CASE REPORT

Racing heartbeats at high altitude: A case of relapsed hyperthyroidism on the Everest Base Camp trail

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SUMMARY

High-altitude environments impose significant physiological stress, particularly on individuals with pre-existing medical conditions. This case report describes a physically fit 36-year-old woman who experienced a relapse of hyperthyroidism on the eighth day of her ascent to Everest Base Camp at an altitude of 5,180 m. Upon returning to sea level, she presented to the emergency department with persistent palpitations and a 3-kg weight loss over twelve days. Thyroid function tests confirmed a relapse of hyperthyroidism. Her liver enzymes were elevated 12 days later, suggestive of hepatocellular injury.

Liver injury following high-altitude exposure is rare but may be attributed to hypoxic stress, oxidative damage, and metabolic strain. Hyperthyroidism increases the metabolic rate and oxygen demand, potentially increasing the liver's susceptibility to hypoxia-induced injury. In this case, the interplay between preexisting thyrotoxicosis, high-altitude hypoxia, oxidative stress, and rapid descent likely contributed to transient liver dysfunction. Additional risk factors, including cold exposure, inadequate caloric intake, and dehydration, may have further exacerbated hepatic stress.

The patient was treated with radioactive iodine therapy for definitive hyperthyroidism control along with supportive care. Her liver enzymes normalised within three months after the descent. This case emphasises the importance of pre-travel risk assessment for individuals with thyroid disorders planning high-altitude activities. Clinicians should acknowledge the potential for hepatic stress in patients with hyperthyroidism exposed to high altitudes and advise appropriate preventive measures. Further research is needed to explore the impact of high-altitude hypoxia on liver health, particularly in individuals with underlying metabolic conditions.

INTRODUCTION

High-altitude environments, typically defined as elevations above 2,500 meters, present significant physiological challenges due to reduced atmospheric pressure and oxygen availability. These conditions can cause various altitude-related illnesses, ranging from acute mountain sickness to severe conditions such as high-altitude cerebral oedema and high-altitude pulmonary oedema. While hepatic dysfunction at high altitudes is less commonly reported, hypoxic stress and hepatic ischemia may contribute to liver injury.

Individuals with preexisting medical conditions, such as hyperthyroidism, may be particularly vulnerable to these physiological stresses, although this aspect remains largely unexplored. Hyperthyroidism, characterised by excessive thyroid hormone production, accelerates metabolic processes and increases oxygen consumption, potentially exacerbating hypoxic stress at high altitudes.[1] This case report details a young woman with relapsed hyperthyroidism who developed liver injury after descending from the Everest Base Camp trail.

CASE PRESENTATION

Case History

A 36-year-old female with a known history of Graves' disease for the past five years had been managed with oral carbimazole (5 mg) daily. After maintaining euthyroid status for six months, her dose was tapered to three times per week before being discontinued in November 2023. Her last thyroid function test (TFT) seven weeks before the trek showed normal thyroid stimulating hormone (TSH; 2.87 mIU/L) and free thyroxine (T4; 9.8 pmol/L) levels. She had no prior history of liver disease, medication overuse, alcohol consumption, or smoking. Physically fit and active, she had previously summited two peaks above 4,000 meters over two consecutive years without complications.

On 10 September 2024, she embarked on a 12-day trek to the Everest Base Camp (5,364 m). Despite following a specified acclimatisation protocol, she experienced racing heartbeats, laboured breathing, and fatigue on the eighth day at an altitude of 5,180 m. Her symptoms were managed with rest, hydration, and meals. She had successfully reached the Everest Base Camp the following day and descended to Lukla (2,804 m) over three days. Throughout the trek, her blood oxygen levels, measured with a pulse oximeter, remained above 95% except for occasional dips (91%–94%) at altitudes above 5,000 meters. She had no muscle pain or other features suggestive of rhabdomyolysis.

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Twelve days after returning, she presented to the emergency department with persistent palpitations and noticeable weight loss. TFT confirmed a third relapse of hyperthyroidism, and she was started on 30 mg carbimazole, tapered to 15 mg within one week. Factors contributing to the relapse included young age (<40 years), a noticeable goitre, large thyroid volume, and high baseline free T_4 levels (≥40 pmol/L).

Clinical Findings

Her initial assessment revealed a pulse rate of 111 beats per minute, with normal blood pressure, respiratory rate, and electrocardiogram. Thyroid function tests showed a suppressed TSH level (<0.005 mIU/L) and an elevated free T4 concentration (58.7 pmol/L), consistent with relapsed hyperthyroidism and thyrotoxicosis. Liver function tests were initially within normal limits but demonstrated elevated aspartate aminotransferase (AST, 97 U/L) and alanine aminotransferase (ALT, 165 U/L) levels, 2.77 to 4.71 times above the upper normal limit, 12 days later, indicating hepatocellular injury. The ALT level subsequently peaked at 178 U/L. Both AST and ALT were normalised within three months after the descent. Her alkaline phosphatase, γ-glutamyl transferase, and bilirubin levels were within the normal range.

The viral serologies were negative for hepatitis A, B, C, and E. The autoimmune marker tests were negative for anti-nuclear, anti-smooth muscle, anti-mitochondrial, and anti-liver kidney microsome antibodies. Her immunoglobulin G level was within normal limits. Autoimmune hepatitis was excluded.

The abdominal ultrasound was unremarkable. The thyroid ultrasound scan in June 2023 showed a thyroid of normal size with no nodules, indicating a reduction from the mild enlargement seen in the 2019 scan (right lobe: 2.3 × 2.1 × 4.7 cm, left lobe: 2.4 × 1.7 × 5.5 cm, isthmus: 0.3 cm).

DISCUSSION

This case highlights the interplay between hyperthyroidism and high-altitude exposure in contributing to liver injury following a trek on the high-altitude Everest Base Camp trail. While various hypothetical mechanisms can be proposed, her hyperthyroidism status may have increased her vulnerability to hepatic stress. The timeline of liver injury induced by high-altitude exposure remains poorly understood. A metabolically active organ with high oxygen demand, the liver is vulnerable to hypoxic injury at high altitudes due to reduced oxygen availability. This patient experienced a hyperthyroidism relapse in a hypoxic and physically demanding environment after 9.5 months of successful remission. A previous systematic review suggests that patients with Graves' disease have a 50% relapse rate within 6–18 months after discontinuing antithyroid therapy.[2] Hyperthyroidism increases the metabolic rate and oxygen consumption, potentially increasing the liver's susceptibility to hypoxia and ischemic hepatopathy. In this case, a combination of these factors and high-altitude exposure likely contributed to liver injury.

Non-regulating oxidative stress plays a key role in hypoxic liver injury. Mitochondrial efficiency declines in low-oxygen environments, producing excessive reactive oxygen species (ROS) that damage cellular components. The thyrotoxicosis state may have acted synergistically with high-altitude hypoxia to cause liver injury. Elevations between 3,500 and 5,500 meters cause an approximately 25% reduction in maximal oxygen uptake, leading to high-altitude hypoxia. At such a high altitude, the expected resting oxygen saturation is around 82%–80%[3], and hepatic antioxidant defences are reduced, allowing greater ROS accumulation than the physiological level, leading to oxidative stress in hepatocytes.

While this patient's ascent followed established safety guidelines with appropriate acclimatisation protocols, her rapid 3-day descent did not provide sufficient time to adjust. Upon return to a normobaric, oxygen-rich environment, individuals previously adapted to hypobaric hypoxia may experience 'de-acclimatisation' phenomena, characterised by oxidative stress and inflammatory activation in tissues of vulnerable organs. This process has been conceptualised as a form of hypoxia-reoxygenation injury, where the richer oxygen environment acts as a pathophysiological insult. The insult acts as an analogue to toxicant exposure, causing a delayed and reversible pattern that aligns with transient hepatic stress rather than overt hepatocellular failure. Hypothetically, this rapid physiological transition can exacerbate physiological stress and increase the risk of cellular injury. Hypoxia-inducible factor 1 (HIF-1) plays a critical role in these scenarios. Experimental data from animal studies show that HIF-1 helps cells adapt to low oxygen levels by regulating physiological processes, such as oxygen delivery, energy metabolism, and inflammation, through ventilatory acclimation to hypoxia. It also helps to maintain oxygen homeostasis by promoting glycolysis, erythropoiesis, and angiogenesis.[4] However, prolonged or excessive HIF-1 activation under hypobaric hypoxia can disrupt cellular equilibrium, leading to oxidative stress, inflammation, and metabolic and structural damage in the liver. Changes in vascular dynamics and organ-specific blood flow regulation further aggravate these effects. The delicate physiological balance achieved at high altitudes is disrupted by rapid reoxygenation during descent. HIF-1 may remain active, perpetuating the damage initiated during hypoxia and amplifying oxidative stress and inflammatory responses.[5] It stimulates the release of proinflammatory mediators[6], leading to liver injury.

While mild, asymptomatic elevations in ALT and AST levels – defined as less than five times the upper limit of normal – are relatively common in primary care settings[7], such findings should not be dismissed. The appearance of transaminitis in these contexts follows an unpredictable trajectory, with a latency period ranging from days to weeks. For example, haematological de-acclimatisation from hypoxia is known to manifest within two weeks[8], suggesting that the effects of hepatocyte hypoxia-reoxygenation injury might follow a similar timeline. Although unmeasured factors could theoretically contribute to the observed liver enzyme elevation, this patient denied alcohol consumption, medication or herbal supplement use, and strenuous activity

during the post-travel period. She resumed her usual daily routine and rested considerably due to palpitations and fatigue. Hence, the liver transaminases elevation is most plausibly attributed to physiological responses of transient hepatic stress related to high-altitude exposure.

Additionally, the exacerbation of oxidative liver damage due to cold exposure at high altitudes (≤19°C), imbalanced energy intake/expenditure, glycogen depletion, and dehydration further highlight the multifaceted nature of altitude-induced liver injury. The body accelerates metabolic processes to generate internal heat, especially through non-shivering thermogenesis in the brown fat, liver, and muscles. This heightened metabolic activity elevates the production of ROS as a byproduct, contributing to oxidative stress.[9] Experimental data from animal studies show that exposure to acute or chronic cold ambient temperatures of around 4°C–10°C prompts metabolic and hepatic adaptations[10], underscoring how cold stress and high altitude can interact to impact liver health. Cold stress may also compromise the liver's antioxidant defences, as the enzymes and molecules responsible for neutralising ROS become overwhelmed. This imbalance between ROS production and antioxidant capacity can lead to oxidative stress in liver cells, triggering inflammation and potential cellular injury.

A disparity between energy expenditure caused by prolonged physical activity and energy intake from an unaccustomed Nepali diet is common. In this case, a 64-kg individual engaging in without load, self-selected speed or normal pace cross-country hiking with a metabolic equivalent of six for seven hours would burn approximately 2688 kcal. However, typical trekking foods – such as eggs (boiled, poached, scrambled, or omelettes), Tibetan bread (fried and sweetened), a handful of French fries, and vegetable fried rice or plain rice – provide significantly fewer calories. Although precise caloric measurement was not performed, the patient's meals were photo-documented during the trek. Using AI-based dietary analysis, the average daily caloric intake was estimated at approximately 2,000 kcal, compared with an energy expenditure of about 2,688 kcal based on activity level and environmental conditions. This modest calorie deficit, combined with inadequate intake of essential nutrients and a reduced appetite commonly experienced at high altitudes, may have contributed to metabolic stress and delayed transient liver enzyme elevation. Nevertheless, these estimates are inferential and based on photo-assisted dietary approximation rather than direct calorimetry. Dehydration, common in high-altitude environments and often compounded by poor hydration strategies due to cool and windy conditions, further exacerbates hepatic stress by reducing blood flow to the liver, thereby contributing to transaminitis development days later.

Treatment Plan

Given her third hyperthyroidism relapse and elevated liver enzymes, this patient was counselled for definitive treatment with radioactive iodine therapy (RAI). Since she exhibited no signs of thyroid storm or liver failure, she promptly underwent RAI, leading to symptom resolution. She was also given supportive care, including hydration, rest, and liver function monitoring. Her liver enzyme levels normalised within three months after the descent. Currently, she is on lifelong thyroid replacement therapy.

Implications for Clinical Practice

This case highlights several important considerations for attending medical practitioners managing patients with thyroid disorders planning to engage in high-altitude activities:

1. Pre-travel risk assessment: Patients with hyperthyroidism, even if well-controlled, should undergo a comprehensive pre-travel assessment before engaging in high-altitude activities. Monitoring their thyroid hormone levels 2–4 weeks before travel may help identify those at risk of relapse. They should also be counselled on strategies to manage potential relapse at high altitudes, including carrying an adequate supply of antithyroid medication for use if necessary.

2. Recognition, monitoring, and mitigation of relapsed hyperthyroidism at high altitudes: The prompt recognition of relapsed hyperthyroidism at high altitudes can be challenging because there is no reliable medical laboratory to guide diagnosis confirmation. The diagnosis relies primarily on the patient's ability to maintain a high index of suspicion and associate palpitations with a potential relapse of hyperthyroidism. The patient must distinguish between palpitations resulting from hyperthyroidism relapse and those induced by excessive exertion on a physically demanding, hilly trail. This patient was fortunate that liver injury resulting from relapsed hyperthyroidism manifested only at sea level. Had it occurred at a high altitude, medical evacuation by helicopter would have been the most appropriate and beneficial course of action.

CONCLUSION

This case highlights the link between hyperthyroidism relapse and increased susceptibility to hypoxic liver injury at high altitude. As this is a single case report, causal inference cannot be established. The proposed mechanisms are speculative and should be interpreted with caution. Nonetheless, the case contributes to existing knowledge by highlighting that even a well-managed thyroid condition does not eliminate the risks of high-altitude exposure. Awareness of relapse beyond six months post-treatment is crucial for effective risk mitigation. A thorough pre-travel assessment is essential, and clinicians should recognise the potential for hepatic stress in patients with hyperthyroidism at high altitude. Further research is needed to understand the effects of high-altitude hypoxia on liver health, particularly in those with metabolic conditions.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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