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REVIEW ARTICLE

Application of Current Hemorrhage Control Techniques for Backcountry Care: Part One, Tourniquets and Hemorrhage Control Adjuncts

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Decade-long advancements in battlefield medicine have revolutionized the treatment of traumatic hemorrhage and have led to a significant reduction in mortality. Older methods such as limb elevation and pressure points are no longer recommended. Tourniquets have had a profound effect on lives saved without the commonly feared safety issues that have made them controversial. Unique tourniquet designs for inguinal and abdominal regions are now available for areas not amenable to current fielded extremity tourniquets. This article, the first of two parts, reviews the literature for advancements in prehospital hemorrhage control for any provider in the austere setting. It emphasizes the significant evidence-based advances in tourniquet use on the extremities that have occurred in battlefield trauma medicine since 2001 and reviews the newer junctional tourniquet devices. Recommendations are made for equipment and techniques for controlling hemorrhage in the wilderness setting.

Key words: hemorrhage, hemostasis, tourniquet, trauma, prehospital, hemostatic agents, topical, dressing, bandage

Introduction

You are in the backcountry climbing with a friend when suddenly his rope gives way, causing him to fall approximately 10 feet onto jagged rocks. He is awake, alert, and calling to you. As you run in his direction, you note a significant amount of blood soaking through his torn right pant leg. You expose the wound and note an open femur with an amount of bleeding that is obscuring your ability to further assess his wound. What would you do in this scenario? Are you prepared? Do you know the risks and benefits of different courses of action?

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Background

Uncontrolled hemorrhage from major trauma remains a significant challenge for providers at all levels, both in the hospital and in the field. It is the leading cause of death on the battlefield[1,2] and the second leading cause of traumatic death in the civilian sector.[3] Even isolated extremity injury in a fully equipped trauma system can result in preventable deaths.[4] When evacuation times are prolonged and resources constrained such as in rural, combat, and wilderness medicine scenarios, early hemorrhage control becomes even more critical. Because the primary components of oxygen delivery are cardiac output, hemoglobin, and hemoglobin oxygen saturation, it is understandable that extensive airway and breathing maneuvers are futile if there is no hemoglobin to saturate. Rapid Emergency Medical System (EMS) transport ensures that stabilization and resuscitation can occur expeditiously in civilian emergency departments. However, this paradigm does not hold in most austere

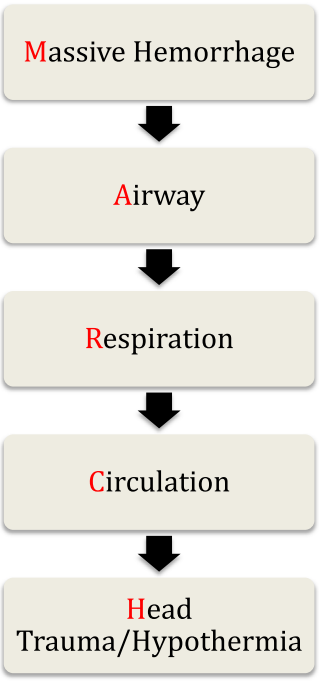

Figure 1. MARCH algorithm for trauma assessment.

settings. The US military utilizes the acronym MARCH (massive hemorrhage, airway, respiration, circulation, head trauma/hypothermia [Figure 1]) to focus efforts on treating rapid exsanguination first in austere settings, even before attempts at managing the airway and breathing/respiration.

If standard crystalloid resuscitation is instituted (normal saline or lactated ringers), the ensuing dilutional coagulopathy can add to the hypothermia and acidosis that form the lethal triad of the deteriorating trauma patient.[5] Thus, a focus on rapid and effective hemorrhage control before rapid transport is critical in avoiding the need for crystalloid resuscitation or transfusion of blood products in the emergency department. When treating significant hemorrhage, it is better to take the time at the point of injury to control the hemorrhage instead of applying the typical "load and go" mantra taught in most trauma courses. Delayed mortality from sepsis and multiorgan failure syndrome can thus be reduced by immediate and effective early hemorrhage control.[6,7]

For centuries, the methods of hemorrhage control have remained essentially unchanged.[8,9] Historically, these approaches have all been used with variable success to control bleeding at the point of injury. Research into improved hemorrhage control has been steadily gaining traction over the past century, but it has only been in the last decade that major improvements in prehospital hemorrhage control have been significantly advanced. For example, Tactical Combat Casualty Care (TCCC) guidelines[10,11] have rapidly evolved as a result of the wars in Afghanistan and Iraq.

The purpose of this paper is to review the current principles of hemorrhage control in the austere setting, to encourage tourniquet use by any level of provider, and to emphasize the significant evidence-based advances that have occurred in the past decade in battlefield trauma medicine.

Hemorrhage First Aid

Traditional approaches to moderate to severe bleeding have been recommended for many decades (See Table 1). However, recent advances in military medicine to control major bleeding on the battlefield have led to the development of improved tourniquets and hemostatic agents.[12–17] No review would be complete without covering initial first aid interventions for acute life-threatening hemorrhage. Pressure points over major arteries have long been recommended as a method to stop significant extremity hemorrhage. Although this method can be effective initially, evidence shows that collateral circulation compensates, and bleeding resumes within 60 seconds in the upper extremity and 30 seconds in the lower.[18] Pressure point use, as well as elevation of the injured extremity, are also no longer recommended by the American Heart Association and American Red Cross, even in situations where definitive care may only be minutes away.[19] They may be effective as a brief temporizing measure while a tourniquet, hemostatic agent, or pressure dressing is applied, but should not be relied on in isolation or beyond the immediate initial occurrence of hemorrhage.

Table 1. Traditional and current hemorrhage control recommendations

Traditional methods	*Current methods (2010 to present)*[a]
Direct manual pressure	Direct manual pressure
Pressure points	Pressure points—no longer recommended
Elevation of extremity	Elevation of extremity—no longer recommended
Pressure dressing	Pressure dressing
Improvised tourniquet (last resort)	Hemostatic agent[b]
	Commercial tourniquet (eg, C-A-T, SOF-TT, EMT)

C-A-T, Combat Action Tourniquet; SOF-TT, Special Operations Forces Tactical Tourniquet; EMT, Emergency Medical Tourniquet.

[a] From Markenson et al.[19]

[b] Hemostatic agents are discussed in part 2 of this article.