SWORBHP Webinar
Tourniquet Use

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OBJECTIVES

• Review epidemiology of exsanguinating extremity injuries
• Understand the historical background of tourniquet use
• Describe the potential complications of tourniquet application
• Review relevant medical literature
• Review the BLS standards in Ontario regarding tourniquet use
DISCLOSURES

None
HEMORRHAGE

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• Exsanguinating limb injuries are commonly described in combat settings
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• Exsanguinating limb injuries are commonly described in combat settings

• Death from extremity hemorrhage in the civilian setting appears rare

• However, recent terrorism attacks have unfortunately increased civilian exposure to these injuries
HEMORRHAGE

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• Exsanguinating limb injuries are commonly described in combat settings

• Death from extremity hemorrhage in the civilian setting appears rare

• However, recent terrorism attacks have unfortunately increased civilian exposure to these injuries

• Exsanguinating limb injuries provide an important opportunity to intervene and potentially save a life in the prehospital setting!!!
HISTORICAL BACKGROUND

Tourniquets are an ancient device, with documented uses since the times of Alexander the Great
HISTORICAL BACKGROUND

• 1586 De Chauliac utilized tourniquets to reduce blood loss during amputations

• In 1674, the French Surgeon Etienne Morel utilized tourniquets to treat battlefield wounds

• Tourniquets have changed design and mechanics many times over the course of their use
MODERN HISTORY

• Throughout the 20th and 21st centuries, opinions on tourniquet use were largely based on anecdotal experience by military surgeons

• There were a lot of negative experiences with tourniquets during WWI and WWII

• Major Blackwood “tourniquets are an invention of the evil one…”

• British war manual 1918 “The employment of [a tourniquet]...usually indicates that the person using it is quite ignorant...”
WHY THE NEGATIVE PRESS?

• The early utilization of tourniquets during these conflicts had many errors:
  • Prolonged transport and tourniquet application
  • Concealment under garments
  • Inappropriate usage for non-life threatening injuries

• Resulted in unnecessary life threatening complications such as amputations and nerve palsies
In the 1980s the IDF began routinely equipping all combat soldiers and medics with tourniquets.

Lakstein et al.
- 91 patients RX with tourniquets
- High success rates of hemorrhage control
- Low (5.5%) incidence of neurologic consequents
A NOT SO NICE REMINDER

• The US conflict in Somalia in the 1990s re–demonstrated that extremity injuries were a continued source of morbidity and mortality.

• Short conflict time limited the amount of scientific data accumulated from the experience.

• Anecdotally, tourniquets = good.
REVIEW QUESTION #1

• Early clinical experiences with tourniquet use were largely:
  a) Positive, based on anecdotal experiences
  b) Positive, based on rigorous scientific study
  c) Negative, based on anecdotal experiences
  d) Negative, based on rigorous scientific study
PHYSIOLOGIC IMPACT OF TOURNIQUETS

SYSTEMIC

LOCAL
SYSTEMIC IMPACT OF TOURNIQUETS

Benefits:
- Centralization of blood volume
- Cessation of active blood loss

Complications:
- Bigger issue when it comes time to remove tourniquet
- Increased in CO2 and potassium concentrations as well as a reduction in core temperature and arterial pH
LOCAL IMPACT OF TOURNIQUETS
LOCAL IMPACT OF TOURNIQUETS—NERVES

• Tourniquet induced nerve injury has been well documented
• Ranges from paresthesias to complete paralysis
• Incidence ranges from 0.1–7.7%
• Nerve injuries result from a combination of local nerve compression and distal ischemia
• Direct compression appears to play a more significant role
• Tourniquet edges represent areas of maximal shear stress
LOCAL IMPACT OF TOURNIQUETS—MUSCLE

• Muscle injury results from local compression, distal ischemia and reperfusion

• Includes rhabdomyolysis and compartment syndrome

• Degree of muscle injury is related to the length of tourniquet application and occlusion pressure

• Acceptable tourniquet time has been derived from elective surgical procedures (~2 hours)
SAFE TOURNIQUET TIME
SUMMARY OF Tourniquet Impact

• Potentially useful for the cessation of ongoing hemorrhage

• Potentially bad for the limb at stake

• Ideal application time likely less than the 2 hour mark suggested through healthy volunteer studies
Physiologic consequences of tourniquet application:

a) Increased pH, increased temp, decrease potassium, decreased CO2

b) Increased pH, increase potassium, increase CO2

c) Decreased pH, increases potassium, increase CO2

d) Simply stops blood loss
FIRST… DO NO HARM

SHOW ME THE EVIDENCE!
Survival With Emergency Tourniquet Use to Stop Bleeding in Major Limb Trauma

COL John F. Kragh, Jr., MC, USA,* Thomas J. Walters, PhD,* David G. Baer, PhD,*
LTC Charles J. Fox, MC, USA,† Charles E. Wade, PhD,* Jose Salinas, PhD,*
and COL John B. Holcomb, MC, USA*

The Journal of TRAUMA® Injury, Infection, and Critical Care

Practical Use of Emergency Tourniquets to Stop Bleeding in Major Limb Trauma

John F. Kragh, Jr., MD, Thomas J. Walters, PhD, David G. Baer, PhD, Charles J. Fox, MD,
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Tourniquet use for peripheral vascular injuries in the civilian setting

Edward Passos a, Brittany Dingley b, Andrew Smith b, Paul T. Engels c, Chad G. Ball b, Samir Faidi a, Avery Nathens d, Homer Tien d,\textsuperscript{*,} for the Canadian Trauma Trials Collaborative

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d University of Toronto, Department of Surgery, Sunnybrook Health Sciences Centre, Canada
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Take away:

Small numbers (8 total tourniquets)

All tourniquets were improvised

6 people died of exsanguinating injury without a tourniquet applied!
BOSTONS CIVILIAN EMS EXPERIENCE

Kue et al. Prehospital Emergency Care. 2015

Retrospective review between 2005–2012

98 cases of prehospital tourniquet application

Injuries:
- Penetrating 66/98 (67.4%)
- Blunt 7/98 (7.1%)

Location
- Upper extremity 53/97 (54.6%)
- Lower extremity 44/97 (45.4%)

Average prehospital tourniquet time was 14.6 minutes
• 54.7% of these tourniquets were removed in the ED

• 14 cases had documented vascular injury requiring repair

• 2 cases of complications potentially attributable to tourniquet use (overall complication rate 2.1%)

• One case of forearm numbness
• One potential vascular complication
BOSTONS CIVILIAN EMS EXPERIENCE

54.7% of these tourniquets were removed in the ED

14 cases had documented vascular injury requiring repair

2 cases of complications potentially attributable to tourniquet use (overall complication rate 2.1%)

One potential vascular complication

High rates of inappropriate application!

Low rates of potential complications
LA COUNTIES EXPERIENCE

Largest civilian study

87 patients who had tourniquets applied over 7 years

Average tourniquet application was 103 minutes

15 patients underwent amputation (14 of which were performed due to the primary injury)

A single patient had a prolonged (8-hour) tourniquet application

Seven patients (8%) suffered complications, including compartment syndrome, acute renal failure, bleeding, coagulopathy, hepatic failure, ARDS, shock and wound infection

Tourniquet contribution to these complications is uncertain

Authors conclusion: low rates of complications and potential life-saving benefit support the AGGRESSIVE use of tourniquets
AN EVIDENCE-BASED PREHOSPITAL GUIDELINE FOR EXTERNAL HEMORRHAGE CONTROL: AMERICAN COLLEGE OF SURGEONS COMMITTEE ON trauma

Eileen M. Bulger, MD, FACS, David Snyder, PhD, Karen Schoelles, MD, FACP, Cathy Gotschall, ScD, Drew Dawson, BA, Eddy Lang, MD, CM CCFP (EM) CSPQ, Nels D. Sanddal, PhD, NREMT, Frank K. Butler, MD, FAAO, FUHM, Mary Fallat, MD, FACS, Peter Tailliac, MD, Lynn White, MS, CCRP, Jeffrey P. Salomone, MD, FACS, NREMT-P, William Seltz, MD, NREMT-P, Michael J. Betzner, MD, FRCPC, Jay Johannigman, MD, FACS, Norman McSwain, Jr., MD, FACS, NREMT-P

Recommendation 1: We recommend the use of tourniquets in the prehospital setting for the control of significant extremity hemorrhage if direct pressure is ineffective or impractical.
Evaluation and management of penetrating lower extremity arterial trauma: An Eastern Association for the Surgery of Trauma practice management guideline

1. In cases of hemorrhage from penetrating lower extremity trauma in which manual compression is unsuccessful, tourniquets may be used as a temporary adjunct for hemorrhage control until definitive repair.
WHAT ABOUT YOUR PRACTICE GUIDELINES?

BLS
Basic Life Support
Patient Care Standards

Emergency Health Services Branch
Ministry of Health and Long-Term Care

Ontario
2. Specific to amputation/avulsion:
   i) With respect to the injury site:
      - control hemorrhage; if hemorrhage cannot be controlled by usual methods, apply and inflate a BP cuff until bleeding stops; administer high concentration oxygen if hemorrhage is severe; attempt to remove rings, tight band jewelry;
Basic Life Support
Patient Care Standards

Version 3.0
Comes into force December 11, 2017

Emergency Health Services Branch
Ministry of Health and Long-Term Care
Soft Tissue Injuries Standard

In situations involving a patient with soft tissue injuries, the paramedic shall:

1. consider underlying injuries to deep structures (e.g. nerves, vessels, bones);
2. control wound hemorrhage on a priority basis, as follows:
   a. apply direct pressure to bleeding sites (e.g. with digital pressure, the hand, pressure dressings, and/or bandages),
   b. if required, apply additional dressings over the initial dressing and/or tighten the bandage,
   c. for persistent extremity bleeding, apply an arterial tourniquet to the injured limb approximately five centimetres above the injury until bleeding stops, and
   d. for extremity bleeding where a tourniquet is ineffective, or for persistent trunk, axilla, or groin bleeding, apply a hemostatic dressing;

Ministry of Health and Long-Term Care
Soft Tissue Injury Standards

Guideline

Use of a tourniquet

- If a tourniquet is applied to stop uncontrollable extremity hemorrhage, it should not be removed in the pre-hospital setting.
- The time of tourniquet application must be documented and communicated to the receiving facility at transfer of care.
- In situations such as multi-casualty incidents (MCI), the time of tourniquet application must be listed on the patient and tourniquet.
- Do not cover the tourniquet once in place.

For extremity bleeding where a tourniquet is ineffective, or for persistent trunk, axilla, or groin bleeding, apply a hemostatic dressing.

Emergency Health Services Branch,
Ministry of Health and Long-Term Care
Arterial Tourniquet - No. 011

Minimum requirements

Arterial tourniquets shall:

1. be constructed of lightweight/durable materials;
2. be single use, disposable;
3. provide circumferential pressure to any extremity with complete occlusion of arterial blood flow;
4. allow for incremental increases in tension;
5. provide a lock or securing mechanism to ensure maintenance of desired tension; and
6. allow for rapid release of tension when necessary.
REVIEW QUESTION #3

Which of the following are true:

a) Exsanguinating limb injuries are common in civilian settings
b) Hemorrhage is the leading cause of death in trauma patients
c) Combat medicine offers little in terms of applicable civilian evidence
d) Tourniquets are dangerous and should never be used in a civilian setting
TOURNIQUET DEVICES AVAILABLE
TOURNIQUET TIPS

• ONLY APPLY WHY BRISK BLEEDING NOT CONTROLLED WITH DIRECT PRESSURE

• APPLY PROXIMAL, BUT AS CLOSE TO WOUND AS POSSIBLE

• NEVER COVER TOURNIQUET

• WRITE DOWN TIME APPLIED

• DO NOT TAKE TOURNIQUET DOWN

• MINDFUL OF PARIXODICAL BLEEDING
PARADOXICAL BLEEDING

• If tourniquet occludes venous flow (low pressure state) but not arterial flow you will have created a one way valve into the extremity

• Blood flowing into extremity but can not leave via venous structures

• See an increase in bleeding from wound site

• When applying tourniquet, continue to tighten until
  a) Bleeding from wound stops
  b) Distal pulses are absent
Contemporary EMS experience suggests that:

a) Tourniquets are associated with high complication rates
b) Tourniquets are routinely used
c) Tourniquets have high rates of inappropriately utilization
d) Tourniquets are not supported by major clinical practice guidelines
ANECDOTAL EXPERIENCE
CONCLUSION

• Exsanguinating limb injuries are a rare injury but they do occur and provide an opportunity to have a significant impact on patient morbidity and mortality in the prehospital setting

• Direct pressure remains the first line therapy to arrest bleeding

• Evidence suggests tourniquet use is associated with low rates of complications

• Avoid; long tourniquet application times (however life over limb!)

• If your going to use it...use it! (get it on tight and stop the bleeding!)