Prehospital Tourniquet Use – A review of the current literature

PHTLS

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**Background:**

The use of extremity tourniquets for exsanguinating limb trauma has remained controversial throughout history. The ancient Romans were likely the first to use battlefield tourniquets and their basic use has evolved little over the years, although many commercially available brands are replacing the folded cravats used previously. Tourniquets were issued in Civil War surgical sets and it was during this conflict that enthusiasm over their use diminished, likely due to the ischemic complications associated with prolonged delays from their application to definitive care.\(^1\) The use of tourniquets has been slowly increasing in military campaigns since the Vietnam War but it wasn’t until the recent experience in the Iraq and Afghanistan conflicts that widespread tourniquet use has been accepted as standard of care in the military.

A review of civilian extremity trauma from 1994-99 noted that 86% of patients who died from an isolated exsanguinating penetrating limb injury had signs of life at the scene but had no discernible pulse or blood pressure upon arrival to the hospital.\(^2\) No patient in their study had a prehospital tourniquet placed by EMS personnel. Several factors account for the reluctance of EMS personnel to use tourniquets. These factors include the perceived complications of nerve injury and deep vein clot formation and the notion that limb ischemia could increase the risk of future amputation. Since the publication of these initial reports, civilian use of tourniquets is becoming accepted as standard of care, primarily due to the data derived from the recent military experience in Iraq and Afghanistan.

The 6th Edition of the PHTLS textbook endorses the use of tourniquets if external bleeding cannot be controlled by direct pressure. It also notes that elevation of an extremity and compression on a pressure point proximal to the injured site are not proven methods of hemorrhage control and are not endorsed by PHTLS. The 6\(^{th}\) edition endorsement of tourniquet use is based on several small published studies demonstrating benefit as well as early evidence arising at the time from the Iraq conflict. Since the publishing of the 6\(^{th}\) edition, significant additional data has appeared in the trauma surgical literature to support the use of tourniquets. We will review these new studies in an effort to keep PHTLS providers abreast of the latest literature on this subject.
**Literature Review:**

The first large study to retrospectively review tourniquet use by the U.S. military in Iraq was published in the Journal of Trauma by Beekley, et al.\(^3\) The authors reviewed their experience during 2004 in Iraq. This was relatively early in the conflict and widespread tourniquet use among military personnel was still in its infancy. The authors reviewed 67 patients who had prehospital tourniquets placed and another 98 patients with severe extremity trauma who did not have tourniquet placement. The average tourniquet time was 70 minutes (range 5-210 minutes). While a survival benefit to tourniquet use was not demonstrated in this initial study, the authors found that among the most severely injured patients (Injury Severity Score > 15) prehospital tourniquet use significantly improved hemorrhage control. No early adverse outcomes from tourniquet use were noted among the survivors. The authors discuss the challenges faced by providers in the combat environment and recognize that documentation of successful hemorrhage control, tourniquet application time, and vital signs was often inadequate. Furthermore, a comprehensive military trauma database was still under development so hospital records were often suboptimal. This study is significant in that it demonstrated that battlefield tourniquets can safely be applied by prehospital personnel with no significant side-effects. Critics point out the retrospective nature of the study as well as the author’s admitted difficulty in data collection early in the war. As data gathering methods improved over the next several years, future research would expand on this early study.

The next two articles are from the prospectively gathered trauma database by the U.S. military in Iraq.\(^4,5\) The articles represent the work from a single combat hospital in Baghdad and cover a span of seven months, March to October 2006. During this time, 2,838 patients were admitted with major limb trauma of which 8% (232 patients) had 428 tourniquets placed on 309 limbs. Some patients had multiple limbs injured, while others had an additional tourniquet placed on the same limb if the initial placement did not adequately control hemorrhage. The average tourniquet time was 1.3 hours.

The first article from this prospective database was published in the Journal of Trauma and evaluated complications associated with tourniquet use.\(^4\) Four patients had nerve palsies diagnosed at the level of the tourniquet, three of which improved within a day. Only one patient had mild persistence of his nerve palsy at 6 days. Seven patients had skin pinching, blisters, abrasions, or bruises in the area directly under the tourniquet. Ten blood clots were noted although the surgeons attributed these to be secondary to the injury itself and not to tourniquet use. No patient developed a pulmonary embolus. There was no apparent association between tourniquet time and the development of clots, nerve palsies, pain, or myonecrosis. Nine fasciotomies were done, but all were prophylactic to prevent compartment syndrome and no cases of compartment syndrome were noted from tourniquet use. Nearly all tourniquets were properly positioned (97%). The low rate of complications noted in this study compares favorably with other prior studies from as far back as World War II which all demonstrate little or no morbidity associated with tourniquet placement.
The next article, published in Annals of Surgery, represents the first prospectively gathered data to demonstrate the survival benefit of tourniquet use. The authors first note five patients who met eligibility criteria for prehospital tourniquet placement who did not receive a tourniquet for various reasons. All five patients were alive in the field, bled to death in the presence of fellow soldiers, and arrived at the hospital 10-15 minutes later without vital signs. The authors conclude those deaths could have been prevented with early tourniquet placement. They also note that timing is critical to tourniquet placement. The patient must have a tourniquet in place before the onset of shock. Patients with a tourniquet placed in the absence of shock had a 90% survival rate versus a 10% survival rate in those whose tourniquet was placed after development of shock. The median time to placement after injury was 10 minutes and placement should be done prior to extrication from the vehicle and transport to the hospital.

The final study to review is a continuation of the previous two papers from the same combat support hospital in Iraq. The authors conducted this study to see if their initial data supporting the use of tourniquets held up as more patients were enrolled in the study over time. The study population included 499 total patients, with 862 tourniquets applied on 651 limbs. A survival advantage was noted in patients who had a tourniquet applied early, before the onset of shock (96% before vs 4% after). Furthermore, a survival benefit was noted in patients with prehospital application of a tourniquet versus hospital application (89% vs 78% hospital). Complications associated with tourniquet placement, such as nerve palsies, remained extremely low in this study as well (< 1.5%). The authors conclude that early tourniquet application, before the onset of shock, saves lives with little to no associated complications.

Summary:

- Prehospital tourniquets are indicated if direct pressure or a pressure dressing fails to control hemorrhage.
- The tourniquet should be placed prior to extrication and prior to transport. There is a clear survival advantage if placement is done prior to the onset of shock.
- The tourniquet is tightened until hemorrhage ceases. An additional tourniquet can be placed next to the first tourniquet if bleeding control is inadequate following placement of the first tourniquet.
- The patient should be transported to a hospital with immediate surgical capabilities whenever possible.
- The time of tourniquet application should be documented and relayed to the trauma team upon arrival at the hospital.
- There are few, if any, significant complications attributed to tourniquet use. It is a safe procedure, should be performed by all EMS personnel, and saves lives.
PHTLS Recommendation:

PHTLS recommends the placement of tourniquets by EMS personnel if direct pressure fails to control extremity hemorrhage.

Bibliography:


