Combat Ready Clamp
medic technique

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Background
Junctional hemorrhage control device use on the battlefield might be lifesaving, but little experience is reported. The purpose of the present case report is to detail prehospital use of the Combat Ready Clamp (called the CRoC by its users, Combat Medical Systems, Fayetteville, NC; Instructions for Use, 2010) in casualty care in order to increase awareness of junctional hemorrhage control. Methods: The CRoC was used to control difficult inguinal bleeding on the battlefield for an Afghani man with a hindquarter traumatic amputation. Results: The device promptly controlled exsanguination from a critical injury when placed during rotary-wing casualty evacuation. The flight medic applied the device in 90 seconds. The device performed well without complications to control bleeding. Discussion: The CRoC, a new junctional hemorrhage control device, was used as indicated on the battlefield with mechanical and physiologic success and without device problems. By controlling difficult inguinal bleeding resulting from battlefield trauma, the device facilitated casualty stabilization and delivery to a surgical facility. The device facilitated the ability of a new flight medic to focus his expertise on a critically injured battlefield casualty with demonstrable success.

Introduction
In the current war in Iraq and Afghanistan, junctional injuries—wounds at the junction of the trunk and its appendages—recently became the most common battlefield cause of potentially preventable death.1-6 The Committee on Tactical Combat Casualty Care (CoTCCC), and the U.S. Defense Health Board made development of a junctional tourniquet a research priority and the U.S. Army Medical Research and Materiel Command made a Request for Information which spurred development of a hemorrhage control device, the CRoC. In 2010, the U.S. Food and Drug Administration (FDA) cleared the CRoC as indicated for difficult inguinal bleeding on the battlefield. The CRoC was the first device so indicated (Figure 1).7,8 The CRoC was designed and manufactured to assist a knowledgeable user with the control of exsanguinating hemorrhage from an anatomically complex region. Approximately 80 devices were distributed to Special Operations Forces (SOF) in November 2010. Now approximately 500 CRoCs have been sold and an estimated 125 are in theater, mainly with SOF units. The CRoc has no formal military service-wide training or doctrinal fielding regimens developed as policy has not yet been developed and formalized. The CoTCCC approved the device in 2011 and offered its own guidelines. There has been little reported on CRoC training or use. Houston physicians at press time notified the CRoC distributor of the first civilian use of a CRoC. The successful emergency use of the CRoC to stop difficult inguinal bleeding prehospital was for one patient in September 2012. The first publishable case presented here was of battlefield use the CRoC that occurred in 2011. The purpose of the present case report is to detail prehospital use of the CRoC in casualty care in order to increase awareness of an innovative, and in this case, successful method of junctional hemorrhage control.

Technique: Control Difficult Inguinal Bleeding with a Combat Ready Clamp (CRoC)
- Remove the CRoC from its case (Figure 2).
- Extend the vertical arm up from its base plate (Figure 3A).
- Lift the horizontal arm locking pin and insert the horizontal arm into the vertical arm (Figure 3B).
- Insert the T-handle into the horizontal arm head and turn the T-handle clockwise to seat it (Figure 3C).
- Snap the disc head onto the tip of the T-handle (Figure 3D).
- Push vertical arm locking pin in to slide vertical arm up to a height to fit over casualty (Figure 3E).
- Slide the base plate under casualty to target the wound or pressure point (Figure 4A).
- Slide the base plate in until the vertical arm touches casualty‘s side near the target (Figure 4B).
- Put the disc head over the target to be compressed.
- Adjust the horizontal arm length by using its locking pin (Figure 4C).
- Adjust vertical arm by using locking pin to press disc head onto target to slow bleeding.
- Turn the T-handle clockwise to compress the target until bleeding stops (Figure 4D).
- Snap the buckle and remove the slack from the strap (Figure 4E).
- Write the application time on the strap label.
- When moving the casualty during CRoC use, be careful not to displace the CRoC.
- For litter loading, roll the casualty onto the uninjured side, place litter,and roll the casualty onto litter.
- To keep CRoC in place, transport casualty on uninjured side, or pad and raise injured side (Figure 5).
- Reassess and adjust casualty and clamp as indicated.

- Removal of the CRoC should occur only at a surgical care facility (Figure 6).
- To remove: Unsnap the strap buckle (Figure 6A).
- Turn T-handle counter-clockwise until disc head clears the casualty (Figure 6B, C).
- Roll the casualty slightly onto the uninjured side and slide the CRoC out and away for removal.

Case Report

In 2011, an Afghani adult male (approximately 30 years old) was injured in an explosion at a road junction near a village in Kandahar province, in southern Afghanistan. An emergency request for medical care went to a U.S. Army aero-medical evacuation military unit deployed in the area where the injury occurred. The response time of the helicopter team to arrive at the point of injury was several minutes. The casualty's left hindquarter amputation injury (including lower extremity loss through the groin) was in the proximal inguinal area, too high for regular tourniquet. Upon arrival of the helicopter team, the casualty was alert and oriented but in mild hemorrhagic shock with little active hemorrhage. The casualty was placed into the aircraft, and the flight medic made an effort to relocate remnants of the thigh with his hands in order to apply a regular tourniquet, but the remaining tissue could be neither gathered nor compressed – the extent of the wound was too proximal. At aircraft takeoff, hemorrhage from this site became severe and uncontrolled. The medic applied manual pressure first with a hand, then with a knee, obtaining transient hemorrhage control while grasping and preparing his CRoC for use. The onset of hemorrhagic shock with its concomitant deterioration of alertness risked airway compromise. The CRoC was assembled and applied in approximately 90 seconds resulting in prompt and sustained hemorrhage control. A bulky dressing was then placed under the disc head as the wound was larger than the disc head. The point of application of the CRoC and compression (hand and knee) was in proximal control of the external iliac artery just proximal to the inguinal fold. Attention was turned to assessment and management of the patient's airway, but the patient was sufficiently stabilized and shortly thereafter arrived at an Afghan hospital near Kandahar. Given the few resources at this facility, the Afghanis triaged the casualty to be expectant. The CRoC remained effective throughout its use without problems or complications. The Afghanis removed the device, and the casualty promptly exsanguinated. The flight medic then recovered the CRoC, and it was sanitized and stowed for future use. The CRoC remained with the coalition forces when the unit was replaced upon redeployment. The flight medic managing this case was twice trained in CRoC use. First was as a prior medical sergeant at Special Operations Combat Medic Skills Sustainment Course at Fort Bragg, NC; the second was near Kandahar in October 2011, with a medical sergeant from the U.S. Army's Test and Evaluation Command. This medical sergeant gave the CRoC to the flight medic for use by his unit. The unit had not previously considered purchasing a CRoC in part because of limited unit funds, but also due to limited awareness of the CRoC itself, and the type of hemorrhage control. The flight medic who used the CRoC was on his sixth deployment with a total of 39 months of experience as a medic deployed in combat. The flight medic provided an after action review on his CRoC experience. On the CRoC's design, the medic noted that the disc head to apply pressure may need to be wider to contact a larger surface, to affect a larger area, and thus to be more effective and safe. A training gap in the experience was that the training did not emphasize enough the importance of using an aid— such as a bystander—to apply manual compression for wound hemorrhage control during CRoC assembly by the CRoC-trained user. Otherwise, hemorrhage may be temporarily uncontrolled during assembly and application (about 90 seconds). The review revealed that the user needs to do many things with his hands and mind sometimes for multiple casualties in little time; aid of a helper and a device can free up the user both initially and thereafter. During the unforgiving minute of CRoC need, the user is saturated with tasks such as hemorrhage control, CRoC assembly, and instructing bystanders. As the battlefield is imperfect for best care, the availability and skill of bystanders is routinely inadequate which makes medic self-sufficiency important in this case by CRoC use. The flight medic's review provided feedback on what other medics experienced in CRoC training; they did not use any CRoC in care. They found the CRoC hard to learn to use properly. Anatomy was complex, exsanguination fast, casualty transfer complicated, and so the medics felt they were likely to fail. They complained that the device was bulkier than a tourniquet and was clumsy in application in that it required new manual skills with additional training. The stark difference between the training experience among the medics and the flight medic indicates that the training quality or quantity may have differed or the attitude of the users differed. The flight medic relayed at his August presentation to the CoTCCC in Florida that increased awareness of the CRoC may increase acquisition of CRoCs for potential use.

Discussion

This is the first reported use of the CRoC in a critically injured casualty where a new junctional hemorrhage control device was used as indicated on the battlefield with prehospital success and without device problems. By describing the technique of use, increased awareness of junctional bleeding, including a personal experience of treating a casualty with difficult-to-control inguinal bleeding on the battlefield, medical leaders and trainers can prepare health care personnel and first responders to become proficient in the device's use before needing it on a real-world casualty. Preparation and training decrease the time required to assemble and apply the device, decreases the duration and degree of exsanguination, and may decrease morbidity and mortality from such critical injuries. An additional finding of the present case report was that the device worked well in multiple ways. The device operated as intended by controlling difficult inguinal bleeding on the battlefield. The device stabilized the casualty for successful delivery to a surgical facility. The device did its job by decreasing the rate of hemorrhage, keeping a casualty alive for enough time to get him to the local hospital with its surgical capability. The device allowed the flight medic to do his job well, which included using a new device under battlefield conditions on a critically injured casualty for his first time; the mechanical success of the first use was just as intended. The need for having an extra set of knowledgeable hands is so common in damage control situations – such as in the present case – that there is an emerging battlefield doctrine, not yet fully enacted, of making two or more medical personnel available in such situations in order to maximize survival rates. Devices that substitute for extra hands can help but must be balanced in a Soldier's load. There are several limitations of the present case report. A case report cannot prove or disprove hypotheses but simply increases awareness of a specific topic like use of a new hemorrhage control device on the battlefield.

Conclusions should not be drawn on one observation, but a useful observation can serve as a base for a larger series that may validate new technology and spur faster fielding. The hospital where the casualty was brought had few resources; the severity of the case reported exceeded the resuscitative capacity of the hospital. Given the decision to triage the casualty as expectant without further resuscitation attempted at the local hospital, safety and effectiveness data of the CRoC was limited to its prehospital use and survival-to-hospital. The duration of use in this case was less than 60 minutes, a time found to be safe. Future directions for research include laboratory and field study of the CRoC other junctional hemorrhage control devices for safety and efficacy, junctional bleeding itself, operational implementation of newly fielded devices or interventions, refinements in design of devices, and study of longer durations of use beyond 60 minutes.

By reporting a case of junctional hemorrhage in need of control on the battlefield, we hope to increase awareness of hemorrhage control device use with these types of proximal exsanguination injuries.

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