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Prevention of Suspension Trauma from Harness Use

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Introduction

The use of harnesses to prevent entrapment and engulfment in grain bins has been recommended for decades. Harnesses (see Figure 1) will save lives if used properly. Details about grain bin entrapment and engulfment – causes, prevention, and rescue – can be found in the link https://www.uaex.edu/publications/pdf/FSA-1010.pdf. Often, workers believe the safety aspect of the harness' job is complete if it can keep workers safe from an impact injury during a fall. As more research and studies have been developed in these areas, researchers found out that the danger was not over after the fall was arrested. Hazards continue after a worker falls and has been caught by his/her fall protection harness. Unfortunately, post-fall suspension trauma and timely rescue are ignored when employers are building a fall protection plan (Occupational Safety and Health Administration, 2011). Regrettably, the blood circulation of the fallen worker is often restricted, causing a condition known as suspension trauma.

This fact sheet defines suspension trauma and explores the chemistry and physiology of suspension trauma during and after the suspension. It also shows safety techniques to protect against this hazard. Additionally, it provides several tips that might help during the rescue process.

Suspension Trauma

In fall protection, one of the approaches for protecting workers from hitting the ground during the fall is the use of a fall arrest. Fall arrest uses personal protective equipment (PPE), which includes a fall protection harness attached to a lanyard. The other end of the cable is connected to an anchor point. With this gear, the energy of the fall is absorbed by the lanyard, when a worker falls. Accordingly, it prevents the worker from hitting the ground. However, once the fall has been halted, the worker is in a hanging position. He/she is still suspended in the fall protection harness.

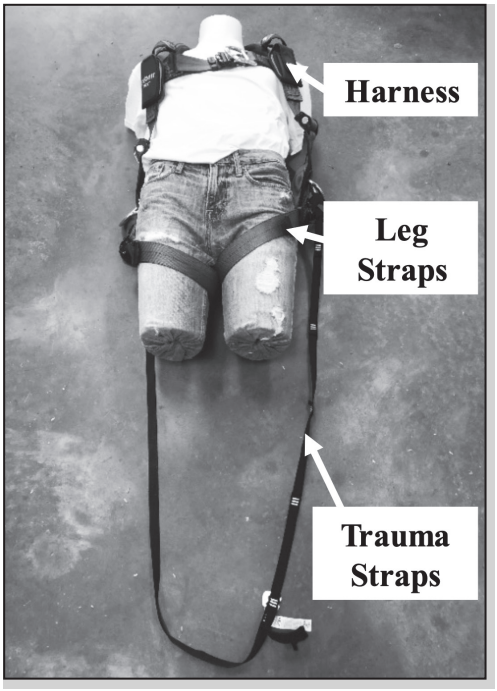

Figure 1: Harness with suspension trauma straps.

During this time in suspension, the most dangerous hazard in fall protection occurs, which is known as suspension trauma. Suspension trauma is also

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denoted as harness hang syndrome or orthostatic intolerance. During suspension, the leg straps (see Figure 1) carry the weight of the body. The leg straps of the fall protection harness press against the femoral arteries on the inside of the legs, obstructing blood circulation. The lack of blood circulation in the leg muscles forces blood to gather in the legs rather than circulate to the heart and lungs for recirculation. This venous pooling leads to the accumulation of too much blood in the veins. It reduces the flow of oxygenated blood to the heart and brain. The loss of circulation causes the heart to work harder to keep the brain and vital organs supplied with blood. This stage of suspension trauma is the onset of circulatory shock. This can result in nausea, unconsciousness, and a drop in blood pressure and heart rate. When blood cannot circulate and becomes trapped in an extremity, the blood can no longer transport oxygen from the lungs. To continue producing energy to support life, the cells in the extremity experience anaerobic respiration (without oxygen). During anaerobic respiration, glucose (blood sugar, C6H12O6) breaks down in half into lactic acid (C3H6O3) in a process recognized as lactic acidosis (see Figure 2).

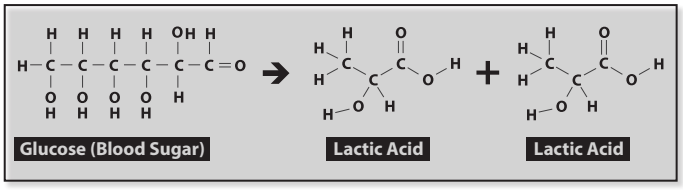

Figure 2. Lactic Acidosis.

Without blood flow in the legs, the lactic acid builds up in the stagnant blood. The buildup of acid in the blood is then released when the worker is brought down and blood circulation returned. High levels of acid flooding the body can overwhelm the kidneys, liver, and even result in heart failure. While there is incomplete scientific research directly focused on suspension trauma, there is adequate knowledge of the body's physiology to exemplify that this condition can be fatal. Unfortunately, a worker can lose consciousness when venous pooling occurs in a standing position.

Suspension trauma can result in brain, heart, or leg malfunction. The worker also can faint and fall to the ground. According to the Emergency Medicine Journal (2007), suspension trauma can become fatal in less than 30 minutes. Additionally, when the leg muscles are relaxed, the veins in the legs can expand dramatically, which is known as vasodilation. Due to the leg muscles not being used to stand, the muscles are not contracting and, consequently, not preventing the veins from expanding. Blood circulation is not restored. Without constraint from the leg muscles, the expansion of blood veins in the legs can result in a 20 percent loss in blood momentary circulation.

Utilization of Trauma Straps

Fortunately, there is a modest technique to protect against suspension trauma by using trauma straps (see Figure 1). Suspension trauma relief straps come packaged in two pouches that attach to each side of a harness. They are a pair of straps, one with hooks and the other with loops for the hooks to connect to. When a person falls and comes to rest, he/she would uncoil the trauma relief straps. He/she would hook them together, put their feet into the straps, press against the loop formed in the straps to simulate standing up, and brace his/her weight against the straps. The harness allows the leg muscles to contract and can release pressure from the leg straps on the femoral artery to help recover circulation. This situation allows the fallen worker to stand up in his/her fall harness. Accordingly, he/she utilizes the leg muscles, taking the weight off the arteries and restoring blood circulation until help arrives. Fall protection equipment businesses should manufacture their fall protection harnesses with trauma straps as a standard practice.

Fall protection harnesses should have trauma straps. However, due to the wide variety of harness manufacturers and harness designs, not all models come with trauma straps as a standard feature. Also, some workers consider that the hip storage pouches get in the way of tool bags or other equipment, so they eliminate the trauma straps. Not providing trauma straps or removing them are unsafe and should be unacceptable practices.

Warning Signs Associated with Suspension Trauma

It is essential to know the cautionary signs associated with suspension trauma. They may include:

- Faintness
- Breathlessness
- Sweating
- Paleness
- Hot flashes
- Nausea
- Dizziness
- Increased heart rate
- Low heart rate
- Low blood pressure
- Loss of vision

Body Malfunction After a Fall Arrest

- **Brain**: Oxygen deprivation of the brain may lead to fainting and eventual death.
- **Heart**: A drop in the blood return to the heart reduces oxygen supply to the brain and other vital organs.

- **Legs**: Harness leg straps compress femoral arteries. Skeletal muscle pumps in legs are less active or completely inactive and cause blood to pool in the victim's legs.

Readiness is Key

Most assuredly, fall arrest systems save lives. Suspension trauma can be avoided while waiting for rescue. Everybody who works off the ground at any height should be wholly trained in fall prevention and protection measures. More exceptional awareness of what suspension trauma is and how it disturbs the body is needed to advance a plan to control the hazards it presents.

The fallen employee should know how to use trauma straps properly. Workers need to be able to organize the relief straps to relieve the pressure on his/her groin. Witness workers should be instructed to not leave the sight of a co-worker who falls. The witness worker should know whom to call for assistance. If there is no skilled emergency response officer onsite, then the fire department should be notified by calling the local emergency number.

For safety experts, especially those writing fall protection plans, this information is essential to comprehend so that danger can be mitigated and rescue goals achieved. For emergency medical workers responding to a suspended worker, knowing the physiology behind suspension trauma is critical to providing proper treatment to the fall victim.

Rescue

Having a protection plan and a rescue plan in place will minimize the consequences of suspension trauma. The following are several essential tips for the suspended person and the witness employee.

Suspended employees awaiting rescue can take these actions to guard against injury:

- Uncoil the trauma relief straps.
- Hook the straps together.
- Put the feet into and press against straps to simulate standing up.
- Brace their weight against the straps. It reduces the amount of blood pooling in the legs.
- Adopt a sitting position if possible.
- Move into a horizontal position as fast as possible.

The witness employees can take the following actions:

- Treat suspension trauma as an emergency.
- Call the fire department for help.
- Instruct the suspended worker to use footholds to lessen pressure, which will provide support for "muscle pumping."
- Instruct the employee on how to "pump" their legs
- Advise suspended employee that pumping legs will activate the muscles and decrease the risk of venous pooling.
- Observe the suspended worker continuously for signs and indications of suspension trauma.
- Keep the worker's air passages open and provide first aid if needed.
- Monitor the employee after rescue and make sure a healthcare specialist evaluates the employee.
- The worker should be hospitalized if applicable.
- Make sure the employee receives standard trauma resuscitation once he/she is rescued.
- Be aware that possible aftereffects, such as kidney failure, which is not unusual in these cases, are hard to assess on the scene.

Conclusion

Suspension trauma poses a severe risk to employees working at suspended heights. The physiological response to suspension trauma can be lethal. However, several steps can be taken to mitigate the hazard of suspension trauma. A fall protection plan should be implemented for all work done at heights.

The fall protection plan should include a rescue plan and training on the proper use of fall protection equipment. With information about what suspension trauma is and how it distresses the body, we can develop a better strategy for these hazards and continue to improve the safety of our workers.

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