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Essay Title:

A critical comparison of the efficiency and safety of a tourniquet and direct
compression in extremity haemorrhage

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Report by: Amber Dawson

Clinical Scenario

You are dispatched to a 28-year-old male. On scene, you see the patient is haemorrhaging from a deep laceration approximately eight centimetres long on his left forearm with an obvious arterial bleed. Your partner suggests the use of a tourniquet to control the haemorrhage.

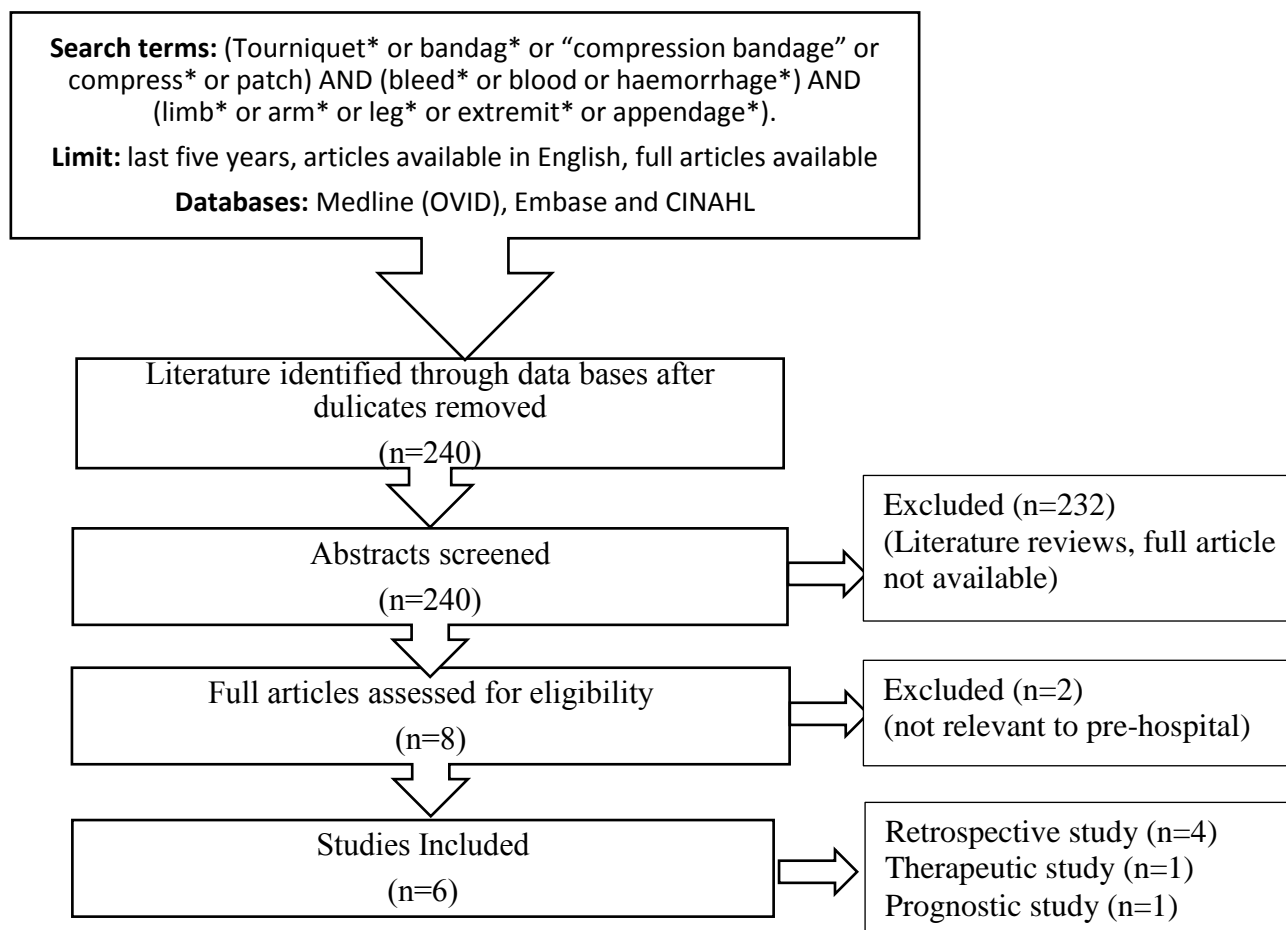
PICO (Population – Intervention – Comparison – Outcome) Question

In pre-hospital patients with extremity trauma that have the potential to cause catastrophic haemorrhage, will tourniquets be a safer and more effective intervention than direct compression to control the haemorrhage?

Search Rationale

Direct compression to stop limb haemorrhage has been outlined as primary treatment in most ambulance protocols. If unsuccessful, protocols increase compression methods to devices including the tourniquet. Tourniquets have a negative connotation due to the severe associated risks. However, tourniquets are greatly beneficial to a haemorrhaging patient to prevent critical blood loss, and can potentially save lives. A search will be conducted to understand the modern application of both treatment methods and determine a superior haemorrhage control based on the efficiency and safety of the method in a prehospital setting.

Search Strategy



Author and date	Population: Sample Characteristics	Design	Outcome	Results	Strengths and Limitations
(Inaba, et al., 2015)	87 adults with extremity injury requiring tourniquet application	Prognostic study	The primary outcome was to analyse amputations. Secondary outcomes included death, length of hospital stay and secondary complications to tourniquet usage.	99 limb amputations occurred however only one was needed due to limb ischemia secondary to the tourniquet. Seven patients experienced 13 complications including acute compartment syndrome, renal failure, shock and wound infection. Definitive conclusions on the role of the tourniquet in these complications cannot be drawn due to the type of injury.	(+) Appropriate sample size (+) Duration of tourniquets between pre-hospital application groups and emergency department application groups were the same (+) Patients scored similarly on the Mangled Extremity Severity Score (-) The unequal distribution between upper and lower limbs (62 vs 25) (-) Non-randomised data set indicates possible sample bias
(Scerbo, et al., 2016)	Patients at a level-1 trauma centre with a tourniquet	Retrospective study	The study was designed to determine the safety of tourniquets in civilians with major limb trauma.	Indicated tourniquet group exhibited greater secondary risks including: higher amputation rates (32% vs 0%), acute renal failure (3.2 vs 0%), compartment syndrome (2.1 vs 0%), and venous thromboembolic events (9.1 vs 8.5%). Adjudication determined that complications were not due to tourniquet usage.	(+) Subgroup analysis aged 18-49 years compared to extremity ages was conducted to reduce age limitations and associated comorbidities on the conclusions drawn (+) Confounding variables (demographic, mechanism of injury, transport method and vitals) between indicated and non-indicated tourniquet groups were maintained relatively consistent. (+) Multiple methods (injury severity score, abbreviated injury

					<p>scale and a resuscitation intensity score) were used to evaluate injury severity to maintain consistency between tourniquet and non-tourniquet groups.</p> <p>(+) Relatively even number of upper and lower limbs were evaluated (54 vs 52)</p> <p>(-) Sample bias may be present</p> <p>(-) Time of use of tourniquet applied in a prehospital setting was assumed from time of arrival at scene to time of arrival at the emergency department.</p>
(Kauvar, Miller, & Walters, 2018)	Adults with arterial injury between the femur and tibia	Retrospective study	The study was designed to determine the influence of tourniquet use on lower arterial injuries in a military setting. Secondary outcomes of the design compared the efficiency of tourniquets versus non-tourniquet.	<p>1. Higher incidence of nerve injury, severe oedema, wound infection, foot drop, vascular above-knee amputation and arterial repair complication in tourniquet group</p> <p>2. Amputation and mortality rates did not differ between tourniquet and non-tourniquet group</p>	<p>(+) Large sample size</p> <p>(+) An equal percentage of injury types between tourniquet and non-tourniquet groups</p> <p>(+) A relatively equal number of patients in tourniquet versus non-tourniquet group (254 vs 201)</p> <p>(-) The retrospective study presents possible sample bias</p> <p>(-) The tourniquet group injuries rated more severely on the Mangled Extremity Severity Score and Abbreviated Injury scale meaning the associated risks cannot be solely attributed to the tourniquet</p> <p>(-) Long term outcomes</p>

					concluded in the study cannot be specifically accounted for due to the tourniquet
(Kelly, Levy, Reyes, & Anders, 2020)	Paediatric patients aged two to seven scheduled for orthopaedic surgery	Therapeutic trial	The study was designed to determine if tourniquets can effectively occlude limb haemorrhage in young paediatrics.	Arterial occlusion measured by the absence of a pedal pulse was obtained on 100% of limbs tested	(+) Relatively even number of upper and lower limbs were evaluated (11 vs 13) (+) Wide range of paediatric limb circumference evaluated (arm: 13-24cm, leg: 24.5-34.5cm) (-) Tourniquets were applied to children influenced by general anaesthesia. Therefore, physiological changes secondary to trauma were not present. (-) Small sample size
(Zietlow, Zietlow, Morris, Berns, & Jenkins, 2015)	Patients with a tourniquet and/or haemostatic gauze applied in a rural setting	Retrospective study	The study was designed to determine the effectiveness of haemostatic bandages and tourniquets in civilian trauma care by evaluating the use of haemostatic bandages and tourniquets in military settings.	1. Tourniquets had 98.7% success in haemorrhage control 2. Subsequent skill-testing 12 months later showed 95% proficiency	(+) Equal distribution of tourniquet on upper and lower limbs (-) The study only measured haemostasis and neglected secondary injuries and vital signs (-) Small sample size (-) Confounding factors such as patient medical history were unknown e.g. patient anticoagulant status was only known in 7.3% of patients
(Smith, et al., 2019)	Adult patients with penetrating extremity trauma	Retrospective study	The study was designed to determine the safety of tourniquets and the efficiency of tourniquets in	1. Tourniquet group has higher systolic pressure (p=0.003) 2. Tourniquet group required	(+) Control groups were matched to limit confounding variables (-) Possible sample bias

			managing limb haemorrhage.	less packed red blood cells (2 versus 9.3) and fresh frozen plasma (1.4 vs 6.2) 3. Fasciotomy was higher in the non-tourniquet group (12.6% versus 31.4%) 4. Limb amputation was higher in the non-tourniquet group (0.8% versus 9.1%)	(-) The efficiency of haemorrhage control was subjective to the observer and may be inconsistent between different incidents. (-) Results were from a single institution with a high percentage of trauma patients. The data collected may be restricted to metropolitan settings.
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Comments

- All articles stated that direct compression should be a primary haemorrhage control method and tourniquets should be secondary haemorrhage control option. This may be due to an increased risk of complications when using a tourniquet including amputation, acute renal failure and compartment syndrome.
- Mortality rates did not differ between tourniquet patients and direct compression patients. Tourniquet groups did have higher systemic complications than direct compression control groups. However, the incidence of adverse effects associated with tourniquets is low and is usually associated with an incorrect or prolonged application.
- Tourniquets are effective in paediatrics of at least pre-school age.

Considerations

Weak evidence was available on the effect of direct compression at the injury site and no studies compared the efficiency or safety of direct compression with tourniquets on haemorrhaging limbs. It was highlighted in articles that haste should be taken in making a treatment plan due to the time-critical nature of a haemorrhaging patient. Therefore, more research should be conducted to determine if the treatment progression method is the most appropriate in a critically haemorrhaging patient.

Inadequate recent studies were available on the relationship between duration of use of a tourniquet and the associated adverse effects. As the risks associated with a tourniquet were due to error in the application or prolonged duration, it would be beneficial for more research to be conducted to ensure protocols stipulate a safe duration of use to avoid adverse complications.

Clinical Bottom Line

Overall, the results of the studied literature suggested that direct compression should be considered an immediate treatment for limb trauma, followed by a tourniquet if haemorrhaging does not improve appropriately. Severe complications are associated with the use of a tourniquet, mainly due to incorrect application or prolonged use. Therefore, the affected limb should be constantly re-evaluated throughout treatment, and appropriate

communication of the tourniquet to other treating staff is vital in reducing the incidence of secondary injuries. Despite the potential complications, tourniquets are life-saving devices with a low incidence rate for complications and should be employed to stop a critical haemorrhage.

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