

Severe gastric involvement due to hypothermia in a victim of snow avalanche

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Summary

A 21-year-old man was caught by a snow avalanche in the Giant Mountains. He was found and extricated after 165 minutes of burial (the depth of the snow mass on extrication was 4.5 metres). On admission to hospital, the core temperature was 20 °C (measured in the oesophagus). Extracorporeal blood rewarming was commenced. Rewarming treatment was complicated by

severe gastrointestinal bleeding. Prompt endoscopy found multiple erosions and areas of intramucosal haemorrhages in the stomach and duodenum. Gastric involvement was diffuse and endoscopically untreatable. The patient died from intractable shock due to prolonged hypothermia and asphyxia 8 hours after being buried by the avalanche. Autopsy

found multiple haemorrhagic lesions in the gastric and duodenal mucosa, so called Vishnevsky spots. This finding is pathognomonic for hypothermia-related deaths.

KEY WORDS: ASPHYXIA, EXTRACORPOREAL REWARMING, GASTROINTESTINAL BLEEDING, HYPOTHERMIA, SNOW AVALANCHE, WISHNEVSKY SPOTS

Souhrn

Závažné postižení žaludku v důsledku hypotermie u osoby zasypané lavinou

Kazuistika popisuje tragický případ 21letého muže, který byl v Krkonoších zasypan lavinou. Nalezen a vyprostěn byl za 165 min. po zasypaní v hloubce 4,5 metru. Při přijetí do nemocnice byla teplota tělesného jádra měřená v jícnu 20 °C. Byl zahájen postupný ohřev metodou mimotělního oběhu.

Tento léčebný postup byl komplikován závažným krvácením do trávicího ústrojí. Urgentní gastroskopie našla mnohočetné eroze a ložiska slizničního krvácení v žaludku. Stav byl endoskopicky neřešitelný. Nemocný zemřel pod obrazem nezvladatelného šoku z protrahované hypotermie a asfyxie za 8 hodin po zasypaní lavinou. Při sekci byly nalezeny mnohočetné hemo-

ragické leze v žaludku a v duodenu, tzv. Višněvského skvrny. Tento nález je patognomický pro smrt z dlouhodobého podchlazení.

KLÍČOVÁ SLOVA: ASFYXIE, GASTROINTESTINÁLNÍ KRVÁCENÍ, HYPOTERMIE, MIMOTĚLNÍ OBĚH, OHŘEV PACIENTA, SNĚHOVÁ LAVINA, VIŠNĚVSKÉHO SKVRNY

Around 140 persons die every year due to snow avalanches (recorded by the International Commission for Alpine Rescue - ICAR), approximately 35 subjects in North America, 100 in the European Alps, and 5 persons in other parts of Europe [14]. Major avalanche catastrophes have also been reported in the Himalayas, South-Eastern Asia Minor, and Iceland [3]. In fatal cases, the most common causes of death are asphyxia (60-75 %), trauma (10-25 %) and hypothermia (up to 7 %), or their combination [3,5,9,11-13,15-18,22]. We report a fatal case of a young skier caught by an avalan-

che with severe gastric involvement due to hypothermia and asphyxia.

CASE REPORT

A 21-year-old man, previously completely healthy, was caught by a snow avalanche in the Giant Mountains (at the Czech-Polish border). The accident happened at 11:30 a.m. External air temperature was minus 13.5 °C. There was a crosswind (21 metres per second). The young man was completely buried by a huge mass of powder snow. The avalanche victim was found and extricated 165 minutes later (the depth of the snow mass on

extrication was 4.5 metres). He was found in a horizontal position with an artificial air pocket. There was cardiac arrest and no spontaneous breathing. The patient was intubated and cardiopulmonary resuscitation was started. The subclavian vein was cannulated, i.v. epinephrine and plasma-expander infusions were administered and external warming was applied. The patient was transferred by helicopter to the Department of Cardiac Surgery of the University Hospital at Hradec Králové. On admission, 225 minutes after being buried by the avalanche, the patient's core temperature was

20 °C, measured in the oesophagus. Extracorporeal blood rewarming was commenced. However, loss of filling of the extracorporeal circulation system occurred on subsequent increase of body temperature. A naso-gastric tube was introduced and a large volume (approximately one litre) of fresh blood was sucked off from the stomach. Prompt gastroscopy was performed and found multiple erosions and areas of intramucosal haemorrhages of the stomach and duodenum (see Figs 1, 3 and 4). This severe diffuse gastric involvement was endoscopically untreatable. The core temperature of 32 °C (measured in the oesophagus) was reached within 120 minutes of extracorporeal blood rewarming. However, it was not possible to maintain systemic circulation. Despite all complex intensive care the young man died with signs of intractable shock 8 hours after being buried by the avalanche. Autopsy found no major trauma. The most important finding was revealed in the stomach and duodenum. There were multiple haemorrhagic lesions in the gastric and duodenal mucosa (so-called Wishnewsky spots), see Figs 2 and 5. This finding is pathognomonic for hypothermia-related deaths. There were also multiple skin, mucosal and organ signs of suffocation. Autopsy concluded that the cause of death was prolonged shock due to severe hypothermia and asphyxia.

DISCUSSION

The avalanche survival probability for victims who are completely buried depends on several factors (including open airways, trauma and hypothermia). However, time to extrication is the major determinant. Probability of survival is about 90 % for persons extricated within 15 minutes but only 30 % at 35 minutes (acute asphyxia of victims without an air pocket). Survival after 35 minutes is dependent on an artificial air pocket in the snow allowing for breathing. Survival at

90 minutes is 25–30 %, but only about 7 % at 130 minutes (death of victims with a “closed” air pocket from late asphyxia and hypothermia) [3,8,9]. We report a catastrophic case of a young man caught by an avalanche with a severe gastric involvement due to prolonged hypothermia and asphyxia. He was found and extricated after 165 minutes of burial (the depth of the snow mass on extrication was 4.5 metres).

Accidental hypothermia plays a less important role in most avalanche disasters than is generally assumed and should not be equated with accidental hypothermia of other aetiology, such as an environmental exposure [3]. Hypothermia is defined as a core temperature below 35 °C, “severe hypothermia” is classified as a status with a core temperature below 28 °C [6]. Hypothermia causes altered cell membrane function, efflux of intracellular fluid, enzymatic dysfunction, and electrolyte dysbalance (including prominent hyperkalaemia). Cell death results from a combination of these injuries and possible crystallization of intra- and extra-cellular water [1]. The fall in body temperature

acts initially as a protective factor in the prevention of hypoxic damage. However, at a core temperature of 32 °C circulatory instability may be triggered. This critical core temperature appears about 90 minutes after snow burial in open areas [3]. During snow burial, hypercapnia increases the core temperature cooling rate [4,10].

The victim of our case report was in a severe hypothermia, his core temperature was only 20 °C (measured in the oesophagus). Extracorporeal blood rewarming in our case was started after admission to hospital as it is con-

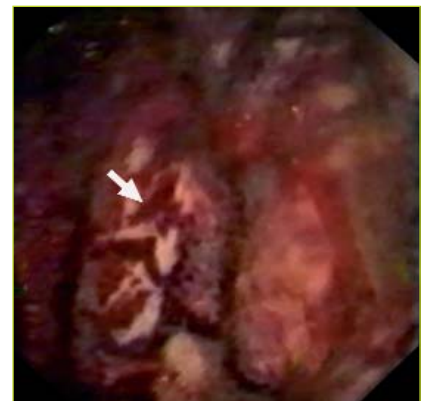


Fig. 1. Upper GI endoscopy. Multiple haemorrhagic lesions in the gastric body (one of them marked with an arrow).

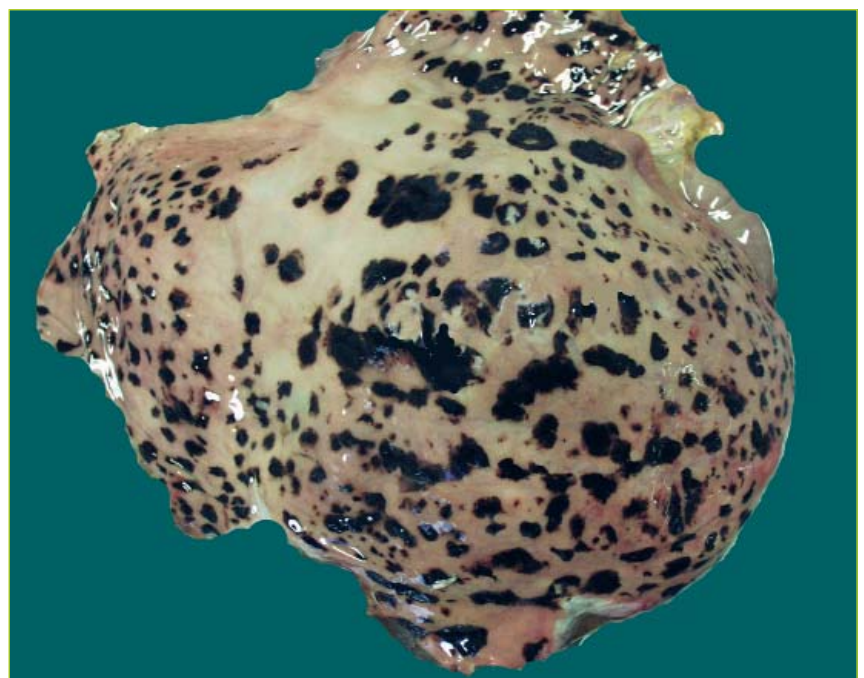


Fig. 2. Autopsy. Wishnewsky spots in the stomach in a victim of prolonged hypothermia.

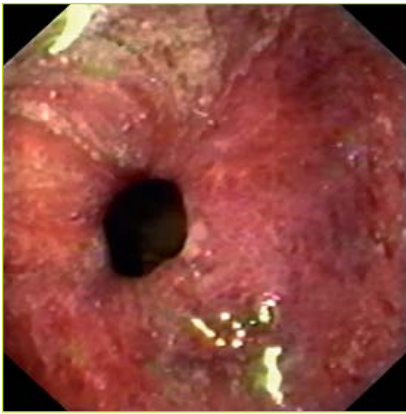


Fig. 3.
Upper GI endoscopy. View of the pylorus and prepyloric part of the antrum. Gastric mucosa is reddish, fragile, covered by remnants of fresh blood.

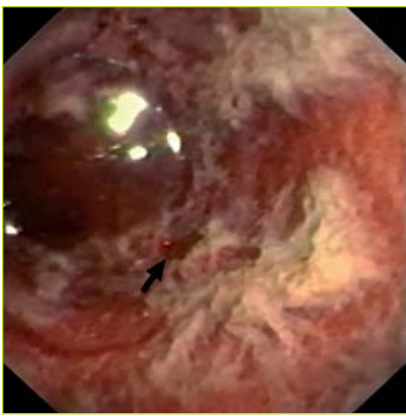


Fig. 4.
Upper GI endoscopy. View of the proximal duodenum. Multiple haemorrhagic lesions are seen, one of them is marked with an arrow.

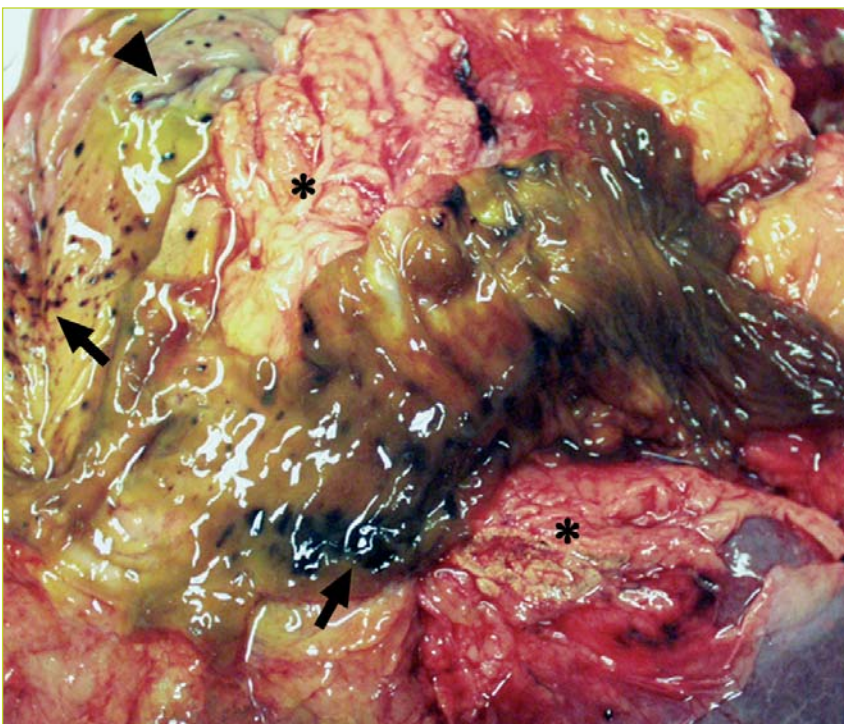


Fig. 5.
Autopsy. Multiple Wishnewsky spots (arrows) in the duodenum of the avalanche victim. The pylorus is marked with an arrowhead, the pancreas is marked with asterisks.

sidered to be the gold standard in the treatment of patients with accidental hypothermia and circulatory arrest [3,7,19]. Heparin-coated systems can be used even in traumatised patients [3,7,21]. Brugger et al. [3] reviewed three studies of avalanche victims and showed that only 6 of 51 victims (12 %) were successfully rewarmed. This low recovery rate is due to the dependence of the prognosis in avalanche victims primarily on the duration of asphyxia and not the degree of hypothermia [3].

Wishnewsky spots in the stomach are considered to be a pathognomonic sign of hypothermia-related death [2,16,20]. Histologically, these lesions are not true gastric erosions or ulcers [20]. Some authors hypothesize that hypothermia primarily leads to circumscribed haemorrhages of the gastric glands in vivo or in the agonal period. Subsequently, due to autolysis, erythrocytes are destroyed and haemoglobin is released. Following exposure to hydrochloric acid, haemoglobin is haematinized, leading to the typical blackish-brownish appearance of

Wishnewsky spots seen at gross examination [20]. Wishnewsky spots in the stomach are frequently found at autopsy in fatal hypothermia. Our case was unusual in this aspect, these haemorrhagic lesions in the stomach and duodenum were diagnosed by gastroscopy and identified as a cause of severe gastrointestinal bleeding during rewarming treatment of severe hypothermia. To the best of our knowledge, there is no similar observation described in the available literature so far. Nevertheless, bleeding diathesis is a known complication during the recovery period after successful resuscitation and rewarming. Other possible complications include arrhythmias, hypotension, hyperkalaemia, hypoglycaemia, rhabdomyolysis, infections, and bladder atony [6].

In conclusion, we have reported severe gastrointestinal bleeding as an unusual complication of a rewarming period of severe hypothermia in an avalanche victim. Prompt endoscopy found multiple erosions and areas of intramucosal haemorrhages in the stomach and duodenum as the source of severe bleeding. Gastric involvement was diffuse and endoscopically untreatable. The patient died from intractable shock due to prolonged hypothermia and asphyxia.

References

1. Biem J, Koehncke N, Classen D, Dosman J. Out of the cold: management of hypothermia and frostbite. *Can Med Assoc J* 2003; 168: 305-311.
2. Birchmeyer MS, Mitchell EK. Wischnewski revisited. The diagnosis value of gastric mucosal ulcers in hypothermic deaths. *Am J Forensic Med Pathol* 1989; 10: 28-30.
3. Brugger H, Durrer B, Adler-Kastner L et al. Field management of avalanche victims. *Resuscitation* 2001; 51: 7-15.
4. Brugger H, Sumann G, Meister R et al. Hypoxia and hypercapnia during despiration into an artificial air pocket in snow: implications for avalanche

- survival. *Resuscitation* 2003; 58: 81-88.
5. Christensen ED, Lacsina EQ. Mountainneering fatalities on Mount Rainier, Washington, 1977 - 1997: autopsy and investigative findings. *Am J Forensic Med* 1999; 20: 173-179.
 6. Crawford Mechem C. Accidental hypothermia. UpToDate 2007. <http://www.uptodate.com/>
 7. Danzl DF, Pozos RS. Accidental hypothermia. *N Engl J Med* 1994; 331: 1756-1760.
 8. Falk M, Brugger H, Adler-Kastner L. Avalanche survival chances. *Nature* 1994; 368: 21.
 9. Grissom CK, Radwin MI, Harmston CH et al. Respiration during snow burial using an artificial air pocket. *J Am Med Assoc* 2000; 283: 2266-2271.
 10. Grissom CK, Radwin MI, Scholand MB et al. Hypercapnia increases core temperature cooling rate during snow burial. *J Appl Physiol* 2004; 96: 1365-1370.
 11. Grossman MD, Saffle JR, Thomas F, Tremper B. Avalanche trauma. *J Trauma* 1989; 29: 1705-1709.
 12. Hohlrieder M, Brugger H, Schubert HM et al. Pattern and severity of injury in avalanche victims. *High Alt Med Biol* 2007; 8: 56-61.
 13. Hohlrieder M, Mair P, Wuertl W, Brugger H. The impact of avalanche transceivers on mortality from avalanche accidents. *High Alt Med Biol* 2005; 6: 72-77.
 14. Paal P, Beikircher W, Brugger H. Der Lawinennotfall. Eine aktuelle Übersicht. *Anaesthesist* 2006; 55: 314-324.
 15. Page CE, Atkins D, Shockley LW, Yaron M. Avalanche deaths in the United States: a 45-year analysis. *Wilderness Environ Med* 1999; 10: 146-151.
 16. Preuss J, Thierauf A, Dettmeyer R, Madea B. Wischnewsky's spots in an ectopic stomach. *Forensic Sci Int* 2007; 169: 220-222.
 17. Stalsberg H, Albertsen C, Gilbert M et al. Mechanism of death in avalanche victims. *Virchows Arch A Pathol Anat Histopathol* 1989; 414: 415-422.
 18. Strohm PC, Köstler W, Hammer T, Südkamp NP. Lawinennotfall und akzidentelle Hypothermie. Seltener Notfall im Südschwarzwald. *Unfallchirurg* 2003; 106: 343-347.
 19. Truhlář A, Honzík M, Mašek J, Lonský V. Principles of admitting hospital selection in treatment of hypothermic patients (in Czech). *Urgentní medicína* 2007; 10: 20-24.
 20. Tsokos M, Rothschild MA, Madea B et al. Histological and immunohistochemical study of Wischnewsky spots in fatal hypothermia. *Am J Forensic Med Pathol* 2006; 27: 70-74.
 21. von Segesser LK, Garcia E, Turina M. Perfusion without systemic heparinization for re-warming in accidental hypothermia. *Ann Thorac Surg* 1991; 52: 560-561.
 22. Xiang H, Stallones L. Deaths associated with snow skiing in Colorado 1980 - 1981 to 2000 - 2001 ski seasons. *Injury Int J Care Injured* 2003; 34: 892-896.

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