Initial Management of Minor Acute Soft-Tissue Injuries

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With over 7 million young people taking part in high school athletics, and countless more children taking part in community sport programs, it is not surprising that pediatricians are frequently called upon to evaluate and treat acute athletic injuries. In fact, one study of a health maintenance organization revealed that 3% of all pediatric visits were due to recreational injuries. The usual picture is that of a youth who has received a direct blow to a muscle or bone which has become painful or swollen (an intramuscular hematoma or bony contusion), or who has “pulled” a muscle (a strain), or who has injured a ligament (a sprain). Although these soft tissue injuries have been common events in office pediatric practice, only in the past decade has there been much scientific inquiry as to their proper management. This paper will review the scientific basis of the initial management of acute soft tissue injuries.

There have been many methods for classifying the severity of sprains and strains, but most would be more or less in agreement with the following:

- **Grade 1** (first degree): mild pain at the time of injury or within 24 hours of injury; especially when stress is applied; local tenderness may be present.
- **Grade 2** (second degree): pain during activity causing the patient to stop; pain and local tenderness are moderate to severe when the injury is stressed.
- **Grade 3** (third degree): complete or near complete rupture or evulsion of at least a portion of a ligament or tendon with severe pain or loss of motor function; a palpable defect may be present.

Pediatricians should be comfortable treating all contusions and strains, and Grade I sprains. RICE is the acronym with which not only physicians but also their older pediatric patients should be familiar. Rest, ice, compression, and elevation are the four components of initial management of acute soft-tissue injuries, i.e., during the first 48 to 72 hours following injury.

**REST**

Injured patients in general, and adolescent athletes in particular, are prone to try to return to full activity immediately following an injury. However, as micro-hemorrhages into the tissue can continue for several days after the injury, it is important that the motion of the joint or muscle does not set off more bleeding. Another reason to rest the injured area is that the damaged (torn or stretched) ligament or tendon may allow more motion at the joint, causing instability, leading to even more damage to the injured tissue. Advising an adolescent to “take it easy” probably has little effect unless it is explained that premature activity can result in further damage and consequently...
TABLE 1

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<th>Mean Period to Complete Recovery</th>
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<tbody>
<tr>
<td></td>
<td>Early Cryotherapy</td>
<td>Late Cryotherapy</td>
<td>Heat</td>
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<tr>
<td>Grade 3 ankle sprains (able to stand only with pain)</td>
<td>6 days</td>
<td>11 days</td>
<td>15 days</td>
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<tr>
<td>Grade 4 ankle sprains (unable to bear weight)</td>
<td>13 days</td>
<td>30 days</td>
<td>33 days</td>
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even longer duration before competition is possible. Putting the patient on crutches if it is a lower limb sprain or a "charley horse" (intramuscular hemorrhage into the quadriceps) may be the only successful way to reduce activity. There are now several commercial splints, eg, the Aircast® (Figure 1), which can immobilize an ankle joint almost as well as the traditional plaster cast, but can be removed for baths, cryotherapy, and rehabilitative exercises, and can be readily applied by a pediatrician.

Within several days of the injury, if the swelling stops progressing, then gentle active range-of-motion exercises can be instituted. Such early mobilization is being increasingly recognized as important, and something that could not occur if the joint were encased in plaster. Immobilization causes muscle wasting and loss of strength, which in turn can set up the patient for a repeat injury of the same joint as soon as it is stressed sufficiently again. The field of rehabilitative exercise is too vast a subject to be addressed here, but monographs are available to help the inquisitive physician. If crutches have been advised, they should be continued until the patient can bear weight painlessly.

ICE

Ice has been used since Hippocrates' day (300-400 BC) when it was noted that it decreased swelling and produced numbness. Ice treatment has now been dignified by the term "cryotherapy." Heat treatment can increase the blood flow to an injured area by means of vasodilation, and this can increase the local hemorrhage with consequent increased acute inflammatory response. Several studies have demonstrated the usefulness of cryotherapy in reducing the pain and period of disability from tissue injuries. Hocutt et al studied moderate and severe ankle sprains and had the patients randomized to receive either: 1) cryotherapy beginning immediately; 2) cryotherapy beginning after 36 hours; or 3) heat treatments beginning immediately. Full activity was noted in 13 days, 30 days, and 33 days respectively in those patients with severe sprains, and the results in moderate sprains were almost as dramatic (Table 1). This study showed that not only is cryotherapy more effective than heat therapy, but it needs to be instituted as soon as possible after an injury. An unfortunate defect in this study was that a fourth "control arm" of no therapy was not included in the study design.

Cryotherapy's effectiveness is undisputed, but how it works has not been completely elucidated. We know it decreases the tissue temperature of the area adjacent to its application. Nerve impulses and conduction velocities are diminished, resulting in anesthesia, and muscle spasm is reduced, possibly by suppressed muscle-spindles firing. Vasocostriction induced by cold therapy reduces both the blood flow to the area and the capillary permeability, thus decreasing continuing bleeding into the tissues. Cryotherapy also has an effect on decreasing tissue cell metabolism, thus reducing the cell's oxygen requirements. If the oxygen supply to a tissue is being impaired by the disruption of its circulation due to hemorrhage or secondary edema, the cells can be protected somewhat from death and subsequent release into the tissues of cell products capable of enhancing the inflammatory reaction by having a decreased requirement for oxygen.

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Ice should be applied for 15 to 20 minutes at least three to four times a day for the first three days after the injury, if any symptoms persist. Cryotherapy is available in several forms: ice chips, frozen-gel packs, and chemical ice; but fortunately the most effective modality, ice chips, is the least expensive and frequently the most available (Figure 2). Ice chips can be contained in a plastic disposable sandwich bag, and kept in place with an elastic bandage; however, the skin should be protected from frostbite by a single layer of wet bandage, which will also assist in transmitting the cold (Figure 3).

McMaster et al. compared three forms of cryotherapy in an animal experiment, measuring the temperature in the tissues below the site of cold application. As can be seen from Table 2, which summarizes some of their data, ice chips were more effective than the other two. The minimal muscle temperature was about 25°C after 30 minutes of cryotherapy. Other in vitro studies of isolated animal limbs have shown that blood flow to hypothermic tissue continues to decrease until about 25°C is reached, and if further temperature decreases ensue, the blood flow will start to increase. Hence cryotherapy should never be applied for more than 30 minutes, but it is usually uncomfortable enough by 20 minutes that excessive perseverance would be unusual. For deeper injuries, longer duration of each application of cryotherapy is needed, and the sooner the ice is applied after the injury the more effective it will be.

COMPRESSION

Post-traumatic edema can increase the extent of tissue damage, delay healing, and contribute to some degree of chronic instability of an injured joint. The accumulation of excess fluid in the interstitium inhibits the delivery of oxygen and nutrients to cells, with consequent cell damage or death, resulting in even more dead tissue in addition to that caused by the original trauma. This necrotic debris, in turn, further increases the osmolarity of the interstitial fluid, producing even more edema—a vicious cycle.

Torn ligaments may remain separated because of edema (Figure 4), and the repair process necessitated

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Figure 2. Ice chips being applied to an acute thumb injury.

Figure 3. Cryotherapy (A) Wet elastic bandage being applied to acute ankle sprain. (B) Ice-gel pack applied to single layer of bandage. (C) Cold source kept in place for 20 minutes.
TABLE 2

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<th>Tissue Temperature Decrease with Various Cold Therapies</th>
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<tr>
<td>Temperature Decrease (°C)</td>
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<tr>
<td>15 minutes</td>
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<tr>
<td>30 minutes</td>
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<tr>
<td>Ice</td>
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<tr>
<td>Frozen gel</td>
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<tr>
<td>Chemical</td>
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Excessive edema can partly restrict active movement of a joint. Disuse of the joint can then lead to fluid stasis and coagulation of the edema by an insoluble mesh of fibrin strands. This could then require many months before it can be resorbed.

These complications of post-traumatic edema can be diminished by external compression. The forces causing fluid to move out of the capillaries into the tissues include osmolarity of the interstitial fluid (which has been increased by tissue damage), and vascular permeability increased by chemical mediators (e.g., prostaglandins and the kinin system) produced by the injury or the resultant inflammatory cells. By applying compression early and throughout the first few days after injury, edema can be minimized. The lymphatics have one-way valves that allow lymph to move in one direction only when an adjacent muscle contracts, thereby compressing ("milking") the lymph vessel. Active exercise increases lymph flow by as much as ten times normal, and hence reduces the edema, another reason why rehabilitative exercises should begin as soon as they can be done without pain.

The most common form of compression is the use of an elastic bandage. It should be worn for several days and only removed for cryotherapy and bathing. Ankle strains require padding to fill the hollow between the continued on page 106
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malleoli and the Achilles tendon. One source of such padding is a layered disposable diaper folded several times and cut into a horseshoe shape which then fits around and inferior to the malleolus.

ELEVATION

Elevation of lower limb injuries will decrease the amount of edema by lowering the hydrostatic pressure within the blood vessels by countering the forces of the heart with gravity. It also facilitates lymphatic drainage. A student may well require a note to the school indicating he or she may have to keep the foot elevated on another chair while the student is in class.

ANALGESIA

Although aspirin has been, and probably still is, the most widely used analgesic for minor pain, it is contraindicated for soft-tissue injuries because of its well known anticoagulant action. Because a single dose of 0.65 g aspirin can double the bleeding time for a week, it does not make much sense to use this drug when continuing hemorrhage into the injured tissues can prolong the time of disability. Arguments that aspirin is anti-inflammatory in addition to analgesic, and therefore doubly useful, ignore the fact that the usual doses used for analgesia are not anti-inflammatory, that state being achieved only by the much larger doses recommended for such things as rheumatic fever, Kawasaki disease, and rheumatoid arthritis.

Acetaminophen would seem to be the best first choice because it is as analgesic as aspirin. If this is not effective then the combination of acetaminophen and codeine becomes my second choice.

Despite the lack of significant numbers of clinical studies demonstrating the superiority of nonsteroidal anti-inflammatory drugs (NSAIDs) in the management of acute soft-tissue injuries, they are being used widely for this purpose, especially ibuprofen. Because prostaglandins are some of the mediators of the acute inflammatory response to injury causing vasodilatation, increased vascular permeability, and chemotaxis, an antiprostaglandin has a theoretical advantage in reducing both inflammation and pain, at least during the first three days following the injury when the prostaglandins are being released. But as the repair mechanism is in itself an inflammatory response, it is probably not rational to continue the NSAID beyond the first few days.

REFERENCES