Support (ATLS) guidelines recommend wrapping a sheet around the broken pelvis for emergent stabilization (see "Pelvic Sheet Wrap, June *JEMS*).

Although this innovation is simple and readily available, emergency personnel aren't always certain how to properly apply a sheet. During

interviews of medical personnel at a Level I trauma center, recommendations for sheet applications ranged from "loose" to "very tight." So four years ago, a trauma surgeon approached Legacy Clinical Research & Technology Center, Portland, Ore., to come up with a better way to stabilize pelvic ring fractures in prehospital settings.

Research answers crucial questions

Because of the lack of clear instructions on sheet application and data documenting the benefits of applying a sheet to a broken pelvis, the U.S. Office of Naval Research supported a Legacy Biomechanics Laboratory study to develop a stabilization device for controlled, safe, pelvic fracture stabilization.

The device would have to provide the proper amount of tension at the right place to best stabilize a broken pelvis. Further, the device should shield the broken pelvis

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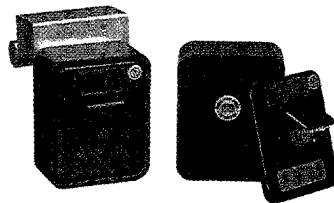
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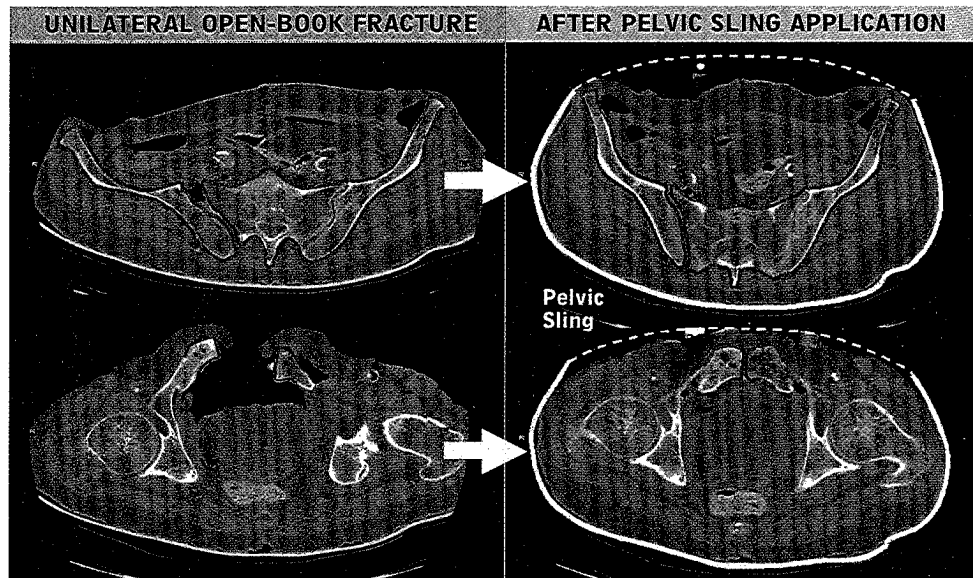
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PELVIC SLING I

Figure 2: CT of a Fractured Pelvis Before & After Stabilization with the Pelvic Sling



from excessive, potentially harmful forces.

To develop this device, we conducted laboratory studies on human cadaveric specimens and posed four key questions:

1. How should a Pelvic Sling

be applied to best reduce and stabilize the pelvis?

2. How tightly should a Pelvic Sling be applied?
3. How effectively can a Pelvic Sling stabilize a fractured pelvis?

4. How safe is this intervention if applied to a variety of pelvic fracture types?

Results of the three-year research effort defined the proper force required to reduce and stabilize a pelvic ring fracture.^{1,2}

Most interestingly, results showed that applying the Pelvic Sling around the hip's greater trochanters and symphysis pubis is more effective than applying it around the iliac crest of the waist.

Applying the Pelvic Sling with proper tension around the hip reliably reduced open-book type pelvic fractures (see Figure 2). It also dramatically improved mechanical stability. In fact, the Pelvic Sling delivered as much stabilization as an invasive pelvic C-clamp, which can only be applied in the hospital after patient transport.

The main concern regarding the Pelvic Sling's safety arises from the fact that it's difficult to assess pelvic fracture type on scene. In a

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PELVIC SLING I

worst-case scenario, the Pelvic Sling may be applied to a highly unstable lateral compression fracture, which is susceptible to over-compression. However, research demonstrated that even in this worst-case scenario, Pelvic Sling application with proper tension remained safe and didn't significantly over-compress the pelvis.

Hospital tests

Laboratory investigations led to the development of an advanced Pelvic Sling that automatically limits applied tension to a safe, proper level. During the past year, this Pelvic Sling has been routinely applied at two Level I trauma centers in a prospective clinical trial, which proved the efficacy and safety of the Pelvic Sling in a real-world environment. The clinical trial also showed that the Pelvic Sling was well-tolerated and didn't cause ischemia or skin breakdown, even if applied for as long as five days. (Details of this clinical trial and the advanced Pelvic Sling can be found at www.pelvic sling.com.)

How the Pelvic Sling works

The Pelvic Sling is a noninvasive device that wraps around the patient's hip (see Figure 3A). The sling's side and back portions are comfortably wide and soft, and allow for passage of air without stretching. The Pelvic Sling is narrower at the front to allow better access to critical areas of interest in the polytraumatized patient: the perineum and the abdomen.

Both ends of the sling are guided through a buckle, placed approximately over the symphysis pubis. Pulling on both ends of the sling in a lateral direction gradually and symmetrically increases sling tension and reduces the pelvis. It provides equally distributed compression to the soft tissue envelope surrounding the hip, which in turn stabilizes the pelvic ring.

Application around the hip's soft tissue envelope effectively prevents direct compression of prominent bony structures, which could otherwise affect the reduction quality.

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Figures 3



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Figure 4



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Figures 3A & 3B: The Pelvic Sling Concept & Device

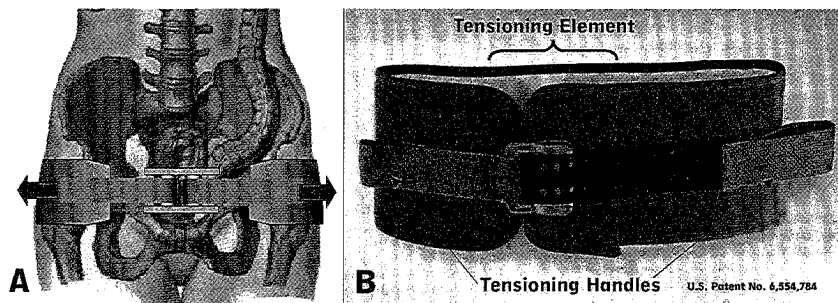
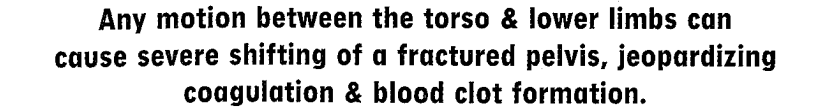
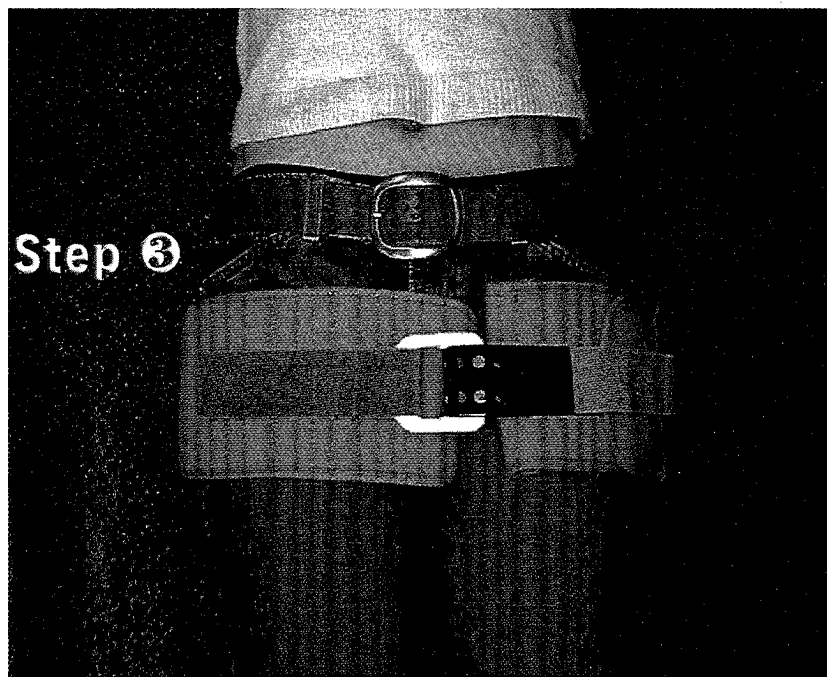
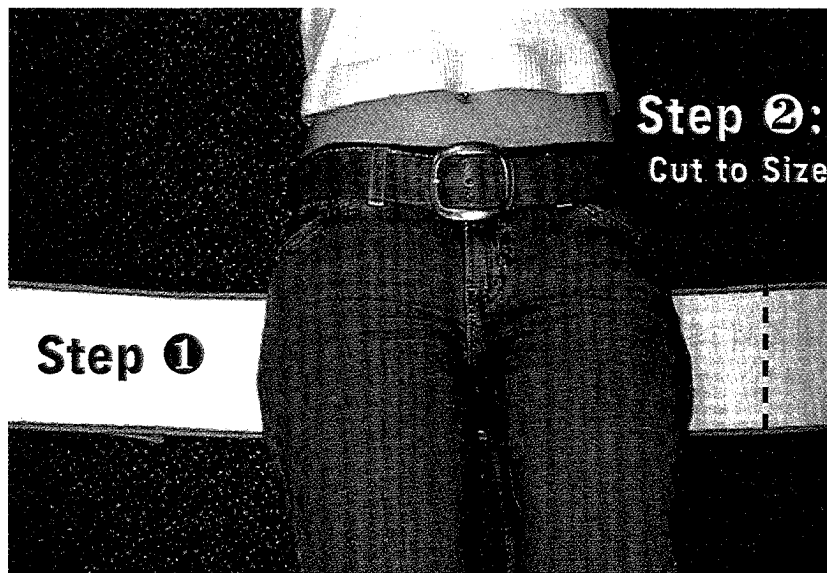


Figure 4: The 3-Step Application Procedure



Any motion between the torso & lower limbs can cause severe shifting of a fractured pelvis, jeopardizing coagulation & blood clot formation.

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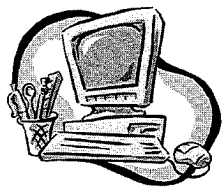
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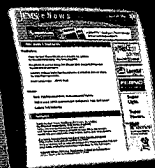
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PELVIC SLING

anism that automatically limits the force applied to the pelvis to the proper level (see Figure 3B, p. 91). When proper sling tension is reached, a mechanical stop, along with a clicking sound, indicates that the pelvis is properly stabilized. This ensures reduction of pelvic ring fractures in a safe, consistent manner, regardless of the amount of tension applied by emergency personnel. Proper sling tension is maintained by pressing the tensioning handles onto the lateral sections of the Pelvic Sling, where they're held in place by Velcro® closures. If required, the tensioning handles can be released and retensioned within seconds.

Applying the Pelvic Sling

The Pelvic Sling is applied in three simple steps, starting with the patient lying flat on their back (see Figure 4, p. 91).

When proper sling tension is reached, a mechanical stop, along with a clicking sound, indicates that the pelvis is properly stabilized.

Step 1: Place the Pelvic Sling around the hip at the level of the greater trochanters and the symphysis pubis. Achieve this by gently lifting the patient slightly to slide the sling under the pelvis or by sliding the sling up from under the patient's legs.

Step 2: Cut the sling ends to size or fold them inside to avoid overlapping of the ends anteriorly.

Step 3: Attach the tensioning unit—containing the tensioning handles and the sling buckle—and apply tension. Although a single rescuer can tension the sling, two people can accomplish it more conveniently.

The Pelvic Sling can typically be applied in less than five minutes and can remain in place for several days until definitive surgical stabilization of the pelvic ring can be provided. However, in cases of prolonged application, skin conditions should be monitored. Although the Pelvic Sling can easily be released and retensioned,

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Figure 5: The Pelvic Sling Features a Lightweight, Compact Design



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Early pelvic stabilization is a potential- ly lifesaving intervention, and patients with open-book pelvic fractures are most likely to benefit from this intervention. The risk for adverse effects in case of alternative fracture patterns is minimal due to the provision of circumferential compression at a proper, safe level.

Once the patient arrives at the hospi- tal, the Pelvic Sling can also facilitate the application of an anterior external fixator for definitive pelvic stabilization by maintaining pelvic reduction during fix- ator frame application.

Typically be ninutes and several days ilization of provided. nged appli- d be mon- c Sling can tensioned,

avoid these actions if possible. Leaving the device in place promotes and pre- serves hematoma formation and helps avoid renewed bleeding.

Indications

The Pelvic Sling serves as an emergent, temporary intervention to reduce the risk of exsanguination from diffuse pelvic hemorrhage before definite pelvic stabilization can be provided. Therefore, emergency personnel should apply the Pelvic Sling in the field on suspicion of pelvic ring fractures to stabilize the pelvis before patient transport.

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Considerations for use in EMS

The Pelvic Sling is lightweight, radiolu- cent and almost invisible on X-ray, with

the exception of two stainless-steel compression springs (see Figure 5). It can remain on the patient for CT and MRI procedures.

The waterproof, noncorrosive sling can function through extreme ranges of normal ambient temperatures. Its simple, intuitive functionality allows for applica- tion by personnel with minimal training.

The Pelvic Sling is a one-size-fits-all disposable device that can be conveni- ently cut to the appropriate size. It automatically applies the proper amount of tension at the right place to stabilize a fractured pelvis. Although the device hasn't been tested for adolescent use, pelvic ring fractures in the adolescent population are rare.

Availability

A commercial version of the Pelvic Sling is available through The Seaberg Company—inventors of the SAM Splint—at 800/818-4726, via e-mail at Seaberg@samsplint.com or online at www.samsplint.com. JEMS

Michael Bottlang, PhD, is research director of Legacy Biomechanics Laboratory, Portland, Ore., and adjunct professor at Oregon Health & Sciences University. The National Institutes of Health primarily funds his research. His efforts in the field of applied interdisciplinary research have yielded several devices and patents to improve patients care. Contact Bottlang via e-mail at mbottlan@lhs.org.

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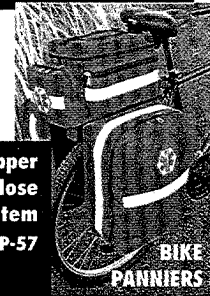
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