New Concepts in the Prehospital and ED Management of Pelvic Fractures

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Abstract

Trauma surgeons worldwide agree on the importance of stabilizing pelvic fractures during the critical golden hour following severe trauma. Because of the potentially devastating hemorrhage associated with such fractures, standard first aid protocol has included applying some type of circumferential binder around the victim's hips. Until recently, there was no reliable device or binding technique for use in the field and emergency departments (EDs). Sheets as well as commercially available binders are options but all of these devices are inexact and provide no precise scientific control on the amount of circumferential compressive force applied to the patient. Legacy Health Systems (Portland, OR) initially developed and tested a pelvic circumferential compression device (PCCD) (pelvic sling) in the laboratory using cadavers. This study was followed by a prospective clinical trial. In both studies, the PCCD provided effective reduction of open book pelvic injuries without causing over reduction of lateral injuries. In the laboratory study researchers established the optimal placement location and range of compression force to achieve safe and effective reduction. The clinical trial involved 16 patients with pelvic ring injuries. The PCCD was used on all patients for temporary stabilization until definitive stabilization was provided. The PCCD significantly reduced pelvic width for external rotation fractures, and approximated the reduction in closure to that of definitive stabilization. With internal rotation fractures, the PCCD did not cause significant over reduction and no complications were observed. Additional clinical experience by the author's EMS Units in Bellingham and Whatcom County Washington, USA, has demonstrated a 50% mortality rate reduction based on application of the Legacy developed PCCD to 42 patients in pre-hospital and emergency departments, of which over 50% had significant, open book or SI joint displaced, pelvic fractures.

MeSH Words: pelvic fracture, stabilization, trauma, hemorrhage, fixation, binder

Introduction

Pelvic ring fractures are associated with a high incidence of mortality and remain the third most common cause of death in motor vehicle accidents (4). Hemorrhage is the leading cause of death in patients with pelvic ring fractures. Blood loss occurs mainly from injury to the sacral venous plexus, from fracture surfaces, and from the surrounding soft tissues. The application of a circumferential compression force device to stabilize (splint) open book pelvic fractures is believed to be an effective strategy to reduce hemorrhage(4). Consistent with the

accident scene such a device should be applied as soon as practically possible. The application could occur at the accident scene or in the emergency department. Early stabilization (splinting) of a pelvic fracture is potentially beneficial on multiple levels. 1) it promotes and protects clot formation at the fracture site by minimizing motion. 2) circumferential compression diminishes pelvic volume which in theory would help tamponade venous bleeding. 3) pelvic splinting contributes to patient comfort. This may reduce the need for narcotics and will facilitate transport. Various non-invasive techniques and devices are available to provide emergent stabilization of pelvic ring fractures at the accident scene, and in the emergency department. These include vacuum beanbags, inflatable military anti shock trousers (MAST), and circumferential pelvic wrapping with sheets4-6. Also, there are various commercial devices such as the Dallas Binder®, and the T-POD®. None of the above mentioned devices, however, were developed utilizing evidence based scientific inquiry.

Laboratory and Clinical Trials

In part, based on the lack of peer-reviewed research, documenting the benefits of applied circumferential force, the U.S. Office of Naval Research, U.S. Department of Defense, funded a 3-year grant to support Legacy Biomechanics Laboratory (Legacy Health System, Portland OR). The grant was funded to develop a pelvic circumferential compression device (PCCD) for controlled, safe stabilization and reduction of pelvic fractures. In developing this device, Legacy set out to answer several key questions, namely:

1. How should the PCCD be applied to best reduce and stabilize the pelvis?

2. Where the PCCD should be applied?

3. How much compressive force should be applied to the pelvis?

4. How effective can a PCCD be in stabilizing a fractured pelvis?

5. How safe is the sling device in preventing unnecessary injury, when applied to a variety of types of pelvic fractures.

Cadaver Studies

Human cadaveric specimens were used in the Legacy study to answer the questions posed above(1,3) . Results from the study defined the proper force required to stabilize and reduce a pelvic ring fracture to be 150-180N (15-18 Kg). Results showed that applying the Sling around the hips at the level of the greater trochanter or symphysis pubis is more effective than applying it around the iliac crest or at the waist. Applying the Sling at the correct level, and force, reliably reduced open-book type pelvic fractures created on the cadavers and dramatically improved mechanical stabilization. The tested Sling, intended for pre-hospital (field) and ED use, provided as much stabilization as an invasive pelvic C-clamp, which can be only applied in the ED or operating room environment. Furthermore, cadaver research demonstrated that the Sling would not over reduce highly unstable lateral compression (internally rotated) pelvic fractures.

Clinical Trials

A unique feature of the PCCD was an auto-stop buckle containing two stainless steel precision springs designed to limit and stop circumferential compression at the desired force (140N). Over a 16-month period, a prospective clinical trial involving 16 adult patients (>16 years) was conducted (3 patients were excluded due to incomplete radiographic data)2. Seven patients had partially stable pelvic ring fractures (OTA 61-B) and six patients had unstable pelvic ring injuries (OTA 61-C). All were admitted to two Level 1 trauma centers (Legacy Emmanuel Hospital and Oregon Health & Science University), both in the city of Portland, Oregon (USA). Six patients arrived at ED with a sheet wrapped around the pelvis, two patients were stabilized with MAST trousers, and the remaining patients had no circumferential stabilization. Upon admission to ED, a plain anteroposterior (AP) pelvic radiograph was obtained to assess the fracture pattern. Pelvic inlet and outlet views were routinely obtained and definitive fracture classifications were made with computed tomography (CT). A third AP radiograph was obtained after definitive stabilization. The PCCD was applied around the patient's pelvis at the level of the greater trochanters to temporarily reduce and stabilize the fractured pelvic ring. The PCCD consisted

of a 15cm wide belt comprised of soft batting material which did not stretch. Both ends of the anterior belt portion of the PCCD were guided through a buckle. Tension was applied by pulling on both ends in the opposite direction until the central buckle stop the pull after reaching 140N.

The average ISS was 24.7, range 10-57. Average blood requirements over the first two days were 3208 mL (red blood cells) and 4420 mL (total blood products).

The studied PCCD significantly reduced pelvic width for external rotation fractures by 9.9±6.0%, and approximated the reduction in closure achieved with definitive stabilization (10±4.1%). In patients with internal rotation fractures, the PCCD did not cause significant over compression. No complications were observed with any patients.

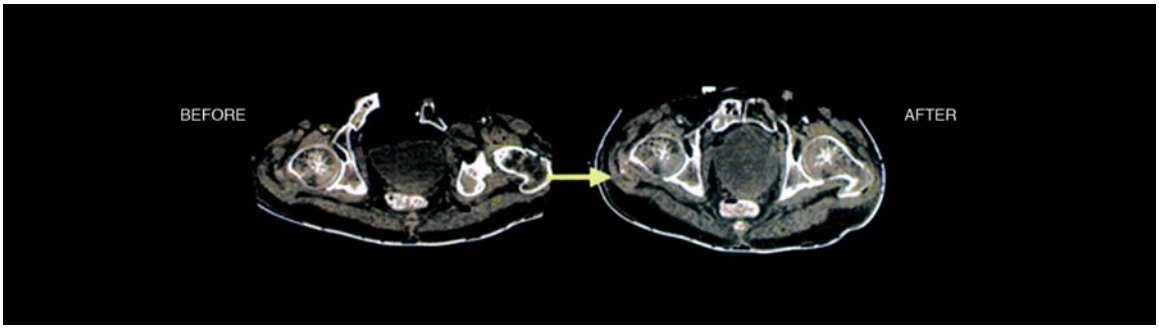
Over the past 15 months the author of this article has been collecting data on the use of a commercial product based on the Legacy developed PCCD (SAM Sling®, SAM Medical Products, Newport Oregon, USA). Data was collected by the Medic Units in Bellingham and Whatcom County, Washington (USA). To date the Sling has been used on 42 patients in the pre-hospital and ED (ED is at single hospital with a level II trauma center). Over 50% of these patients were found to have significant pelvic fractures. While the number of patients treated has not reached a level of statistical significance, the device has reduced the mortality in all of the patients with significant injuries by over 50% based on ISS scores (average 25.2, range 9-55). The author has extended use of the PCCD to all EMS providers in our community at the emergency medical technician (EMT) level and higher. He has also included the device as part of the continuing education program for all EMS providers. The PCCD allows our EMS, and physician, providers to apply safe and effective circumferential compression at the accident scene or in the ED to help reduce morbidity and mortality in patients with pelvic fractures. Indications for application is a high level of suspicion of significant pelvic injury. This will be based on subjective complaints, physical findings or mechanism of injury.

Conclusion

The results of the laboratory and clinical study and experience with use over time suggest the PCCD can rapidly reduce and stabilize open-book pelvic ring fractures. The PCCD has not caused complications when applied to a range of pelvic ring injuries, including internal rotation injuries that are prone to internal collapse. The PCCD can be applied by EMS providers, (EMT and above) at the accident scene for early and effective stabilization before, and during, transport, or by physicians in the ED.

Figure 1: Sling Applied by Two People

Figure 2: Pre and Post Application



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Note:

The pelvic circumferential compression device (PCCD) is available commercially as the SAM Sling®) from SAM Medical Products, Newport, Oregon, USA.

Author disclaimer:

The author has no financial relationship with SAM Medical Products or any other company manufacturing pelvic stabilization devices.

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