Duration of Cryotherapy Application

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Cryotherapy is a term used to describe cold as a therapeutic modality. Cryotherapy is widely used as the primary tool in managing inflammation associated with acute athletic injuries (Figure 1). It is typically used during the acute inflammatory response to decrease metabolism, which is believed to reduce secondary hypoxic injury and secondary enzymatic injury (collectively referred to as secondary injury)\(^1,2\) and to decrease local blood flow by limiting the normal vasodilation associated with inflammation.\(^3\) In addition, cryotherapy can reduce pain and muscle spasm,\(^4\) and some evidence suggests that it can curb edema formation.\(^5-7\) Cryotherapy has been studied extensively, and much information is available in the literature. Little attention has been devoted, however, to the duration of individual treatments. The reports that do address duration of treatment often lack explanations for the chosen duration of application and provide few instructions for modifying it under differing circumstances. The goal when using cryotherapy should be to significantly decrease tissue temperature without damaging sensitive structures such as superficial nerves. The difficulty when using it in a clinical setting is that we typically do not measure tissue temperature. Therefore, the purpose of this article is to provide some guidance for choosing the appropriate duration of application under a number of conditions when using cryotherapy. The recommendations provided here are theoretical and should be tested with scientific investigation.

A commonly accepted general recommendation for the duration of application with cryotherapy is 20 min.\(^8\) This recommendation is incomplete, however, because the appropriate duration of application is not the same from treatment to treatment. Differences in treatment parameters and treatment conditions can greatly affect the appropriate duration of application. Following is a list of factors that should be considered when choosing the duration of application:

- Type of cold medium
- Compression
- Location of treatment
- Thickness of subcutaneous tissue
- Temperature of the athlete
- Patient sensitivity to cold

The most common cold medium is crushed ice packaged in a plastic bag and applied directly to the skin (Figure 2). The commonly accepted general recommendation for duration of application assumes that crushed ice is used to deliver the treatment. With any other treatment the duration of application should be altered. For example, if a barrier such as a towel is placed between the skin and ice, then time should be added. Tsang et al.\(^9\) found that a 40-min treatment when a towel was used as a barrier resulted in a decrease in temperature similar to that with a 12.5-min treatment with no barrier.
If ice is used to massage the injured area, less time is required.\textsuperscript{10,11} Lowdon and Moore\textsuperscript{12} measured temperature at a depth of 2 cm and showed a significant reduction in intramuscular temperature over a small area with a 5-min ice massage (Figure 3). Longer applications did not bring about a significant further temperature decrease. Conversely, with treatment with ice packs, the temperature decrease has been shown to be greater with 40-min treatments than with 20-min treatments.\textsuperscript{13}

Securing the ice pack with compression wraps will increase the rate and magnitude of cooling. Merrick et al.\textsuperscript{14} showed that adding compression wraps increased cooling at the skin’s surface and at depths of 1 and 2 cm below the fat layer. At a depth of 1 cm the temperature was 26.5 °C with ice and compression and 28.2 °C with ice alone. The decreased temperature was attributed to improved contact between the skin and the pack, decreased blood flow as a result of the compression, and insulation provided by the wrap.

The location of treatment is important with respect to the proximity of superficial nerves. If treating over superficial nerves such as in the lateral aspect of the knee (common peroneal nerve) or medial aspect of the elbow (ulnar nerve), care should be taken. To prevent nerve injury these treatments should never exceed 30 min in duration.\textsuperscript{15}

The depth of the target tissue in cryotherapy can vary greatly from patient to patient. When treating areas with a thick subcutaneous layer, such as over the quadriceps, the duration of application should be extended so that the cold can reach the target tissue\textsuperscript{16} (Figure 2). When treating areas with little subcutaneous tissue, however, such as the dorsal surface of the hand, shorter application times are indicated (Figure 4). A recent study assessed the time required to lower temperature 7 °C at a depth of 1 cm below the adipose layer. It was found that the time required to lower temperature with a bag of crushed ice was dramatically different depending on the thickness of the adipose layer. The required treatment durations were 12, 30, 40, and 60 min for skinfold thicknesses of 0–10, 11–20, 21–30, and 31–40 mm, respectively.\textsuperscript{17}
An athlete’s baseline temperature might vary significantly depending on the environmental temperature and whether the athlete is active before treatment. An athlete injured while participating in the heat will require a longer treatment than an athlete entering the athletic training room for therapy on a cold day. Mancuso and Knight\textsuperscript{18} showed that skin temperatures were higher after exercise and that these temperatures remained higher after icing when compared with a no-exercise condition. When looking at repeated ice application, Palmer and Knight\textsuperscript{19} demonstrated that activity led to a more rapid rewarming; thus, reapplication was required sooner. Some patients have a sensitivity to ice and might not tolerate longer treatments. Knight\textsuperscript{19} suggested that patients typically go through a sequence of pain, burning, tingling, and, finally, numbness. Individuals with a heightened sensitivity to ice might experience a more intense level of discomfort that does not subside. Knight\textsuperscript{19} reported that approximately 10–20% of patients fail to experience numbness during cryotherapy. Those who do not experience numbness will be less likely to tolerate longer treatments. In a more recent study, Ingersoll and Mangus\textsuperscript{20} reported that the time of treatment typically associated with numbness was characterized with the terms stinging, freezing, and cold. In that study, numbness was not described until the 21st minute of treatment. It should be noted that the use of an insulated toe cap has been shown to decrease pain sensation during cold-water immersion.\textsuperscript{21}

**Conclusion**

Cryotherapy is widely used as the primary tool in managing acute injuries. The duration of application is affected by a number of factors. As a general rule, ice should be applied for 20 min, with time added or subtracted depending on the following: type of cold medium, whether compression is used, location of treatment, thickness of subcutaneous tissue, temperature of the athlete, and patient sensitivity to cold.

**References**