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Suspension trauma—The silent killer

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Abstract

Fall harnesses have become much more prevalent for those who work at heights. Safety harnesses and fall arrest systems are commonly used by the construction industry, mountain climbers and other recreational activities where fall risks are a concern. Through the efforts of occupational health and safety legislation, job site safety programming and workplace harm reduction culture, there is a growing understanding of how and when to don these safety devices and the potential perils associated with their use. However, there is a paucity of information within the healthcare community in how to clinically manage a patient who has suffered a pattern of injury that can arise from these devices—known as suspension trauma. This condition may also be termed as harness-induced pathology, orthostatic shock while suspended and harness hang syndrome. This article helps to increase awareness and understanding of what suspension trauma is and how to pragmatically manage this condition from both a prehospital and emergency department perspective.

Key Takeaways

- **Early recognition/rescue**—If suspension trauma is suspected it will be critically important to maintain these patients in the highest Fowler's position for no less than 30 minutes or until the suspension trauma is proven otherwise. Removal of harness would be required to further reduce any potential circulatory restrictions. Communicate any suspension trauma suspicions to your team.
- **Establishing time of injury**—The impetus of safe and effective suspension trauma care is, in part, established through a detailed primary and secondary nursing assessment, which should establish and give importance to the mechanism of injury sustained by the patient and the time and duration that the suspension injury occurred.
- **Nursing assessment, intervention and documentation**—While conducting the primary and secondary assessment, maintenance and reassessment of the airway, breathing, circulation and the patient's disability should be conducted and recorded frequently. Placing the patient on a cardiac monitor and conducting an ECG, including vital signs, will help to establish the patient's hemodynamic baseline status. Assess and document concomitant injuries. Anticipate a treatment plan from the prescriber that may include administration of oxygen with an effective airway management, IV access for the administration of an isotonic solution, which may also include sodium bicarbonate for acidotic patients, serum sampling for CBC and differential, electrolytes, myoglobin, lactate, coagulation studies, urinalysis, ABGs and radiographs. Consider significant suspension trauma injuries may result in ionic disruption, thus allowing an increase of serum potassium levels, so cardiac monitoring should always be established immediately. Keep the patient warm to avoid hypothermia and ensure renal perfusion is adequate with urine output at 0.5 to1.0 ml/kg/hr (Campbell & Alson, 2016).
- **Monitor and anticipate suspension trauma complications**—Placing the patient on a cardiac monitor and gaining IV access will be instrumental in both identifying potential cardiac dysrhythmia and providing an effective route for medication delivery. Collect baseline and ongoing data on patients' vital signs including neurological assessments
- **Introduce a neutral position**—Slowly place the patient in a supine position after maintaining the highest Fowler's position for greater than 30 minutes. Monitor for potential cardiac dysrhythmia while efforts are being made to lower the patient to a supine position. Continually reassess the primary and secondary survey and document these findings.

In a world of imbedded safety, fall harnesses have become much more prevalent for those who work at heights. Safety harnesses and fall arrest systems are commonly used by the construction industry, mountain climbers and other recreational activities where fall risks are a concern. Through the efforts of occupational health and safety legislation, job site safety programming and workplace harm reduction culture, there is a growing understanding of how and when to don these safety devices

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and the potential perils associated with their use. However, there is a paucity of information within the healthcare community in how to clinically manage a patient who has suffered a pattern of injury that can arise from these devices—known as suspension trauma. This condition may also be termed as harness-induced pathology, orthostatic shock while suspended and harness hang syndrome.

This article has been prepared to increase awareness and understanding of what suspension trauma is and how to pragmatically manage this condition from both a prehospital and emergency department (ED) perspective. The inspiration for this paper resulted from an actual clinical experience that occurred in an ED while providing care to a patient who suffered from what is known as suspension trauma. This experience identified knowledge deficits while identifying an opportunity to improve care provision amongst EDs concerning the clinical symptoms and management required to produce a favourable outcome for the patients.

Trauma suspension, also known as orthostatic incompetence, relates to the physiological effects of decreased cerebral perfusion due to blood pooling in the lower extremities (Raynovich et al., 2009). The conceptual idea is that when an individual is wearing a safety harness and they suddenly become vertically suspended by a safety line (with their entire weight supported by the straps of the harness), the ability to mechanically pump and circulate the blood from the legs back to the body core is lost, thus decreasing circulatory blood volume to the cerebrum and placing the patient at risk for a presyncopal or syncopal episode. The underlying threat for individuals who become unresponsive while in a harness is the inability to become horizontal, which would naturally corrects and increases the return of circulator volume to the myocardium, as well producing normal blood flow to the cerebrum. Due to the safety harness, the suspension trauma victim is then left in a vertical position that perpetuates the suspension trauma condition.

There is a general medical understanding of the biomechanics with how blood is pumped back up to the myocardium through the mechanical actions of muscle contractions in the legs (Raynovich et al., 2009). Without this mechanism functioning, the victim's blood is sequestered in their lower extremities resulting in orthostatic incompetence. This can best be demonstrated with individuals who stand for a long period of time without any lower extremity movement, which ultimately results in a significant volume of circulatory blood collecting in the lower legs and causing the victim to become unconscious. The primitive mechanism of becoming unresponsive will then naturally allow the body to become horizontal and inevitably promotes blood circulation back to the brain. With cerebral perfusion being reestablished and a correction of this cerebral hypoxic event, the victim should regain consciousness in the absence of any significant injuries (Kolb & Smith, 2015).

The use of a safety harness (fall arrest system) is a widely adopted measure of injury prevention for those individuals who are working at heights. Canadian provinces such as Alberta, for example, have enacted legislation requiring properly fitted harness in concert with other safety device(s), when working at height (Occupational Health & Safety, Part 9, 141-1, 2009). The utility of safety harnesses is instrumental in preventing significant harm and injury from falls, but does require rapid rescue in such event to minimize the risk of secondary injuries, as seen with suspension trauma.

Figure 1: Suspension trauma
Reproduced from Modern Eastern Trading

The inherent risk with suspension trauma is that once the individuals becomes unresponsive, the natural ability for the body to become horizontal and promote cerebral blood flow is lost. As the victim is vertically suspended while becoming unresponsive, the cerebral injury is exaggerated and lower extremity cellular injuries will occur as well. Tissue that is not well supplied with oxygen and nutrients will undergo toxic changes and cellular death is imminent (Blansfield, 2020).

In the event that a victim is vertically suspended in midair by a safety harness, a conscious victim could effectively move their legs to encourage redistribution of the vascular volume collected in their lower extremities to potentially avoid the injuries associated with suspension trauma. The theory of continuous leg movement is that the promotion of circulation by mechanical action from the lower extremities to the central circulation preserves the victim's neurological status while they are waiting to be rescued. If the victim cannot move their legs, a rescuer can potentially raise them on the victim's behalf to help prevent further pooling. However, rescue should not be delayed.

The rescue and management of a trauma suspension victim should be approached with an abundance of caution. However, suspended victims do require a timely rescue. If there is a delay in rescuing the victim believed to have been suspended for longer than 30-minutes, there is risk of causing "rescue death" if the victim is placed in a horizontal position immediately post rescue (Lee & Porter, 2007, p. 238). The etiology behind "rescue death" is right ventricular overload from the pooled blood returning to the heart, which may, in fact, carry an aggregate of toxic cellular debris from the lower extremity injuries causing myocardial dysfunction (Lee & Porter, 2007). While the acute phase of venous stasis is occurring, tissue hypoxia will trigger a cascade effect of cellular damage, which will result in acidosis from anaerobic metabolism and cellular damage allowing intracellular potassium into the lower extremity venous space (Lee & Porter, 2007). A large return of acidotic, low-oxygenated and high-serum potassium levels blood back to the myocardium can potentially be mitigated though placing the victim in a semi-Fowler's position. Extending the medical management considerations beyond right ventricular overload, myocardial irritation and ischemic heart failure, renal injury should be assessed during post-rescue care since there is evidence that suspension trauma can cause rhabdomyolysis by similar mechanism to crushing injuries (Lee & Porter, 2007).

There are several authors suggesting that keeping the patient in an upright, semi- to high-Fowler's position for 30 minutes before placing the patient in a horizontal position would be the safest practice for this reason (Adisesh et al., 2009; Lee & Porter, 2007; Lewis, 2007). Fowler's positioning slows the rate of circulatory toxins that would return to the myocardium and potentially irritate the myocardial tissue, helping prevent the occurrence of myocardial ischemia or dysrhythmia (Raynovich et al., 2009). However the medical science is equivocal and some controversy exists regarding the strength of this recommendation, as some researchers and guideline authors also recommend the supine position for all patients (Lee & Porter, 2009).

The approach of keeping an unresponsive suspension trauma victim in as high a head-of-bed position as is feasible will help minimize the associated risks of the cardiac arrhythmia or cardiac dysfunction. Although every effort should be made for proper suspension trauma recovery, clinical awareness to the patient's primary survey, which includes the victim's airway patency, breathing and circulatory adequacy, must be assessed and treated accordingly. If the patient cannot have their primary care needs met in a high-Fowler's position, the head-of-bed must be lowered.

The recommendation for rescued suspension trauma patients, who have been vertically suspended for greater than 30 minutes, is to keep the victim in a semi-Fowler's position for no less than 30 minutes. At which time lowering the head-of-bed position into a gradual supine position would minimize any further complications related with suspension trauma.

If a nurse finds themselves in a position of advocacy and leadership in the clinical care of a trauma suspension victim, drawing a venous blood gas from above and below the harness could help illustrate the physiological derangements resulting from suspension trauma. Furthermore, the nurse could anticipate the responsible prescriber ordering medications to "buffer" the acidotic and hyperkalemic blood, using therapies such as intravenous sodium bicarbonate and/or calcium gluconate. If the trauma team leader or responsible clinician orders lowering the head-of-bed, it is reasonable to do so in a slow fashion, the same advice can be applied to removal of the harness and/or loosening of the straps.

The purpose of this article is to bring awareness to suspension trauma, the risks associated to rescue management and physiological complications that may be present with these patients. Although these efforts should be exercised to prevent further suspension trauma injury, it should not preclude efforts towards assessing and managing the victim's primary survey. The ability to recognize and correct time-sensitive clinical findings with the victims airway patency, breathing and circulatory adequacy, as well as neurologic disability, would demonstrate an axiomatic practice.

About the author

Richard Drew is currently working as a clinical nurse educator (CNE) with Covenant Health at the Misericordia Emergency Department in Edmonton, Alberta. He has several years of clinical trauma experience both in the pre-hospital and emergency department environment. Included in this experience he also has several years of occupational health nursing clinical experience. As a CNE his interests are trauma care, knowledge translation and the promotion of nursing practice.

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