

Suspension Trauma

From "Will Your Safety Harness Kill You?" by Bill Weems and Phil Bishop
(<http://www.cdc.gov/elcosh/docs/d0500/d000568/d000568.pdf>)

Suspension trauma death is caused by orthostatic incompetence (also called orthostatic intolerance). Orthostatic incompetence can occur any time a person is required to stand quietly for prolonged periods and may be worsened by heat and dehydration [...] What happens in orthostatic incompetence is that the legs are immobile with a worker in an upright posture. Gravity pulls blood into the lower legs, which have a very large storage capacity. Enough blood eventually accumulates so that return blood flow to the right chamber of the heart is reduced. The heart can only pump the blood available, so the heart's output begins to fall. The heart speeds up to maintain sufficient blood flow to the brain, but if the blood supply to the heart is restricted enough, beating faster is ineffective, and the body abruptly slows the heart. In most instances this solves the problem by causing the worker to faint, which typically results in slumping to the ground where the legs, the heart, and the brain are on the same level. Blood is now returned to the heart and the worker typically recovers quickly. In a harness, however, the worker can't fall into a horizontal posture, so the reduced heart rate causes the brain's blood supply to fall below the critical level. Orthostatic incompetence doesn't occur to us very often because it requires that the legs remain relaxed, straight, and below heart level. If the leg muscles are contracting in order to maintain balance and support the body, the muscles press against the leg veins. This compression, together with well-placed one-way valves, helps pump blood back to the heart. If the upper-legs are horizontal, as when we sit quietly, the vertical pumping distance is greatly reduced, so there are no problems. In suspension trauma, several unfortunate things occur that aggravate the problem. First, the worker is suspended in an upright posture with legs dangling. Second, the safety harness straps exert pressure on leg veins, compressing them and reducing blood flow back to the heart. Third, the harness keeps the worker in an upright position, regardless of loss of consciousness, which is what kills workers.

From "Harness Suspension: Review and Evaluation of Existing Information" by Paul Seddon
(http://www.ropesafety.com/site/technique/harness_suspension.htm)

The fall and the arrest of it are only part of the story, and not necessarily the most dangerous. After the fall and its arrest comes the suspension phase, when the casualty either rescues him or herself, if capable, or awaits rescue by another person or persons. After a fall, the body is likely to be in a state of shock. If the casualty is badly injured or unconscious, there is unlikely to be any movement of the legs and there can be serious consequences. The orientation of the body and the comfort of the suspended person, determined to a large extent by the design of the harness and the position of its attachment point to the system, also play their part in the outcome.

For climbers in a vertical rescue situation, an unconscious victim is in extreme danger. The initial injury which caused unconsciousness is a medical emergency. Further, being suspended unconscious in a harness is a medical emergency. The rescuer should consider the danger of suspension trauma when considering any rescue plan.

When suspended in a harness, even conscious climbers should be sure to maintain active leg muscles to promote blood return to the heart.