

The Tourniquet Controversy

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Describing a tourniquet as “an instrument of the devil that sometimes saves a life”¹ encapsulates the considerable risk to a limb when a tourniquet is applied to arrest life-threatening extremity hemorrhage. The use of tourniquets is widespread in both military and civilian environments, particularly in the developing world; however, the balance of risk is unclear, and its efficacy is controversial and unduly influenced by folklore and dramatic Hollywood images. The tourniquet controversy remains unresolved and has not, to our knowledge, reached the pages of medical journals since 1940.² The clinical questions that remain unanswered are as follows:

- Under what circumstances should a tourniquet be applied?
- Relative to the number of tourniquets applied:
 - How many lives are actually saved?
 - How many limbs are lost or left with ischemic contractures?
- How long can a tourniquet be left on without risking loss of limb or limb function?
- How does the risk of crush syndrome increase with time?
- When can a tourniquet be released safely?
- How much damage is done to the tissues under a tourniquet?
- Are some tourniquets safer or more effective than others?
- How urgent is the inevitable amputation for a tourniquet that has been left on for more than 6 hours?
- How does the application of a tourniquet influence the priority for movement?

Little evidence exists to resolve these questions; however, the following points appear uncontroversial and represent first principles to support a coherent strategy:

- Most extremity hemorrhage, including that from traumatic amputation, can be controlled with direct pressure and elevation.
- Tourniquets have saved lives.
- It is accepted military practice to apply a tourniquet to move an injured person from the point of injury to a place of relative safety (or to continue fighting).
- The tourniquet should be broad, tight enough, and as low as possible, but not over a joint.
- Narrow, improvised tourniquets can crush the underlying tissues but may be unavoidable at the point of injury.
- An improvised tourniquet should be removed or replaced as soon as possible.
- Tourniquets lead to more (possibly many more) ischemic complications and unnecessary amputations than lives saved.
- Severe hemorrhage may not reoccur when an effective tourniquet is released after 2 hours.
- The “tourniquet time” for extremity surgery is 2 hours.³
- Surgical doctrine holds that if an occlusive tourniquet has been applied for more than 6 hours, the limb should be amputated above the level of the tourniquet without it being removed.
- When a tourniquet has been applied for a large wound or traumatic amputation and left in place for 12 hours or more, there is a high risk of gas gangrene that increases with time.
- A tourniquet is very painful.

It seems there are few, if any, exclusively clinical reasons to apply a tourniquet to arrest extremity hemorrhage. For instance, in the admission room of a hospital, control is achieved by other means such as direct manual pressure. However, as injured people move from the point of injury to a surgical hospital, other factors come into play that may impact on and in some circumstances override purely clinical considerations. In the military context, the point of injury is a very dangerous environment, with considerable risk of injury to the care provider and of further injury to the injured person. There may be neither the time nor the materials to control hemorrhage, and it is rarely feasible to extract injured people from danger while maintaining manual pressure and keeping the injured limb elevated. The initial imperative must be to move people to relative safety; applying a tourniquet to expedite this clearly outweighs the clinical risk.

The nonclinical factors that must be considered when deciding whether to apply a tourniquet may pertain to situa-

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tions other than at the point of injury. Moving injured people toward definitive care means that manual pressure and elevation may be impossible. There may be insufficient materials to apply adequate dressings or insufficient hands to apply manual pressure. Multiple casualties may accentuate this. This relative lack of resource can make conventional care impossible and so tourniquets become an appropriate and pragmatic solution.

Accepting that tourniquets may have to be applied, there are some universal rules that state that tourniquets should only be applied if hemorrhage is genuinely life-threatening, all feasible conventional measures have failed, and the consequences of applying a tourniquet can be managed adequately. Beyond these rules lies the question of how to manage tourniquets once they are applied. First principles suggest two key points in time that represent either end of a spectrum of risk. At one end, removing a tourniquet at 2 hours has minimal risk of ischemic complications and hemorrhage may have been controlled. Beyond 6 hours, the risk of arrhythmias and crush syndrome is so high that amputation above the level of the tourniquet is mandatory. Between these time points, the likelihood of serious complications including death increases with time and the chance of salvaging the limb decreases toward zero. These risks have not been quantified.

We feel that the controversy can be resolved as follows. It is unlikely that there are any exclusively clinical situations in which a tourniquet must be applied to arrest hemorrhage. Outside the surgical hospital, nonclinical constraints may override clinical considerations. A strict, safe, and generic strategy for the use of tourniquets has been published pointing to the need for further research.¹ It accepts the occasional need for tourniquets to arrest hemorrhage and proposes three concepts governing their application, as follows: the tactical tourniquet, a trial of tourniquet, and a tourniquet of last resort.

The "tactical tourniquet" is a short-term, usually improvised tourniquet applied at the point of injury either by a care provider or by the injured person. Its specific aim is to arrest life-threatening hemorrhage while the injured person is moved to a place where initial care can be given in relative safety. At this point, the need for the tourniquet ceases and best possible care begins.

The "best possible" initial management of hemorrhage must always be application of a pressure dressing and elevation of the limb. In some circumstances, nonclinical factors

mean that hemorrhage cannot be controlled in this way. A "trial of tourniquet" involves both correct application of a tourniquet to the limb and the most effective pressure dressing possible on the wound. The tourniquet is released after 2 hours (or 2 hours after application of a tactical tourniquet if one was applied). In many cases, hemorrhage will have ceased and there remains a chance of retrieving a functional limb in the long term. If serious hemorrhage recurs and it still cannot be controlled by a pressure dressing and manual pressure, then the trial has failed and the tourniquet must be reapplied.

A "tourniquet of last resort" is applied if the trial of tourniquet fails; unless the injured person reaches a surgical hospital within minutes, he or she is likely to require surgical amputation of the limb above the level of the tourniquet without the tourniquet being removed. Decisions about the priority for movement to hospital are complicated by many factors including time, resources, and the condition and number of others injured. In some cases, there may be no realistic possibility of a wounded person reaching a surgical hospital; not applying a tourniquet of last resort in this situation may be the kindest option.

We believe that strict adherence to these guidelines will result in fewer tourniquets being applied but in a safer manner. Application of tourniquets should not be taught in occasional first aid courses.

Of the questions above, three remain. Answering each will help to refine the guidelines further. They are as follows: Is it true that all extremity hemorrhage can be controlled without tourniquet given adequate skills and resources? Is it true that a trial of tourniquet is usually successful? What is the spectrum of risk of removing a tourniquet beyond 2 hours? We hope these questions will guide research in the future.

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