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Skin burns following cryotherapy in misdiagnosed pediatric injuries

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ABSTRACT

Superficial local cryotherapy is frequently and safely used for pain relief following musculoskeletal injury or disease. However, serious skin complications have been reported in adults following inappropriate application. Skin burns following superficial local cryotherapy have not been previously reported in children.

The consequences of inappropriate use of various forms of cryotherapy in four children following sport injuries are presented. They were all primarily misdiagnosed with a soft tissue injury. The incorrect usage was due to the high severity of the local symptoms and signs. They were all referred with partial thickness skin burns. Diagnosis on referral indicated a bone injury in all of them. The value of the initial clinical examination is emphasized considering that fractures, including physeal injuries, are more common than ligamentous lesions, and the high incidence of the radiographically occult acute injuries in children. The use of superficial local cryotherapy following injuries in children should always follow the rules of proper usage and should be avoided in cases that the clinical examination cannot exclude a potential sprain or fracture to prevent further ligament, joint or bone damaging.

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1. Introduction

Superficial local cryotherapy is widely used in adults for temporary pain relief and for its anti-inflammatory effects in sport injuries and musculoskeletal disorders. It can be used in the form of cold applications or topical anesthetic skin refrigerants. Improper use of the various cryotherapy techniques may cause serious complications, such as frostbite and nerve injuries (Meeusen and Lievens, 1986; Swenson et al., 1996; Kostopoulos and Rizopoulos, 2008). Vapocoolants (cold spray) are quick acting analgesics for pain treatment during minor interventions such as venipuncture, shave biopsy, needle insertion or intravenous catheter placement and may also reduce immunization pain in school-aged children (Cohen Reis and Holubkov, 1997; Griffith et al., 2016). However, there is no guidance in the literature on the indications to apply cryotherapy in children following sport or exercise injuries.

This case series presents four children who were treated with superficial local cryotherapy following sport injuries. The incorrect use of cryotherapy was due to the high severity of the local symptoms and signs that were misdiagnosed as a soft tissue lesion rather than a bone injury. All cases were complicated with partial

thickness skin burns. The value of a proper clinical evaluation of the acutely injured child and the indications of superficial local cryotherapy in children are discussed.

2. Materials and methods

Four children were referred in the outpatient clinic for partial thickness skin burns following the application of superficial local cryotherapy for the treatment of acute sport injuries that were dated 3 to 4 days ago. There were 2 boys and 2 girls. Their age ranged from 10 to 13 years (average 11.5 years). All injuries resulted from a fall that occurred while participating at sports. The 2 boys were aged 10 and 11 years, respectively. They were injured while playing football. Their injuries involved the ankle and hand, respectively. A topical vapocoolant (cold spray) was used in both of them. The 2 girls were aged 12 and 13 years, respectively. They were injured while playing volleyball. Their injuries involved the ankle joint. An ice pack and a gel pack were, respectively, used.

3. Results

The initial physical examination was reported to be indicative of severe local pain and swelling in all cases. In the 2 boys the topical application of the skin refrigerant was reported to exceed the usual length of time that vapocoolants are usually applied due to their

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intense pain. In the 2 girls the ice pack and the gel pack, respectively, were applied directly to the injured site without any intervening material. Numbness and deadness of the affected skin area was reported on the first day post-injury in all cases. A varying extent of red and blistered skin area that was also painful and swollen followed on the second day post-injury. Partial thickness (second-degree) cold burns were diagnosed on reference in all cases (Figs. 1–3).

Radiographic examination was also performed in all cases. In the patient with the hand injury radiographs showed an undisplaced diaphyseal fracture of the proximal phalanx of the middle finger. Plain films indicated a fracture across most of the distal fibular growth plate passing up through the metaphysis in all children with an ankle injury (Salter-Harris type II lesion).

Minor debridement of the blisters and the slough was initially performed. All fractures were treated conservatively with splints for a 3-week period. The skin lesions were treated with dressing changes using Vaseline gauze every second day for an approximately 2-week period. A scar formation with hyperpigmentation of the surrounding skin was the final outcome in all cases (Fig. 4).

4. Discussion

The term “cryotherapy” comes from the Greek words ‘κρύο’ meaning cold, and ‘θεραπεία’ meaning therapy (cure). The primary reason for using ice or cold in acute closed soft tissue injury management is to lower the temperature of the injured tissue. This reduces cellular metabolism, attenuate leukocyte-mediated tissue destruction and microcirculatory impairment, decreases regional inflammation and muscle necrosis and promotes the constriction of blood vessels reducing bruising into the skin from damaged blood vessels (Schaser et al., 2007; Galdyn et al., 2015).

Cryotherapy, compression and elevation are the basic principles of acute soft tissue injury in adults, although specific evidence-based reports on the clinical outcome and the appropriate use of cryotherapy is not sufficiently given in the literature and continues to be made on an empirical basis (MacAuley 2001a,b; Bleakley et al.,



Fig. 1. A 10-year-old boy injured his right ankle. Several bullae on a red base were evident due to the local application of a topical refrigerant anesthetic spray.



Fig. 2. An 11-year-old boy injured his right hand. An approximately 3 cm bulla was evident on his middle finger due to the local application of a topical refrigerant anesthetic spray.



Fig. 3. A 12-year-old girl injured her left ankle. A violaceous semiannular patch with some erosions and crusts developed following local application of a cold gel pack.

2004; Collins 2008).

Various forms of cold application may be valuable using vapo-coolants, re-freezable ice or gel, etc. The use of refrigerant gases for the temporary relief of minor sport injuries is followed by standard precautions. Most superficial topical applications that use ice, have a built-in protective layer, so ice is not applied directly to the skin, which can result in a burn to the area sometimes known as a “cryoburn” (Gamble and Bonnetcarre, 1996; O’Toole and Rayatt, 1999; Keskin et al., 2005). Cryoburn occurs when a localized area of the body’s skin is exposed to ice or other objects with subfreezing temperatures for an extended period of time (Akgun et al., 2004; Long et al., 2005; Golant et al., 2008). The value of cryotherapy in children has not been proved. No reports suggesting the proper use or reporting the consequences of inappropriate application of cryotherapy in children could be found in the literature.

On the other hand, the immature skeleton has significant anatomical and physiological differences compared with adults, which must be taken into consideration when managing acute pediatric injuries (Rang et al., 2005). In children, the growth plate, also known as epiphyseal/physeal plate or physis, is weaker than the nearby tendons, ligaments or joint capsule, and obviously weaker than bone. Hence, the incidence of physeal plate injuries is greater than that of the ligaments but less than that of bone. This apparent paradox may be explained by the fact that only shearing,

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