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CASE REPORT

Kite Skier's Toe: An Unusual Case of Frostbite

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Frostbite is a well-known occurrence in outdoor winter activity and exploration. We report the first documented case of frostbite associated with kite skiing. Kite skiing is an emerging sport that uses a kite to harness wind power for recreation and to travel long distances on skis. Certain characteristics of this sport may predispose athletes to frostbite injury. The stance required to resist and redirect the force created by the wind and kite puts constant pressure and repetitive trauma on the downwind great toe. This can compromise blood flow and increase risk of cold injury. Future kite skier expeditions should focus on specific prevention methods including properly fitting boots, adequate boot insulation, and frequent rest periods to inspect and warm toes.

Key words: frostbite, kite skiing, Antarctica, cold exposure

Introduction

Two men recently completed a journey crossing Antarctica on skis powered by wind and kites. This form of travel is known as "kite skiing." The toes of one of the expedition members sustained frostbite injuries during the trip whereas those of the other member did not. The injuries were likely caused by a combination of factors including subzero temperatures, boot selection, repetitive microtrauma, and pressure ischemia unique to kite skiing. Frostbite was first diagnosed on day 38 of the 81-day expedition and was subsequently followed by remote physician consultation using satellite technology. The patient's toes have healed without amputation.

Case Report

A 48-year-old man and a 27-year-old male companion set out on an attempt to cross Antarctica. The team used kites to harness wind power and propel themselves across the ice while on skis (Figure 1). The expedition traveled from the Russian Station of Novo to the Pole of Inaccessibility, the South Pole, and then on to Hercules Inlet. They set out on November 6, 2011 (S70°51.333 E011°32.992, elevation 649 m [2128 feet]) and completed the expedition on January 23, 2012 (S79°58.370 W079°43.314, elevation 217 m [712 feet]). They averaged 50.6 km/d for 81 days and covered a total of 4100 adjusted kilometers in that time (Figure 2).

Temperatures ranged between −30°C and −45°C. With wind chill and at higher elevations temperatures likely reached as low as −60°C. The expedition started at 649 m (2128 feet), and the team ascended to 2896 m (9500 feet) pulling loads on skis during the first 2 weeks of the trip. For the next 50 days they stayed between 2896 m (9500 feet) and 3658 m (12,000 feet) before starting their descent to sea level on day 81. The sun was present 24 hours a day. After their initial ascent, kites powered 90% of the trip. The kite skiing allowed them to quickly cover large distances. Sastrugi, sharp irregular ridges formed on snow surfaces by wind erosion, dominated the landscape they traveled on.

The subject wore Dynafit ZZero 4 PX-TF Alpine Touring Boots with fiberfill overboots and Rossignol S86 Skis with Dynafit bindings. The fiberfill overboots were insulated with Kevlar and Nomex and had a wind-resistant outer layer. His partner wore Millet Everest mountaineering boots and Rossignol S3 skis. Their sock systems included a thin base layer, a vapor barrier, and a

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Figure 1. Kite skiing in Antarctica.

thick wool layer. Boots were kept loose to allow for improved circulation throughout the day. Both participants were diligent about monitoring their feet for sufficient warmth, rotating socks regularly, and keeping their feet dry. Despite preventive measures, the patient developed numb toes early in the expedition.

On day 22 of the expedition, the subject injured his right big toe. His toenail broke, and the distal toe subsequently became swollen and developed a friction blister. This blister then burst and continued to ooze serosanguinous fluid throughout the coming weeks. The fluid underwent repeated freezing and thawing, which contributed to cold injury. Initial care was ibuprofen, 800 mg twice daily, and dressing the toe with both antibiotic ointment (Fucidine and polysporin) and medical tape each morning and evening. On day 38, the subject sought medical advice via satellite phone from the physician based at the Union Glacier Camp (D.G.). The subject was also able to e-mail digital photos of the affected toe to aid the consultation (Figures 3–7). The diagnosis was established as a combination of bruising from trauma and frostbite. An additional opinion was requested from a UK expert in frostbite injuries (C.I.). Internet communication was established, and the consultant confirmed the diagnosis of frostbite and postulations were made about the mechanism of injury.

The doctors present in Antarctica, in conjunction with consulting off-site physicians, advised a couple of days of rest to evaluate healing in the temporary absence of further trauma and cold temperatures. There was some concern that continuing the expedition for the remaining 6 weeks would be detrimental for the long-term health of the toe. Evacuation was considered, but with noted injury improvement, the expedition made the decision to continue.

On resuming the expedition, the team made changes to their itinerary and footwear systems. Initially they had

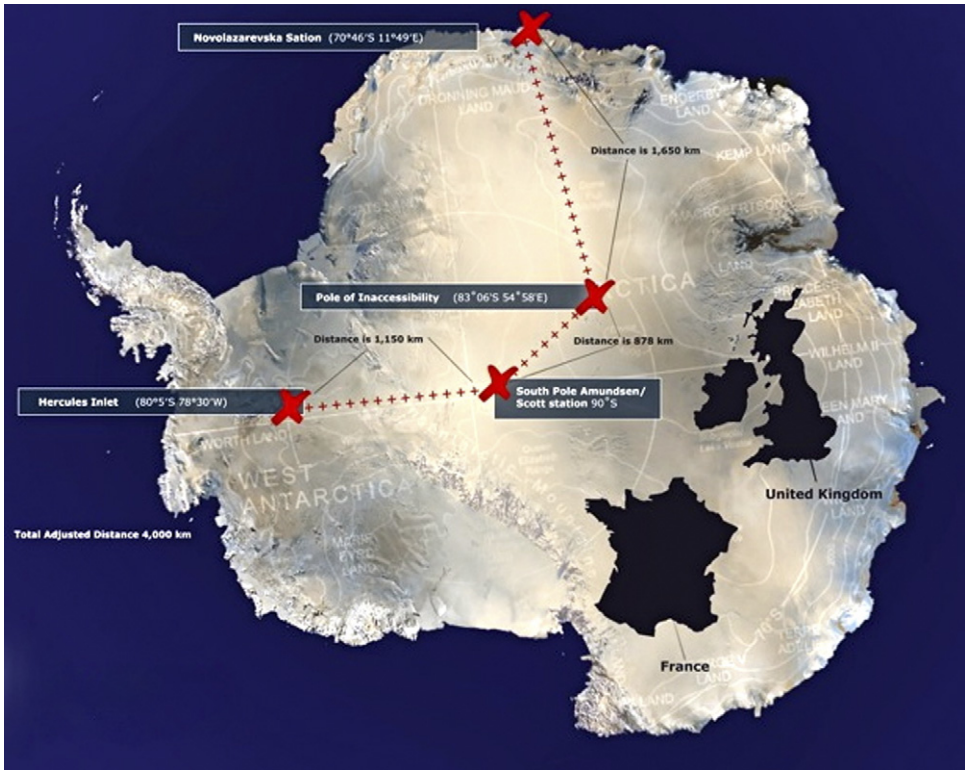

Figure 2. Route taken by kite skiers on the Antarctica 2011–2012 Legacy Transcontinental Expedition.