

Deep snow immersion suffocation — the deadly threat

Sylweryusz Kosiński^{1,2}, Jakub Jasiński, Stanisław Krzeptowski-Sabała¹,
Jan Gąsienica-Roj Jr.¹, Andrzej Górka¹

¹Tatra Mountain Rescue Service, Zakopane, Poland

²Pulmonary Hospital, Zakopane, Poland

Abstract

This report presents the case of non-avalanche-related snow immersion death in the Tatra Mountains, which meets all the criteria of this rare phenomenon. The causes and mechanism of deep snow immersion suffocation as well as prevention strategies are discussed.

Key words: asphyxiatia, snow, immersion, skiing, cardiopulmonary resuscitation

Anaesthesiology Intensive Therapy 2013, vol. 45, no 1, 33–34

Non-avalanche-related snow immersion death (NARSID) is an extremely rare cause of death of skiers. In the past two decades, only several tens of NARSID cases were documented in the United States and Canada [1]. The first NARSIDs were described in 1994 [2] and were followed by further reports about victims among off-piste skiers and snowboarders [3, 4]. This report describes the case of snow immersion death in Polish Tatra Mountains, which fulfils all the diagnostic criteria of this rare phenomenon.

CASE REPORT

In the winter of 2009, the group of young men went skiing downhill in deep, unconsolidated snow in the region of Niżna Goryczkowa Równia (Western Tatra). At that time, the average snow cover was 270 cm, including 30 cm of fresh snowfall [5]. The skiers were going down a sparsely-wooded gully of 50° slope, whose lower portion united with the popular ski run. Searching for the optimal skiing conditions, the skiers were gradually increasing distances among them; the powdery snow and trees additionally hindered the visual contact. The victim was a 30-year-old experienced skier closing the group. Having reached a clearing at the end of the gully, the partners waited for him for several minutes and started searching. The victim was last seen at about 12:15. At 12:37, the accident was reported to the Dispatch Centre — the attempts to dig out the skier without vital signs were visible from the adjacent hill. Two rescuers were immediately sent from the station at the top of the

trail to the accident site; the helicopter crew was notified and started preparations. At 12:50, the rescuers found the accident site. The victim was buried in snow, face down, at the angle of 40°; only some part of his skis was visible. The partner administering the first aid was unable to get the victim out; nevertheless, he tried mouth-to-mouth ventilation in deep snow. The rescuers transported the victim to another place where the snow was shallower and continued basic resuscitation procedures. At 12:55, the helicopter arrived and a physician and a rescuer with medical equipment were lowered on a rope. The endotracheal intubation was performed and lung ventilation with 100% oxygen started using a self-reinflating resuscitation bag. The indirect heart manual chest compressions were continued. Adrenaline, 3 mg, and atropine, 3 mg, were administered via intraosseous access on the tibial tuberosity. Once the ECG monitor was connected, asystole was diagnosed. Due to extremely difficult conditions of resuscitation, the rescue team decided to transport the victim to the packed trail. At 13:15, they started the toboggan transport down the gully and at 13:30 the helicopter waiting on the clearing took the victim to the hospital. Chest compressions as well as ventilation with a self-reinflating bag were continued throughout the transportation period. On arrival to the Emergency Department, active external warming was initiated and CPR continued. Twenty-five minutes after admission spontaneous circulation was restored. The patient was transferred to the Intensive Care Unit, where he died

30 hours later due to cerebral ischaemic damage, despite the treatment provided.

In order to determine the causes of circulatory arrest, coronarography and computed tomography of the head and chest were performed, which showed no abnormalities. Moreover, the physical examination did not reveal any external injuries, apart from the CPR-associated superficial ones. The analysis of accident circumstances and results of additional tests explicitly demonstrated snow immersion asphyxiation.

DISCUSSION

The comparison of the accident circumstances with the available literature data, [1, 2, 3, 4, Paul Baugher — personal communication] showed that the cause of death was deep snow immersion asphyxiation, the phenomenon extremely rare in Polish mountains [1, 2, 3, 4]. NARSIDs predominantly occur in the United States and Canada where 96 victims were recorded. Some laconic and rather anecdotal reports describing characteristics of this rare phenomenon in Poland can be found; however, no comprehensive descriptions have been presented [6, 7].

One-third of snow immersion cases occurs in the open area and 2/3 near the trees. In both cases, the thick snow layer is the major cause. The tree wells are particularly hazardous for skiers. Huge snowfalls gradually cover the lowest branches with free spaces among them; the surface of snow around conifers may be even or slightly depressed. Having exceeded the critical distance to the tree trunk, the skier falls into a trap; he rapidly caves in and is covered with snow falling from the branches and edges. Trying to get out and making rapid movements, the victim immerses deeper in snow and loses spatial orientation. It should be emphasised that this mechanism is observed more often in victims who managed to unfasten their skies [1, 4]. In the open space, where the wells cannot form, snow immersion usually results from a fall.

Our victim was near the tree yet could not reach its branches; therefore, the second variant was more likely in this case.

Irrespective of the sequence of events leading to immersion, the direct cause of death is asphyxiation; in most cases, injuries and hypothermia are not observed [4]. However, the pathomechanism of asphyxiation is unknown. The avalanche-related asphyxia mechanisms are considered to be involved – airway obstruction by snow or food content, positional asphyxia caused by excessive bending of the head to the trunk or asphyxia caused by reduced oxygen levels and carbon dioxide accumulation in the closed air pocket [4]. Generally, victims suffocate within 15–30 min; in some cases, death occurs already 5–10 minutes after the time of burial [1, 4].

Non-avalanche-related snow immersion deaths usually affect experienced skiers, with good skiing skills in unconsolidated snow outside the designated runs. The main preventive measure is the assistance of partners. Only skiers accompanying the victims or witnesses of accidents are able to dig them out before asphyxia develops. In most cases, the time of notification and arrival of rescue teams is too long to save the victims. Therefore, the importance of maintaining visual contact during downhill skiing is strongly stressed.

Based on experimental studies, the management guidelines for those affected were formulated [1, 4, 8]. Victims should avoid rapid movements and focus on creating and securing an air pocket. Moreover, they should not try to unfasten skis or snowboards; left fastened, they are likely to prevent further immersion. It is extremely difficult, if not impossible, to get out unaided. The findings of experimental studies demonstrate that about 10% of skiers managed to get out without help, yet due to safety reasons, the experiment was conducted under substantially milder conditions compared to real cases [1]. In the snow wells near the trees, there is some chance to grab the branches or trunk if reachable. In the majority of cases, creating and maintaining an air pocket and waiting for help are the priority.

Deep snow immersion and falling into the snow well may result in asphyxiation of skiers in any region with suitable skiing conditions. The individuals interested in off-piste skiing and members of mountain rescue services should be aware of snow immersion risks and know how to manage and prevent them.

References:

1. *Baugher P*: Recent trends and prevention strategies for avalanche and snow immersion risk at U.S and B.C ski areas. Proceedings of the International Snow Science Workshop, Whistler, British Columbia, September 21–27, 2008: 766–773.
2. *Kizer K, MacQuarrie MB, Kuhn BJ, Scannell PD*: Deep snow immersion deaths: a snowboarding danger. *Phys Sportsmed* 1994; 22: 49–61.
3. *Cadman R*: Eight nonavalanche snow immersion deaths. A 6-year series from British Columbia ski areas. *Phys Sportsmed* 1999; 27: 31–43.
4. *van Tilburg C*: Non-avalanche-related snow immersion deaths: tree well and deep snow immersion asphyxiation. *Wilderness Environ Med* 2010; 21: 257–261.
5. National Climatic Data Center, Climate Data Online. <http://www7.ncdc.noaa.gov/CDO/cdo>
6. *Dryszel A*: Więcej szczęścia niż rozumu. <http://www.przegląd-tygodnik.pl/pl/artykul/wiecej-szczescia-niz-rozumu>
7. *van der Coghén P*: Utonąć w śniegu. <http://www.piotrvandercoghen.pl/pl/89/gawedy-starego-ratownika>
8. *Baugher P*: Tree well and deep snow safety. <http://www.treewelldeepsnowsafety.com>

Corresponding author:

Sylwester Kosiński MD
Pulmonary Hospital in Zakopane
ul. Gładkie 1, 34–500 Zakopane, Poland
tel.: + 48 18 201 50 45
e-mail: kosa@mp.pl

Received: 30.06.2012

Accepted: 14.10.2012