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TACTICAL COMBAT CASUALTY CARE: TRANSITIONING BATTLEFIELD LESSONS LEARNED TO OTHER AUSTERE ENVIRONMENTS

Junctional Hemorrhage Control for Tactical Combat Casualty Care

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During historic, as well as more recent, conflicts, most combat casualties who die from their injuries do so in the prehospital setting. Although many of the injuries incurred by these casualties are nonsurvivable, a number of injuries are still potentially survivable. Of those injuries that are potentially survivable, the majority are truncal, junctional, and extremity hemorrhage. Novel and effective approaches directed toward prehospital hemorrhage control have emerged in recent years, some of which can prove useful in the management of junctional hemorrhage whether in a military or civilian setting. An initial comprehensive review of junctional tourniquets was conducted by the Department of Defense Committee on Tactical Combat Casualty Care in 2013. The objective of this article is to provide an updated review of junctional hemorrhage control efforts and devices as they apply primarily to military prehospital trauma management and Tactical Combat Casualty Care and to prompt further consideration and application of these devices in nonmilitary prehospital, austere, and wilderness environments. Four junctional tourniquets are currently cleared by the Food and Drug Administration (FDA) for junctional hemorrhage control, and 1 junctional tourniquet is also FDA-cleared for pelvic stabilization. As junctional hemorrhage control efforts progress, scientists need to continue to conduct research and clinicians need to continue to monitor the performance of junctional tourniquets, especially in conjunction with morbidity and mortality outcomes, for both military and civilian trauma patients.

Keywords: battlefield, junctional hemorrhage, junctional tourniquet, prehospital, Tactical Combat Casualty Care

Introduction

Junctional hemorrhage has been defined as compressible hemorrhage occurring at the junction of an extremity with the torso at an anatomic location that precludes the effective use of an extremity tourniquet, which includes the base of the neck.[1] Junctional hemorrhage is an externally compressible hemorrhage. Externally compressible hemorrhage can be controlled in the prehospital setting. Survival of trauma is associated with the time that has elapsed between injury and receiving a required intervention or capability. Thus, nonmedical and medical first responders must have the capability to successfully compress and control junctional hemorrhage through appropriate training and effective use of junctional tourniquets.

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Background

Over the past decade, the application of tourniquets for extremity hemorrhage has become more ubiquitous in both the military and civilian settings. As this transpired in the US military, junctional hemorrhage surpassed extremity hemorrhage as the most common cause of battlefield death from externally compressible, and thus potentially survivable, hemorrhage.[2] Of note is that junctional hemorrhage is also a significant component of what has become known as the "dismounted complex blast injury."[3] Thus, another factor that contributed to the increased incidence of death from junctional hemorrhage on the battlefield was the expanded use of antipersonnel

pressure-activated improvised explosive devices (IEDs). Specifically, the comprehensive Eastridge et al study of US combat fatalities in the recent conflicts of Afghanistan and Iraq reported that 17.5% (171 of 976) of potentially survivable prehospital deaths resulted from junctional hemorrhage.[2]

In January 2013, a US Central Command and Department of Defense (DoD) Joint Trauma System report on prehospital trauma care in Afghanistan highlighted the above findings and advocated for more research and expanded fielding of junctional tourniquets.[4] In August 2013, the assistant secretary of defense for health affairs directed the Committee on Tactical Combat Casualty Care (CoTCCC) to consider all devices for junctional hemorrhage that had been cleared by the Food and Drug Administration (FDA).[5] At that time there were 4 such devices for the indication of junctional hemorrhage control: the Abdominal Aortic and Junctional Tourniquet (AAJT; Compression Works, Birmingham, AL); the Combat Ready Clamp (CRoC; Combat Medical Systems, Fayetteville, NC); the Junctional Emergency Treatment Tool (JETT; North American Rescue, Greer, SC); and the SAM Junctional Tourniquet (SJT; SAM Medical Products, Portland, OR). Additional details and photos of these devices can be found on manufacturer websites as well as in the 2015 *Wilderness & Environmental Medicine* article on hemorrhage control techniques by Drew et al.[6]

The CoTCCC considered these 4 devices and recommended 3 junctional tourniquets (CRoC, JETT, SJT) for inclusion in the Tactical Combat Casualty Care (TCCC) guidelines and for rapid fielding to prehospital providers on the battlefield.[1] After 3 years, all 4 of these junctional tourniquets remain on the market as an option in the management of junctional hemorrhage, and there are no new FDA-cleared junctional tourniquets. Research studies and case reports have been published on these junctional tourniquets during the interim. Thus, another review of the medical literature is warranted.

CoTCCC Review

In 2013, the CoTCCC reviewed the medical literature and recommended 3 junctional tourniquets (CRoC, JETT, SJT).[1] The CoTCCC also modified the TCCC guidelines to reflect the committee's recommendation for junctional hemorrhage control during the phases of Tactical Field Care and Tactical Evacuation, as follows: "If the bleeding site is appropriate for use of a junctional tourniquet, immediately apply a CoTCCC-recommended junctional tourniquet. Do not delay in the application of the junctional tourniquet once it is ready for use. Combat Gauze (Z-Medica, Wallingford, CT) applied with direct pressure should be used if a junctional tourniquet is not available or while the junctional tourniquet is being readied for use."

The 2013 CoTCCC review also noted the following 5 points: 1) With preventable death from extremity hemorrhage greatly reduced by extremity tourniquet use by the US military, junctional hemorrhage surpassed extremity hemorrhage in frequency as a cause of battlefield mortality; 2) the incidence of combat death from junctional hemorrhage due to expanded use of antipersonnel, pressure-activated IEDs had increased; 3) junctional hemorrhage is a component of what has become known as dismounted complex blast injury; 4) pelvic fractures may be seen in association with junctional bleeding in dismounted IED attacks; and 5) data suggest dismounted IED casualties with traumatic amputation higher than a below-the-knee amputation warrant empiric application of a pelvic binder.

Since the 2013 CoTCCC review, no prospective trials to support the efficacy of current FDA-cleared junctional tourniquets on casualties in the prehospital environment have been published. Available evidence for junctional tourniquets continues to be derived from laboratory studies and case reports.

Studies Comparing the 4 Junctional Tourniquets

Five comparison studies were conducted on the 4 FDA-cleared junctional tourniquets. Metrics from these studies are summarized below and in the Table.

1. Kotwal et al (2013)[1]: A CoTCCC review of junctional tourniquets. The JETT and SJT were less expensive than the AAJT and CRoC. The AAJT and SJT weighed less than the CRoC and JETT. The CRoC consumed the least space by volume.
2. Kragh et al (2013)[7]: A laboratory assessment of out-of-hospital interventions to control junctional bleeding from the groin in a manikin model. The median and mean time to stoppage of bleeding was lowest for the SJT. The median and mean blood loss volume was lowest for the SJT.
3. Kragh et al (2014)[8]: A study of military medic use of junctional tourniquets in simulated prehospital trauma care. Nine medics used 4 different junctional tourniquets (CRoC, AAJT, JETT, and SJT). All tourniquets used were safe under the conditions of the study. Both the SJT and CRoC had high effectiveness percentages (the difference was not significant). The SJT and CRoC had fast times to effectiveness (the difference was not significant). Users preferred the SJT and CRoC (the difference was not significant).