Nerve Injury in Athletes Caused by Cryotherapy

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ABSTRACT: Cryotherapy is a therapeutic modality frequently used in the treatment of athletic injuries. In very rare circumstances, inappropriate use in some individuals can lead to nerve injury resulting in temporary or permanent disability of the athlete. Six cases of cold-induced peripheral nerve injury from 1988 to 1991 at the Sports Medicine Center at Duke University are reported. Although disability can be severe and can render an athlete unable to compete for several months, each of these cases resolved spontaneously. Whereas the application of this modality is typically quite safe and beneficial, clinicians must be aware of the location of major peripheral nerves, the thickness of the overlying subcutaneous fat, the method of application (with inherent or additional compression), the duration of tissue cooling, and the possible cryotherapy sensibility of some individuals.

The initial treatment of choice for athletic injuries is almost always some form of cryotherapy. Coaches, athletic trainers, and physicians treat a wide variety of acute injuries with universally good results (10). It appears that the vast majority of individuals can be treated safely with cryotherapy modalities, because thousands of successful applications are performed in athletic training settings each year throughout the world.

Although cryotherapy was initially used empirically, the physiologic effects of this treatment have been shown to be beneficial (10). The most obvious physiologic effect is that of decreasing tissue temperature. While superficial temperatures decrease extremely rapidly, deep temperatures do not decrease as fast; but, they do continue to decrease after the cold modality is removed (9,16). It appears that the decrease in tissue temperature is intimately related to a circulatory response (2,11). Although the circulatory response is important, of primary importance may be the decrease in metabolic activity seen with tissue cooling (1,9,10,14). Local effects also have been shown to effect inflammation, spasticity, and the excitability of nerve endings, thus producing an increased pain threshold (2,5,7-10). Unfortunately, in very rare circumstances, peripheral nerve injury can result from improperly applied or excessively applied cryotherapy (4,6,12).

In this paper, we present six cases of peripheral nerve insult in athletes (mean age = 22 yr ± 2 yr). The injuries of these athletes were cryotherapy-induced and were referred to the Duke University Sports Medicine Center. It is interesting to note that all were males actively participating in organized sports. Each had a history of previous use of cryotherapy without difficulty. Four of the subjects were collegiate athletes, while the fifth (two nerves) was a professional basketball player. The peripheral nerve injuries included three peroneal nerves, two lateral femoral cutaneous nerves, and one supraclavicular nerve.

Case Reports

Case 1: A 22-year-old college football player injured his right knee during practice. The athletic trainer evaluated this individual and thought that the neurovascular assessment was normal, but that a second-degree sprain of the lateral collateral ligament had occurred. A plastic ice bag (crushed ice in a gallon bag) was applied and held in place on the lateral aspect of the knee by an elastic wrap. The athlete was removed from practice and walked with crutches in a partial weight bearing state. Approximately 30 minutes later, the ice bag was removed, and a follow-up evaluation of this athlete by the athletic trainer demonstrated a right peroneal palsy with decreased sensibility and motor weakness. To evaluate the severity and neuromuscular response, an electromyography (EMG) was performed at 4 weeks, which indicated axonotmesis (ie, nerve injury without severing the nerve). Six months postinjury, this athlete had recovered sensation and motor function completely.

Cases 2 and 3: The day after a very strenuous game in which he had played for 40 minutes, a 24-year-old professional basketball player underwent cryotherapy to the lateral aspect of the left hip and the lateral knee. These treatments involved the application of a "crushed ice/water bag" supported by elastic wraps for approximately 30 to 60 minutes. After the ice bags were removed, numbness was noted over the anterior lateral thigh and the dorsum of the foot. The athlete also noticed his inability to control his foot (complete footdrop). Clinical evaluation by the athletic trainer and the physician using a percussion test demonstrated a complete peroneal nerve palsy at the level of the fibular head, as well as decreased sensation of the anterior lateral thigh and a sensory pattern for the lateral femoral cutaneous nerve.

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This athlete was unable to participate in the remainder of the professional season, but did continue to improve. At 6 months, he essentially had complete resolution of symptoms. He played the next season without problems.

Case 4: A 21-year-old collegiate sprinter complained of pain over the anterior superior iliac spine after a track meet. The following week (2 days postinjury) he applied a plastic bag filled with crushed ice to the area for 15 to 20 minutes once daily for 5 days. The bag was "hand held" in place during treatment. On Friday, he began to note numbness over the lateral aspect of the thigh. Evaluation by the team physician revealed decreased sensation over the distribution of the lateral femoral cutaneous nerve and a positive percussion test. We recommended discontinuing cryotherapy. Symptoms completely resolved 4 days later.

Case 5: A 20-year-old defensive back reported an area of decreased sensation and paraesthesia over the anterior aspect of the left shoulder. He had been ice massaging the shoulder for 10 minutes three times daily for the past 3 days, because of generalized soreness; but, he denied any major injury or trauma in the recent past. He noted the decreased sensation following cryotherapy the previous weekend. Examination demonstrated a decreased sensation to pinprick in the area extending from the clavicle outward to the anterior deltoid. He also had a positive Tinel's sign over the base of the neck, which indicated a compromised supraclavicular nerve. The athlete demonstrated complete normal neurologic findings at a follow-up exam approximately 2 to 3 weeks following the cessation of cryotherapy.

Case 6: A 21-year-old college football player injured the lateral aspect of his lower leg/knee and received cryotherapy through the application of an ice pack and an elastic wrap for 30 minutes while in a long sitting position. After that time, the patient noted numbness over the dorsum of his foot. On examination by the team physician, the athlete revealed decreased sensation over the dorsum of the foot and minor decreased function of the great toe extensor and the evertors of the foot (4/5—good rather than normal grade). One hour later, his symptoms were resolved completely.

The application of ice with varying levels of compression led to neurologic compromise in the described subjects. The duration of treatment was from 15 or 20 to 60 minutes. The duration of disability ranged from less than 1 hour to greater than 6 months; yet fortunately, all patients did experience complete recovery.

These patients represent individuals seen in our training room or seen by physicians at our Sports Medicine Clinic on a referral basis from 1988 to 1991. As a referral center, we treat many patients for whom the general use of cryotherapy is extremely safe. These six cases are representative of rare injuries.

Discussion

Several authors have delineated the mechanism of injury to peripheral nerves by cold application (3,13). Sunderland (15) summarized the work of many in his text and concluded the following:

1. Motor functions are affected first and to a greater degree than sensory functions. This may be related to fiber size.
2. Different sensory modalities are not affected equally or simultaneously.
3. If necrosis does not develop, rapid restoration of function is seen as warming occurs. It is interesting to note that, generally, sensory functions are normalized prior to motor functions.
4. There is tremendous variation in the resistance of individuals' peripheral nerves to injury from cryotherapy.
5. It appears that injury does not result unless the peripheral nerve is cooled below 10°C.
6. Cryotherapy can disturb function at temperatures above freezing. Total motor/sensory loss can occur between 0° and 5° C.

It is important to note that some of Sunderland's conclusions were developed as a result of dissected nerves being subjected to direct cold treatment using noncompressive liquid or gas techniques. This allows the collection of direct and nonconfounded data, but also minimizes the true effects of clinical application of cryotherapy. Direct exposure of nerves does not occur in the clinic, as multiple overlying tissues intervene and respond during the application of cryotherapy. Thus, although the aforementioned studies outline indirect effects, we must be aware that additional insulative factors are present in the clinic.

All of the patients in this series were relatively thin with very little subcutaneous fat. The majority of athletes, however, probably have a level of subcutaneous fat that adequately insulates peripheral nerves from cold injury. It is interesting to note that we are aware of only one female cross-country runner reported to have nerve injury, as reported in a conversation with Randy Kegerreis and Laura Kegereis (October 1991). Thus, it is our opinion that the insulating effect of skin and subcutaneous fat, as well as the circulatory response to the application of cold, minimizes the opportunity for damage in the vast majority of athletes.

The experimental data (3,9,13) reported by others outline and explain the clinical findings revealed by the patients in our series. It is interesting to note that although time did not appear to be a primary factor in the experimental studies, it may be a more important factor in clinical use, particularly when it is combined with compression. The longer the cold is applied, the greater the opportunity for cooling the nerve below the critical threshold.

Experimental studies (3,13,15) have described axonotmesis to the damaged nerves. Electromyographic examination in the peroneal nerve injury was consistent with axonotmesis (Case 1) and the clinical presentation of the severe injuries in our series.

Clinical Relevance

The inappropriate, unmonitored application of cryotherapy to acute injuries may cause disabling neuropathies in select individuals. Fortunately, it appears that the majority of patients obtain full recovery, but the disability may be transient (less than 3 days) or prolonged (up to 6 months). We recommend that cryotherapy be restricted to relatively short time frames (approximately 20 minutes) in areas of the body where peripheral nerves may be somewhat superficial, and that extreme care be used in the application of compression with the use of this modality in those patients who might be more susceptible or reactive to cryotherapy (ie, application of ice in an athlete who is thin and where attenuation of the effects of cryotherapy may develop).

Although it is obvious that compression can be applied by an elastic bandage, it also is important to remember that pressure from the cold modality by the weight of the affected body part or a heavy ice bag may produce unwanted compressive forces.

Many questions remain regarding the combination of cryotherapy and compression. Fortunately, patients can be assured that this condition is temporary, but interim

care may require the restriction of activities that would place the patient at risk (ie, ankle injury from weak peroneal muscles, abnormal responses, etc). This article is not an attempt to discourage the use of cryotherapy, but rather to encourage the athletic trainer to be more attuned to cases in which the application may require additional care.

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