Eccentric Exercise in Chronic Tendinitis

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Chronic tendinitis, particularly of the Achilles tendon, frequently outwits traditional programs of therapy including surgery and/or prolonged immobilization. A hypothesis proposes that disruption of the tendon, micro or macro, occurs under specific conditions of eccentric loading. In order for the healing tendon to be adequately rehabilitated, the treatment program must include specific eccentric strength rebuilding exercises.

Chronic tendinitis continues to plague the orthopedic surgeon. The literature offers a veritable potpourri of techniques, usually surgical, to abolish this bane. Unlike cancer or trauma in which the foe is obvious, the pathomechanics of chronic tendinitis remain elusive. Commonly, surgical procedures such as debridements, lengthenings, and formal releases are executed in frustration when the syndrome has failed to resolve with casting, inflammatory medications, ultrasound, and/or corticosteroids. Meanwhile, with the contemporary explosion in physical fitness, the ranks of patients of all ages presenting with chronic tendinitis have swollen considerably.

Within a very active university-based sport medicine clinic, traditional techniques for treating chronic tendinitis were infrequently successful. Although prolonged immobilization would ameliorate pain, the dividend was predictable atrophy and decrease in structural strength of the tendon. This prevailing environment of dystrophy in the healing environment would predispose to renewed symptoms when the tendon was stressed anew.

It was further observed clinically and by basic scientists that subjects suffering with recalcitrant Achilles tendinitis were experiencing pain when they decelerated and reversed direction during their activities. Likewise, patients suffering with patellar tendinitis (jumper's knee) would experience pain as they decelerated when landing from a jump rather than when the tendon contracted during the liftoff. The tennis elbow syndrome was seen in novice recreational tennis players who would tend to strike the ball away from the center of the racquet face, on the backhand stroke. The force from the racquet would overwhelm the intrinsic strength of the wrist extensors and result in proximal lateral epicondylar pain.

Several researchers, including Komi[6] and others from Italy, have articulated consistently that the common denominator with these syndromes of tendinitis was in the character of the force involved, specifically eccentric loading of the tissue.

HYPOTHESIS

Rest has long been advocated as the modality of choice in the treatment of chronic tendinitis. Indeed, if loading stresses are removed from an injured tendon (ligament or

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muscle), symptoms usually subside. However, numerous authors have demonstrated the negative effect rest and immobilization have on both normal and injured tendons and ligaments.[1,4,9,10,11,13] Even normal ligaments, when forceably immobilized for eight weeks in a primate model,[9] may take 12 months to return to normal strength.

Tendon was long considered an inert mechanical link between muscle and bone. Tendon is very much a metabolically active tissue that responds to stress in the same fashion as muscle and bone.[5,7] It has been shown consistently that both intact (normal) and injured (abnormal) tendon/ligaments respond to controlled progressive stress, resulting in progressive increase in tensile strength.[2,12,14,15] Komi[6] and others have shown that eccentric stresses may exceed conventional concentric and isometric forces threefold.

When a viable tendon is trained to a specific strength, it will not disrupt under stress unless the applied stress exceeds the inherent strength of that specific tendon. However, the tendon will disrupt partially or totally when the force applied exceeds the inherent tensile strength of the tendon.

If a tendon is torn, the treatment program must include strength training in order to render that tendon invulnerable to the quantity of stress that forced the initial disruption. When the type of damaging force was eccentric in type, the tendon must be retrained in an eccentric fashion.

TYPES OF CHRONIC TENDINITIS

Assuming that the tendon is not affected by one of the many autoimmune disorders; *i.e.*, rheumatoid arthritis, systemic lupus erythematosus, *etc.*, one can divide chronic tendinitis into two subgroups. (1) Exogenous tendinitis: this group includes those traumatic injuries of tendon that occur primarily as a consequence of pressure from external forces; *i.e.*, the impingement syndrome of the supraspinatus tendon; de Quervain's Tenosynovitis. In the chronic state, it is invariably necessary to treat these patients by relieving the external forces; *i.e.*, acromioplasty. (2) Endogenous tendinitis: this group constitutes the most common type of chronic tendinitis. Essentially no external mechanical forces can be identified. It is hypothesized that the tendon is not of sufficient strength to meet the expectation of the applied forces. The tendon responds with microruptures or gross tearing within its substance. Nirschl[8] suggested the importance of this mechanism in the etiology of tennis elbow. To avoid breakdown in the integrity of a tendon under these conditions of exaggerated tension, the tendon must be prepared with a specific strength training program.

CONCEPT OF ECCENTRIC TRAINING

Muscle-tendon contraction can occur in a variety of ways. With concentric contraction, the muscle-tendon unit shortens in length resulting in positive work. With isometric contractions the same unit does not shorten in spite of resisting a force and no work is generated. Eccentric contraction occurs when the muscle-tendon unit lengthens in the face of stress, producing so-called negative work. An indepth review of muscle-tendon physiology is beyond the scope of this report; however, it can be stated from a basic science perspective that more force can be generated on a tendon using eccentric contraction rather than with concentric or isometric loads. A strength retraining program must be tailored to the specific tasks requested of the tendon tissue.

TECHNIQUE OF EXERCISE

The eccentric exercise program is based on three tenets. (A) Length: stretching is an integral part of the program. By increasing the resting length of the muscle-tendon unit, there is a decrease in the strain occurring during joint movement. (B) Load: progressively increasing the load subjects the tendon to progressive stresses resulting in increased tensile strength. (C) Speed of contraction: a forced velocity curve[6] indicates that increasing the speed of contraction increases the force developed. Based on these concepts, the program outlined in Table 1[3] has been developed.

The eccentric strengthening program for chronic patellar tendinitis follows the basic program outlined in Figure 1. A static stretching and warm-up program is employed for five minutes. The patient, from a standing position, flexes the knees and drops to a squatting position abruptly, then recoils to the standing position. At the point of reversing direction, some discomfort will be experienced in the tendon at the inferior pole of the patella. The velocity of the "drop" is increased until the patient can perform the exercise as rapidly as humanly possibly *without pain.* At this point the patient places sandbags over the shoulders to increase the load to the tendon. The shoulder weights and velocity of the exercise are monitored to make certain that the procedures are done without pain. Muscle soreness however, is a common byproduct and is to be expected. As an illustration, an elite olympic male volleyball player may find it necessary to drop with a load of 50 kg, whereas a younger/older and less demanding patient would require less load to normalize the strength of his/her patellar tendon. The strength training activity is continued until the pain is resolved or reduced to the point of not hampering the activities of daily living.

DISCUSSION

Historians who have studied musculoskeletal disorders have acknowledged the value of regular mechanical stress as one factor in the maintenance of the integrity of bone, muscle, and tendon. Scientifically surgery, immobilization, steroids, and high-dose ultrasound have been demonstrated to cause destruction of tendon. However, these techniques still remain the cornerstones in the treatment of recalcitrant chronic tendinitis. To rehabilitate or normalize endogenous chronic tendinitis, measures to promote anabolism must be adopted, primarily progressive and monitored strength training. This strength training must be specific to the proposed task of the tendon.

Prospectively, in a study of 200 patients who had suffered with chronic tendinitis over a mean of 18 months, 90% had marked restriction on their activities of daily living. Each patient had been exposed to at least six varied programs of physiotherapy, and had had at least three injections of corticosteroid. The physiotherapy programs were highly varied in type and quality, most lacking strength training. Each subject was placed on the eccentric strength training program, performed once

TABLE 1.

1. Stretch
   a. Static stretch
   b. Hold 15 to 30 seconds
   c. Repeat 3 to 5 times
2. Eccentric exercise
   a. Three sets of 10 repetitions
   b. Progression:
      Days 1 and 2: slow
      Days 3 to 5: moderate
      Days 6 and 7: fast
   c. Increase external resistance; after day 7, repeat cycle
3. Stretch, as prior to exercise.
4. Ice: crushed ice or ice massage applied to tender or painful area for 5 to 10 minutes

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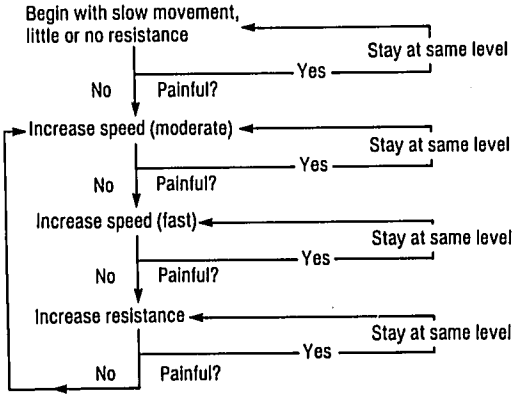

FIG. 1. General outline of eccentric exercise program. (Reproduced with permission from Curwin, S., and Stanish, W. D.: Tendinitis: Its Etiology and Treatment. Lexington, MA, Collamore Press, D. C. Heath and Company, 1984, p. 65.)

daily, over a six-week period. At a mean follow-up period of 16 months, 44% of patients had complete relief of pain and functional impairment, 43% had a marked decrease in symptoms (complaining of mild pain after athletic activities), 9% had virtually no change in their clinical state, and 2% were worse after the exercise program.

While some of the basic concepts on which the eccentric exercise program is based are open to debate and require further investigation, the clinical data suggest the program is effective. It has several advantages over conventional and traditional treatment plans. The patients were allowed to continue their athletic activities (within the limits of pain) while they were doing their rehabilitation strength training program. There are several prerequisites in order for this program to be successful in the treatment of chronic tendinitis: (1) a contemporary physiotherapy facility; (2) patient compliance and cooperation, and (3) evidence of severe scaring of the tendon (usually secondary to surgery and/or steroids) mitigates towards a less than ideal result. Current research in the area of tendon is being focused on achieving direct measurements of the tensile strength of the muscle-tendon unit in varied states of disease, as well as after exposure to varied treatment modalities.

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