

Does the horizontal position increase risk of rescue death following suspension trauma?



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ABSTRACT

Background: It is widely believed that placing a patient who has been subjected to suspension trauma in a horizontal position after rescue may cause rescue death. The discussion whether position is important has been dominated by non-medical personnel. Subsequently, this has led to a general advice on emergency treatment of these patients, which may cause incorrect or even fatal treatment.

Methods: To determine whether there is any medical evidence supporting that horizontal positioning after suspension trauma may cause rescue death, the authors located publications, reports, expert opinions and other sources of information addressing the acute treatment of suspension trauma. These sources were then evaluated.

Results: Several thousand hits regarding suspension trauma were located on the internet and five articles on the PubMed. Although most of them warned of the dangers of rescue death brought about by assuming the horizontal position after prolonged suspension, the authors found no clinical studies, and none of the sources offered any conclusive evidence as to whether the horizontal position increases the risk of rescue death. Neither the authors, nor the suspension trauma experts who were contacted, had ever experienced or heard of case reports supporting the causal relation between the horizontal position and rescue death.

Conclusions: After evaluating the current literature, the authors found no support for the view that the horizontal position may be potentially fatal for patients exposed to suspension trauma. In the absence of any evidence to the contrary, the authors suggest that the initial management of patients who have had suspension trauma should follow normal guidelines for the acute care of traumatised patients, without special modifications.

Suspension trauma is a natural reaction to the body being held motionless in an upright position. After a short time, blood begins to pool in the lower part of the body, and the patient eventually faints.¹⁻³ This physiological phenomenon has been observed during military parades, in the operating theatre and during crucifixion.⁴ Prolonged motionless vertical suspension in a patient unable to fall over is life-threatening and requires urgent attention.⁵ The exact pathophysiological mechanisms leading to death following suspension trauma have not yet been explained fully.² However, many sources report the widely held belief that a rescued suspension trauma patient must be positioned initially with the upper body raised (semirecumbent position) to prevent rescue death.⁶ The discussion whether position is important has been dominated by non-medical personnel and has concluded with a medical advice that may cause

incorrect or even fatal treatment. The aim of this study was to find if there is any medical evidence supporting the belief that positioning the patient in the horizontal position following suspension trauma may cause rescue death.

METHODS

Using various search strategies, we located publications, reports, expert opinions and other sources of information addressing the acute treatment of suspension trauma. We searched the PubMed database for scientific publications by using the search terms *suspension trauma*, *orthostatic syndrome*, *harness suspension* and *orthostatic intolerance*. We then identified similar articles through an extended search. The authors then screened relevant articles and references. Two major internet search engines (<http://www.Alltheweb.com> and <http://www.Google.com>) were accessed with the same search words (5 July 2008). The located web pages were then screened for suggestions regarding acute treatment and additional information regarding suspension trauma.

We also approached colleagues involved in national and international mountain medicine societies and rescue medicine, either by email or by personal contact, to obtain expert opinions. The various articles and reports supporting either the semirecumbent position or the horizontal position were then tabulated. Finally, we scrutinised the papers that were being cited as evidence for the claimed hazards of placing suspension trauma patients in the horizontal position. No statistical analyses were performed.

RESULTS

We identified only five medical articles in PubMed pertaining to suspension trauma.^{1 2 6-8} None of them provided any conclusions as to whether the horizontal position increases the risk of rescue death. However, the internet search yielded 20 000 and 903 hits on Alltheweb.com and Google.com, respectively. Because of the high number, we performed a second search using *suspension trauma* and *horizontal position* as search phrases. The results are listed in table 1.

The hits were mainly from commercial industrial fall protection companies, climbing and caving associations, governmental occupational safety administrations and even YouTube. There were plenty of opinions offered by laypersons regarding the possibility of rescue death if the patient is placed horizontally after rescue. We realised early on in our research that there were many "circle citations"—for example, articles citing each other or the same publications. The main findings from

Table 1 Hits from the internet search with search phrases *suspension trauma* and *horizontal position*

Type of website/hit	Alltheweb.com	Google.com
Industrial or commercial fall protection	35	14
Governmental health safety reports	20	8
Climbing and caving associations	110	44
Non-scientific medical	45	14
Discussion forums	25	10
Other	15	5
Total	250	95
Reference to the Seddon report ⁹	110 (44%)	63 (66%)
Horizontal position may be dangerous	165 (66%)	77 (81%)

the internet search were numerous citations warning against the horizontal position, but no case reports.

The Seddon report,⁹ a thorough review and evaluation of suspension trauma, appears to be the most cited article. This report cites articles that advocate treating suspension trauma patients in the horizontal position and also articles suggesting that this treatment may cause death. Despite this disagreement, Seddon concludes that a suspension trauma patient should not be positioned horizontally, except in cases of cardiac arrest. This conclusion is based primarily on case reports presented at a conference on mountain medicine in Innsbruck in 1972.¹⁰ Table 2 summarises the case reports from this conference.

Stuhlinger *et al*¹¹ conducted a test with 10 volunteers who were suspended in a harness until circulatory collapse immediately after they were placed in a horizontal position. Some of the test subjects had sinus arrhythmias and ventricular extrasystoles. From these findings, the researchers concluded that the rapid venous return of pooled blood might induce cardiac arrest and cause rescue death.¹² Our survey among international medical colleagues did not reveal any personal observations or studies supporting the causal relation between the horizontal position and cardiac arrest.

DISCUSSION

Rapid removal from the suspended position is of major importance in managing suspension trauma patients, but there is no consensus among medical experts regarding the emergency treatment of suspension trauma patients after they are lowered to the ground. However, many current guidelines emphasise that these patients should not be initially placed in the horizontal position because of the risk of cardiac arrest. Some also warn about the possible adverse effects of fluid replacement because of reflow syndrome. The pathophysiological mechanisms causing the patients to faint are medically accepted, but

the exact mechanisms causing cardiac arrest after prolonged suspension are still being debated. One theory is that the Bezold-Jarisch reflex causes cardiac arrest as a consequence of venous pooling (Ledoux Xavier, personal communication with SCS, 5 October 2007). It is known that mechano-electrical feedback may cause arrhythmogenic activity because of acute mechanical stretching of myocardial tissue.^{13 14}

It is thought that this mechanism could cause acute cardiac volume overload in suspension trauma, if the patient is placed in a horizontal position after rescue, leading to cardiac arrest. We have not found any evidence corroborating this theory as a cause of death in healthy subjects exposed to suspension trauma, nor does the existing literature offer any exact explanations as to the precise cause(s) of cardiac death in these patients. Whether death is caused by an acute cardiac arrhythmia or by acute heart failure due to volume overload is still unknown. The suspension trauma patients are generally healthy individuals at work or in rather demanding leisure activities. One would therefore believe that their cardiovascular system would well tolerate the volume challenge that supine positioning could possibly represent. There are few reasons to believe that volume treatment and horizontal positioning should be dangerous to a patient suspended by some kind of harness, when it is supposed to be the correct treatment in similar patients with acute circulatory failure—for example, anaphylaxis, cardiac arrest, traumatic hypovolemia or vasovagal syncope. The arrhythmias described in one study are also often seen in young healthy persons and do not necessarily represent any sign of significant pathology.¹¹

Only chest harnesses were used in all the reported fatalities from the 1972 Innsbruck conference, and the median suspension time was 5.25 h. Combined with the long time to death after rescue (median 9.25 h), none of these case reports provide any evidence that the horizontal position was the cause of death.

Table 2 Potential suspension trauma/rescue death cases reported at the mountain medicine conference in Innsbruck (1972)

Year	Age	Suspension time	Time to death after rescue
1955	25	3 h	11 days
1957	18	6.5 h	1.5 h
1957	24	7 h	32 h
1961	21	4 h	2 h
1963	33	3 h	19 h
1963	19	0.5 h	Dead when found
1964	17	24 h	Dead when found
1968	19	8 h	17 h
1970	25	24 h	2 h
1972	23	4 h	A few minutes
Median	22	5.25 h	9.25 h

Adapted from Flora and Holz.¹⁰

Prehospital care

In the prehospital setting, assessing and securing the airway, breathing and circulation to ensure optimal cerebral oxygenation and perfusion are always the first vital steps in managing an unconscious or traumatised patient. The optimal position for managing this in an unconscious patient is the horizontal position. Managing an unconscious suspension trauma patient in an upright position is practically challenging and does not allow for optimal control of these vital functions. Any arguments to deviate from the “normal” management of unconscious patients according to modern advanced life support (ALS) principles should therefore be well documented and carefully assessed before being presented as general guidelines.

We could not find clinical evidence in the current medical literature that delayed fluid resuscitation is beneficial in treating suspension trauma patients. Indeed, accurately diagnosing hypovolemia in an unconscious patient is difficult, particularly in a prehospital trauma setting. Appendix A presents a case report in which a focus on positioning rather than on volume therapy may actually have caused rescue death. If one accepts that one of the major contributions to the circulatory failure of a suspension trauma patient is a drastically reduced central venous return, treating the hypovolemia would be one of the more sensible acute measures. Therefore, we suggest that the emergency management including fluid replacement should follow established guidelines as described in Appendix B.¹⁵

Conclusion

We found no support for the belief that the horizontal position may be potentially fatal for suspension trauma patients. As long as evidence is lacking, we suggest that the initial management of these trauma patients should follow international ALS guidelines without modification. Further investigations and clinical trials would have to be performed to evaluate whether there are specific circumstances in suspension trauma syndrome that may require particular care.

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APPENDIX A FOCUS ON RESCUE DEATH COULD CAUSE RESCUE DEATH

In May 2005, the Norwegian Broadcast Cooperation (NRK) reported of a 29-year-old industrial worker who died after being suspended in a safety harness in an upright position. It took the rescuers about 20 min to lower the patient to the ground. The patient was alive after the fall, but he died shortly thereafter in the hospital. Fall protection “experts” criticised the rescue operation and assumed that the worker’s death was caused by suspension trauma. However, it was also reported that the worker died because of major internal haemorrhage. If this worker, with severe hypovolemia, had been placed in a sitting position with no volume therapy, even if circulatory shock had occurred, the focus on suspension trauma could have caused, rather than prevented, rescue death (http://www.nrk.no/nyheter/distrikt/nrk_ostafjells/buskerud/4752562.html).

APPENDIX B MANAGEMENT OF SUSPENSION TRAUMA

1. The best way to manage suspension trauma is to prevent it.
2. If possible, ask the patient to move in the harness (pendulum motions of hips and knees).
3. When rescuing, avoid hoisting in the vertical position if possible, without delaying rescue.
4. When patient is rescued and put in the horizontal position, start primary survey and resuscitation:
 - a. airway management with cervical spine control
 - b. breathing
 - c. circulation and haemorrhage control
 - d. disability and neurological assessment
 - e. exposure and environment: avoid hypothermia.
5. Perform further resuscitation according to ALS guidelines.
6. All patients experiencing any symptoms of suspension trauma or exposed to high energy should be admitted to the hospital.



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