Tendinitis and Other Chronic Tendinopathies

Louis C. Almekinders, MD

Abstract

Chronic tendon problems are common in orthopaedic patients. Relatively little is known about the etiology of these common problems and the efficacy of available treatments. It is believed that the cause of many injuries is repetitive mechanical trauma followed by an inflammatory response. Other factors, such as age-related degeneration and relative avascularity in the tendon, may play an important etiologic role as well. Histopathologic studies have generally revealed degenerative lesions consistent with tendinosis and/or inflammation of the peritendinous tissues consistent with peritendinitis. Initial treatment should focus on patient counseling and correction of associated mechanical factors, if present. Nonsteroidal anti-inflammatory drugs can give pain relief, but there is no convincing evidence that they alter the natural history. Corticosteroid injections can be used selectively in resistant cases, but recurrences are frequent. Surgery can be very successful when the affected tendon is treated directly.

J Am Acad Orthop Surg 1998;6:157-164

Chronic tendon problems are often seen in primary-care, sports medicine, occupational medicine, physical medicine and rehabilitation, and orthopaedic practices. Among the various diagnoses grouped under this rubric are those that are labeled on the basis of the presumed etiology (e.g., overuse injury, cumulative trauma disorder, and repetitive strain injury) and those that are designated with more pathoanatomic terms (e.g., tendinitis and tenosynovitis). Epidemiologic surveys show that more than half of all occupational illnesses can fit under one of these diagnoses. In sports medicine, the overall prevalence and incidence of chronic tendon problems are unknown, but in certain sports they account for a significant number of injuries. James et al[1] reported that chronic tendon problems represent nearly 30% of all running-related injuries, and Gruchow and Pelletier[2] found a prevalence of almost 40% in tennis players. Apart from their frequent occurrence, tendon injuries also present a difficult problem because of their chronicity, lasting for several months to years in spite of attempted treatment.[3]

Many chronic tendon problems are considered to result from excessive mechanical load. Applied mechanical loads of high intensity and/or high frequency are thought to injure the tendon structure. Spontaneous healing may occur, but if the healing capabilities of the tendon are exceeded, clinical symptoms may become more apparent. One of the responses to these mechanical stresses is inflammation, leading to the frequent use of the diagnosis tendinitis. Although this may represent a plausible explanation for some chronic tendon problems, neither the basic science nor the clinical literature uniformly supports this theory. The literature suggests that many other factors play a role in this problem. For this reason, treatment aimed at removing the excessive mechanical load and reversing the inflammatory changes does not always lead to a satisfactory clinical outcome.

The purpose of this article is to review the factors that are involved in the etiology, diagnosis, and treatment of chronic tendon problems.

Etiology

Many authors have commented on the relationship between overuse, cumulative trauma, and the role of mechanical overload in the etiology of tendon problems. In the sports medicine literature, a few studies have focused on the relationship between frequency and intensity of

Dr. Almekinders is Associate Professor, Department of Orthopaedics, University of North Carolina School of Medicine, Chapel Hill.

Reprint requests: Dr. Almekinders, Department of Orthopaedics, University of North Carolina School of Medicine, CB#7055, Burnett-Womack Building Chapel Hill, NC 27599-7055.

exercise and tendon injury rates. Lysholm and Wiklander[4] found such a relationship in runners, and Gruchow and Pelletier[2] were able to correlate the playing time of tennis players with the occurrence of lateral epicondylitis. In occupational injuries, this relationship has been inadequately examined,[5] and studies have often suffered from a lack of diagnostic criteria.

Mechanical overload is often thought to be modified adversely by other external factors, such as training errors, improper techniques, and use of inadequate equipment by athletes or workers. These factors have been frequently reported in retrospective studies as the cause of chronic tendon injuries.[1,6] However, these retrospective studies did not contain adequate control groups.

Prospective studies on the effects of correction of external factors are scarce. A few studies have investigated the effects of footwear and have supported an overall decrease in injuries as shoe design has improved.[7] In spite of the limited data, many recommendations involving training techniques and equipment in sports, as well as ergonomic changes in the work situation, have been widely implemented.

In some patients with chronic tendon problems, the mechanical overload is thought to be precipitated or adversely impacted by intrinsic factors, such as malalignment, inflexibility, eccentric muscle use, and muscle weakness or imbalance. These conditions can result in excessively high and/or frequent mechanical loads on tendons during normal activities. In theory, they can be directly responsible for some tendon injuries, but the studies that have been conducted were flawed in design.[8]

Other potential etiologic factors include age-related degeneration and decreased vascular supply.[9] Pathologic studies of patients with chronic tendon problems reveal a predominantly degenerative histologic picture, with few, if any, inflammatory changes found within the tendon. However, those studies that evaluated the paratenons have reported inflammatory cells in these tissues.[10] It is possible that the tendon goes through an inflammatory phase when it is first injured. This phase is usually not analyzed histologically, because most biopsy specimens are obtained only after the tendon has failed to heal following prolonged nonoperative treatment.

Some of the pathologic tendon changes also may be age-related. Several studies have found a clear relation between the incidence of chronic tendon problems and age.[2,11] In the rotator cuff and the Achilles tendon, these changes have been attributed to ischemia secondary to poor vascular supply. More recent studies involving the use of laser-Doppler techniques have not confirmed this hypothesis. However, it is possible that once a frank tendon problem develops, secondary attempts at healing result in a relative increase in vascular supply. This secondary increase in vascularity may explain some of the conflicting results.

Chronic tendon injuries appear to have a multifactorial etiology (Table 1). Certain factors may be more important in one patient than in another. For instance, in the young athlete with otherwise healthy tendons, the repetitive mechanical overload from exercise may be the predominant factor, whereas in the aging patient with preexisting tendon degeneration, exercise may merely be the "permissive factor" that allows the problem to become symptomatic.

Pathology

On the basis of the findings from clinical, pathologic, and imaging studies, it appears that there are several types of chronic tendon injuries and problems (Table 2). When the tendon sheath or peritendinous tissues are involved, the diagnosis of peritendinitis, paratenonitis, or tenosynovitis is appropriate. Inflammatory changes involving the tendon sheath have been well documented in the Achilles tendon, the thumb abductor (de Quervain's disease), and the long-finger flexor tendon (trigger finger).[10] However, inflammatory

Table 1
Etiologic Factors in Chronic Tendon Problems

Extrinsic factors
Repetitive mechanical load
Increased duration
Increased frequency
Increased intensity
Technique errors
Equipment problems
Footwear
Racquet size
Running surface
Protective gear
Intrinsic factors
Anatomic factors
Malalignment
Inflexibility
Muscle weakness
Muscle imbalance
Decreased vascularity
Age-related factors
Tendon degeneration
Decreased healing response
Increased tendon stiffness
Decreased vascularity
Systemic factors
Inflammatory enthesopathy
Quinolone-induced tendinopathy

Table 2
Types of Chronic Tendon Problems

Diagnosis	Tissue Involved
Paratenonitis	Tendon sheath; para-, meso-, and epitenon
Peritendinitis	Tendon sheath; para-, meso-, and epitenon
Tendinitis	Tendon, endotenon
Tendinosis (insertional or midsubstance)	Tendon, endotenon, tendon-bone junction
Tenosynovitis	Tendon sheath; para-, meso-, and epitenon

lesions of the tendon have not been demonstrated. Therefore, it remains uncertain whether tendinitis is a distinct pathoanatomic entity.

Degenerative changes in tendons have been clearly documented and can be described as tendinosis or tendinopathy. Degenerative tendinopathy appears to be prevalent at or near the bony origin or insertion of the tendon (Fig. 1). Degenerative lesions tend to occur on the joint side of the tendon-bone junction and appear similar to the enthesopathy seen in some inflammatory arthritides. Common locations are the rotator cuff, the common wrist extensor (lateral epicondylitis), the patella (jumper's knee), and the Achilles insertion. Occasionally, the degenerative changes affect the midportion of the tendon, particularly in the Achilles tendon, which some believe may be a precursor to Achilles tendon rupture.[12]

Diagnosis

Some tendons, such as the Achilles and patellar tendons, are anatomically very superficial, allowing straightforward evaluation. Others, such as the rotator cuff tendons, are relatively inaccessible, and the differential diagnosis is more extensive; sophisticated means of evaluation may be necessary to rule out some etiologic possibilities. The most common locations of chronic tendon problems are listed in Table 3.

History

The histories of patients with a chronic tendon problem can vary widely, because of the wide spectrum of etiologic factors that may be involved. The role of repetitive and/or intense mechanical overload can be determined by careful inquiry about changes in work, sports, and other recreational activities, not only in the days leading up to the first symptoms but also in the preceding weeks or even months. Any type of change in training or work routine can represent increased mechanical stress for certain tendons. The history should also include questions regarding the workplace or training conditions and the use of appropriate shoes and protective equipment. However, the absence of a history of repetitive mechanical overload does not exclude the possibility of a chronic tendon problem.

Other factors, particularly age-related changes, appear to weaken certain tendons, making them prone to injury without an actual change in the mechanical load placed on the tendon. The history may also reveal

Fig. 1 Histologic section from a resected lateral epicondylitis lesion. Disorganized, relatively acellular and avascular area consistent with a degenerative lesion (solid arrow) is seen on the joint side of the otherwise normal tendon (open arrow) (original magnification, ×40).

Table 3
Most Common Diagnoses and Locations of Chronic Tendinitis

Diagnosis	Location
Rotator cuff tendinitis	Supraspinatus tendon insertion
Lateral epicondylitis (tennis elbow)	Common wrist extensor tendon origin
De Quervain's disease and trigger finger	Sheath/pulley of abductor pollicis longus and long finger flexors
Hamstring tendinitis	Hamstring tendon origin
Quadriceps tendinitis	Quadriceps tendon insertion
Patellar tendinitis (jumper's knee)	Patellar tendon origin
Achilles tendinitis	Sheath, midsubstance, or calcaneal insertion
Posterior tibial tendinitis	Midsubstance

a "gelling" type of pain. Many chronic tendon problems cause marked pain with use after a period of rest (e.g., on arising in the morning). As opposed to morning stiffness associated with inflammatory arthritis, the pain of tendon problems usually subsides rapidly, sometimes within seconds or minutes of initial use.

Physical Examination

The physical examination may yield the definitive diagnosis. Peritendinitis and tenosynovitis often result in visible or palpable swelling of the tendon sheath, sometimes accompanied by crepitus or symptoms of triggering. In other forms of tendinopathy, the tendon will be point tender to direct palpation. In insertional tendinopathy, deep palpation of the bone-tendon junction is occasionally necessary because the affected tendon tissue is usually located on the deep joint side of the tendon (Fig. 1). Testing the tendon in tension (similar to muscle strength testing) often reveals surprisingly little pain compared with direct palpation. In some locations, like the shoulder, direct palpation may be difficult. Indirect pressure on the affected tendon through the impingement maneuver in the shoulder can indicate a chronic rotator cuff tendon problem. Restriction of joint motion also can be present.

Diagnostic Tests

Routine radiographs are often not needed during the initial visit if involvement of the tendon or tendon sheath is evident. When there is doubt, radiographs are appropriate to eliminate the possibility of a problem such as degenerative arthritis of the adjacent joint or a stress fracture near the tendon-bone junction. Calcification or ossification within the tendon and traction spurs at the bone-tendon junction support the diagnosis of a tendinopathy; however, these findings can occur in asymptomatic individuals as well.

In cases that are complex or that do not respond to treatment, more sophisticated imaging techniques can be helpful. Technetium bone scanning can be positive in active insertional tendinopathy, although its clinical importance has yet to be determined. Evaluation of the tendon can also be accomplished through diagnostic ultrasound. Enlargement of the tendon, degenerative lesions, and partial and complete tears can be documented by an experienced ultrasonographer (Fig. 2). Magnetic resonance (MR) imaging will allow evaluation of the tendon as well as the surrounding structures, such as the adjacent joint (Fig. 3). However, the degree of tendon involvement depicted by MR imaging does not always correlate with the clinical symptoms. Diagnostic injections of a local anesthetic can be very helpful in confirming the source of pain in chronic tendon problems.

Nonsurgical Treatment

Once the diagnosis of a tendinopathy has been made, treatment can be initiated. Before recommending a certain form of treatment, it may be important to explain the nature and the expected course of the problem to the patient. Several studies have found that many patients go through a protracted course of chronic pain, often lasting several months or longer.[2,3] Realistic patient expectations may avoid further problems during the treatment period.

Correction of External Factors

The initial treatment should be aimed at modifying etiologic factors that are identified in the history. Relative rest achieved by removing the mechanical overload will at least diminish the symptoms and allow any intrinsic healing to proceed. This goal can often be accomplished with a temporary change in the training regimen or occupation. Changes in technique, ergonomics,

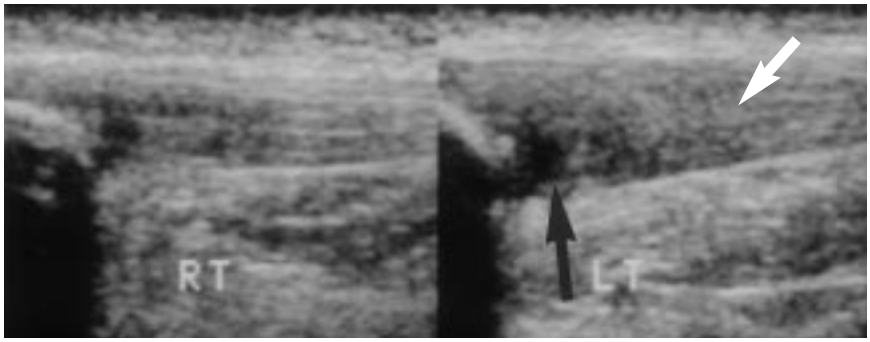

Fig. 2 Sonograms of the right and left patellar tendons depict more enlargement of the left tendon (white arrow) and a hypoechogenic area consistent with insertional tendinopathy (black arrow).

and equipment should be considered. Use of appropriate shoes, racquet size, and protective devices may be helpful, although controlled studies on these interventions are not available.

Absolute rest achieved by casting or another form of immobilization does not appear indicated for most patients. Laboratory investigations demonstrate that immobilization has detrimental effects on both healing and normal soft tissues. Intermittent splinting, especially at night, is sometimes used, particularly in patients with severe pain. Some clinicians have recommended intermittent splinting as a means of placing the affected tendon under light stretching for prolonged periods of time. The mechanical stretching is thought to stimulate a healing response.

Fig. 3 MR image demonstrates that Achilles tendinopathy has progressed to a joint-side partial tear (arrow).

Physical Therapy

Evaluation of the flexibility and strength of the involved muscles, as well as those proximal and distal to the affected area, may reveal unusual tightness and/or imbalances. Correction through exercise therapy is often recommended, although the efficacy of this treatment modality has not been clearly documented. A controlled study of exercise therapy in the shoulder has shown some potential benefits.[13] Exercise therapy with an emphasis on eccentric strengthening also has been advocated, but prospective, controlled studies are not available to document its superiority over other forms of exercise therapy.[8]

Physical modalities, such as ice, heat, and ultrasound, are often used as an adjunct in the treatment of tendinopathies. Although laboratory studies have suggested some beneficial effects, they have not yet been confirmed in clinical practice.[14]

Nonsteroidal Anti-inflammatory Drugs

Nonsteroidal anti-inflammatory drugs (NSAIDs) are generally recommended for the initial treatment of symptomatic tendinopathy. A review of the literature revealed that in five of nine placebo-controlled studies of NSAID use in the treatment of chronic tendon problems, the results in the groups of patients given NSAIDs were superior to those in the control groups; however, all were short-term studies that did not document complete resolution of the problem.[15] While NSAIDs may cause moderate analgesia, it is not clear whether they actually alter the natural history of tendinopathy. Side effects such as gastrointestinal ulceration, nephrotoxicity, and hepatotoxicity are not uncommon with long-term use in the elderly patient with arthritis. These side effects seem to be less of a concern with temporary NSAID use in the younger patient with tendinitis.

Corticosteroid Therapy

If the initial treatment fails, more invasive intervention may be appropriate. In general, such interventions are not considered when the patient's symptoms are low-grade and do not interfere with daily activities. If the symptoms and functional impairment warrant further intervention, a local corticosteroid injection can be tried. Oral corticosteroids have been used, but there is little support for their use in the literature.

Local injections, particularly around weight-bearing tendons, such as the Achilles and patellar tendons, are controversial because

of the possibility of steroid atrophy and subsequent tendon rupture. Laboratory investigations support this potential deleterious side effect. Intratendinous injections also may cause tendon injury, especially if a large volume is used, because of the increased pressure following the injection; therefore, they generally are not recommended. Clinical reports of tendon ruptures following steroid injections are numerous; however, these have not been controlled studies. Since ruptures also occur without prior injection, the actual risk that can attributed to the steroid injection is not known.

Of eight controlled studies in the literature, three indicate improvement with an injection even at long-term follow-up.[15] The initial success rate was high in many studies, but recurrences were common. Although not specifically studied, it seems appropriate to minimize the number of injections to a maximum of two or three with at least 3 months between injections. It is generally recommended to avoid strenuous activities involving the affected tendon for 2 to 3 weeks after the injection in the hope of avoiding tendon rupture during the phase of maximal steroid atrophy.

Surgical Treatment

If the symptoms and functional impairment continue beyond 4 to 6 months after the start of treatment, surgery can be considered, weighing the potential side effects against the level of severity of symptoms. Many patients will be able to manage the problem well with only modest changes in their lifestyle and will not require further invasive treatment.

Although there are few controlled studies of the efficacy of surgery, clinical reports tend to show a high percentage of good and excellent results.[16,17] Most reports recommend that surgery should directly address the involved tendon. It can be helpful to obtain a preoperative MR imaging or ultrasound study to try to identify specific tendon involvement. If the tendon itself is involved, the degenerated tendon tissue should be visualized and debrided. This is accomplished by splitting the tendon longitudinally and, if necessary, detaching some of the tendon tissue from its insertion. Normal tendon tissue should be left attached. Sometimes most of the tendon is affected; in this circumstance, complete excision with primary repair and/or grafting can be considered. Many surgeons recommend curettage of any exposed bone. It is not clear whether this is important, but reactive changes noted on bone scanning and histologic studies indicate that pathologic changes can extend into the insertion point.

In patients with predominant peritendinitis, surgery should be focused on the peritendinous tissues, with release and/or excision of the tendon sheath. Occasionally, tight pulleys or retinacular tissue (often found in the wrist and hand) can be found and released. A special situation exists when surrounding bony prominences can be removed, thereby relieving mechanical pressure on the tendon and peritendinous tissues. Impingement of the acromion on the supraspinatus tendon is a common example of this situation.

Specific Conditions

Achilles Tendinitis

Achilles tendon problems present as insertional tendinopathy, midsubstance tendinosis, or peritendinitis. The first two will mainly result in local pain and tenderness at the site of involvement. Peritendinitis can result in crepitus and diffuse swelling along the tendon. Further evaluation may reveal tightness in the Achilles tendon–muscle unit.

Initial treatment usually includes relative rest from overuse, a temporary heel lift, NSAIDs, and a stretching program. Depending on the severity of the condition, recovery can take as long as 3 to 6 months. Even in resistant cases, corticosteroid injections are generally not recommended because of the possibility of progression to a complete Achilles tendon rupture.

If 6 to 12 months of nonoperative treatment fails to result in improvement, surgery can be considered. Additional studies can be helpful at this point. A lateral radiograph will allow evaluation of potential impingement on the posterior process of the calcaneus. An MR imaging study can better define the extent of tendon involvement (Fig. 3).

Surgical procedures should focus on the injured or diseased tissue.[16] Affected and/or scarred peritendinous tissue should be released or removed. If the tendon itself is involved, it should be debrided; a local graft may be needed if this results in marked weakening of the tendon. The results of surgery will be good in most cases as long as the specific pathologic changes in the tendon are addressed.

Posterior Tibial Tendinitis

Posterior tibial tendinitis appears to be largely an age-related degenerative tendinopathy. It usually occurs in the midsubstance of the tendon as it courses along the medial side of the hindfoot. The initial symptom is medial foot pain, which may progress to a painful flatfoot as the tendon attenuates and ruptures.

Initial treatment involves relative rest with a well-molded arch support and NSAIDs. If the symptoms persist for several months, surgery can be considered. In the early stages of the tendinopathy, this can include debridement and/or repair. In more advanced stages, a tendon transfer or even subtalar arthrodesis may be needed to alleviate symptoms.

Patellar and Quadriceps Tendinitis

Patellar tendinitis is mainly found in patients who participate in jumping or running activities (hence the name "jumper's knee"). The eccentric muscle contraction that occurs with landing on one leg is thought to contribute to the mechanical overload in this situation.[8] It is most common at the inferior pole of the patella as an insertional tendinopathy. Quadriceps tendinitis is a similar problem at the superior pole of the patella. Both result in localized pain and tenderness at the affected site.

Initial treatment involves a decrease in impact exercise, quadriceps stretching and strengthening exercises, and NSAIDs. In resistant cases, friction massage and physical modalities such as ultrasound can be considered. Corticosteroid injections are generally not used because of the risk of rupture. If there is no improvement after 6 to 12 months, surgical treatment may be warranted. Radiography may be helpful in ruling out other knee disorders, but further imaging studies are often not needed if the diagnosis is clear. Surgery involves removal of the affected tissue through a tendon-splitting approach. Curettage of the exposed bone at the patellar pole may be recommended. Surgery can result in significant improvement in pain, although failures have been reported.

De Quervain's Disease and Trigger Finger

Tendon problems appear to be common in the hand and wrist. Many syndromes have been described, but most lack definitive proof that they should be considered as distinct entities. However, inflammation and thickening of the peritendinous tissues (and possibly the tendon itself) of the abductor pollicis longus tendon near the radial styloid (de Quervain's disease) and of the long-finger flexors near the A1 pulley (trigger finger) appear to be two distinct chronic tendon problems in the wrist and hand. De Quervain's disease mostly results in local pain and swelling, whereas trigger finger usually is not a problem until the tendon starts triggering in and out of the pulley. Both conditions may respond to temporary immobilization with or without a local corticosteroid injection. If nonresponsive, surgical release of the first dorsal compartment or A1 pulley is usually successful in resolving the problem.

Lateral Epicondylitis

Lateral epicondylitis, or tennis elbow is an insertional tendinopathy of the origin of the wrist extensors at the lateral epicondyle. Pain with use of the wrist and hand and localized tenderness are the most common signs and symptoms. Initial treatment can include relative rest (sometimes with a temporary wrist splint), NSAIDs, and wrist stretching and strengthening exercises.

In severe or resistant cases, corticosteroid injections are often used. Relief may be obtained, but recurrences are common. Surgery is used for resistant cases and generally is thought to result in good pain relief for the vast majority of patients, although controlled studies are not available. Debridement of the common extensor tendon with curettage or even ostectomy of the epicondyle is generally used.

Rotator Cuff Tendinitis

Rotator cuff problems range from mild tendinopathy to frank tendon tearing. The pathologic changes seem to involve the supraspinatus tendon preferentially and cause pain with both use and rest in some patients. It may be considered an insertional tendinopathy at the greater tuberosity as well as a tendon injury due to impingement on the acromion.

Initial treatment includes relative rest with a decrease in overhead activities, NSAIDs, and a stretching and strengthening program for the rotator cuff and scapular stabilizers. If no improvement is seen in 2 to 3 months, a subacromial injection of corticosteroids can be tried. If pain persists or recurs, radiographs can be obtained to rule out other pathologic conditions and to evaluate the shape of the potentially impinging acromion. An arthrogram can document tendon tears but will be normal in most cases of tendinopathy without a frank tear. Magnetic resonance imaging can visualize pathologic changes in the tendon; however, these changes may not correlate well with the patient's symptoms and should be viewed with caution. Other problems in and around the shoulder, such as instability and labral disorders, can cause similar problems, such as primary cuff tendinopathy. If nonoperative treatment fails, a subacromial decompression can be considered after 6 to 9 months of conservative treatment.

Whether acromial impingement is mostly responsible for supraspinatus tendon disorders is not certain. Subacromial decompression has been shown to yield good to excellent results in approximately 80% of patients,[18] compared with nearly 100% for surgical release of resistant epicondylitis. This sug-

gests that the intrinsic tendinopathy of the supraspinatus is not always addressed by a subacromial decompression alone. If a partial tear of the supraspinatus tendon is present, excision and primary repair of the tendon can be considered.

Future Directions

Many questions about chronic tendon problems remain unanswered. Current scientific knowledge suggests that many tendon problems are not simply the result of mechanical overuse, but that many other factors contribute to their development. The relative lack of efficacy of currently used treatment methods has led to research in new directions. Extracorporeal shockwave treatment, similar to that used in nephrolithiasis, has been used in initial pilot studies of chronic tendinopathy.[19] More recently, growth factors have been shown to have positive effects on tendon fibroblasts, particularly in conjunction with motion.[20] On the basis of these findings, novel treatment methods are being investigated.

Summary

Peritendinitis and degenerative tendinopathy or tendinosis appear to make up the majority of chronic resistant tendon problems. The etiology is likely to be multifactorial, including such factors as repetitive mechanical overload, aging, and relative avascularity. Initial treatment includes counseling, relative rest, use of NSAIDs, and physical therapy. Corticosteroids and surgery should be reserved for resistant and disabling cases.

References

1. James SL, Bates BT, Osternig LR: Injuries to runners. *Am J Sports Med* 1978;6:40-50.
2. Gruchow HW, Pelletier D: An epidemiologic study of tennis elbow: Incidence, recurrence, and effectiveness of prevention strategies. *Am J Sports Med* 1979;7:234-238.
3. Almekinders LC, Almekinders SV: Outcome in the treatment of chronic overuse sports injuries: A retrospective study. *J Orthop Sports Phys Ther* 1994;19:157-161.
4. Lysholm J, Wiklander J: Injuries in runners. *Am J Sports Med* 1987;15:168-171.
5. Vender MI, Kasdan ML, Truppa KL: Upper extremity disorders: A literature review to determine work-relatedness. *J Hand Surg [Am]* 1995;20:534-541.
6. Clement DB, Taunton JE, Smart GW: Achilles tendinitis and peritendinitis: Etiology and treatment. *Am J Sports Med* 1984;12:179-184.
7. Schwellnus MP, Jordaan G, Noakes TD: Prevention of common overuse injuries by the use of shock absorbing insoles: A prospective study. *Am J Sports Med* 1990;18:636-641.
8. Stanish WD, Rubinovich RM, Curwin S: Eccentric exercise in chronic tendinitis. *Clin Orthop* 1986;208:65-68.
9. Leadbetter WB: Cell-matrix response in tendon injury. *Clin Sports Med* 1992; 11:533-578.
10. Kvist M, Józsa L, Järvinen MJ, Kvist H: Chronic Achilles paratenonitis in athletes: A histological and histochemical study. *Pathology* 1987;19:1-11.
11. Kannus P, Niittymäki S, Järvinen M, Lehto M: Sports injuries in elderly athletes: A three-year prospective, controlled study. *Age Ageing* 1989;18: 263-270.
12. Kannus P, Józsa L: Histopathological changes preceding spontaneous rupture of a tendon: A controlled study of 891 patients. *J Bone Joint Surg Am* 1991;73:1507-1525.
13. Brox JI, Staff PH, Ljunggren AE, Brevik JI: Arthroscopic surgery compared with supervised exercises in patients with rotator cuff disease (stage II impingement). *BMJ* 1993;307: 899-903.
14. Haker E, Lundeberg T: Pulsed ultrasound treatment in lateral epicondylalgia. *Scand J Rehabil Med* 1991;23:115-118.
15. Almekinders LC, Temple J: The etiology, diagnosis and treatment of tendinitis: An analysis of the literature. *Med Sci Sports Exerc* (in press).
16. Schepsis AA, Leach RE: Surgical management of Achilles tendinitis. *Am J Sports Med* 1987;15:308-315.
17. Nirschl RP, Pettrone FA: Tennis elbow: The surgical treatment of lateral epicondylitis. *J Bone Joint Surg Am* 1979;61:832-839.
18. Roye RP, Grana WA, Yates CK: Arthroscopic subacromial decompression: Two- to seven-year follow-up. *Arthroscopy* 1995;11:301-306.
19. Rompe JD, Rumler F, Hopf C, Nafe B, Heine J: Extracorporal shock wave therapy for calcifying tendinitis of the shoulder. *Clin Orthop* 1995;321:196-201.
20. Banes AJ, Hu P, Xiao H, et al: Tendon cells of the epitenon and internal tendon compartment communicate mechanical signals through gap junctions and respond differentially to mechanical load and growth factors, in Gordon SL, Blair SJ, Fine LJ (eds): *Repetitive Motion Disorders of the Upper Extremity*. Rosemont, Ill: American Academy of Orthopaedic Surgeons, 1995, pp 231-245.