Rotator cuff tendinopathy

Authors: Stephen M Simons, MD, FACSM, David Kruse, MD
Section Editor: Karl B Fields, MD
Deputy Editor: Jonathan Grayzel, MD, FAAEM

All topics are updated as new evidence becomes available and our peer review process is complete.

Literature review current through: Jul 2019. | **This topic last updated:** Dec 07, 2018.

INTRODUCTION

Shoulder pain is a common complaint in the primary care setting. Patients with rotator cuff pathology comprise a sizeable portion of this subpopulation. A basic understanding of the anatomy and pathophysiology of the rotator cuff will help the clinician evaluate these patients.

The clinical pathophysiology, diagnosis, and management of rotator cuff tendinopathy are reviewed here. The general evaluation of the patient with shoulder pain, the shoulder examination, other specific shoulder problems, and general treatments for tendinopathy are discussed separately. (See "Evaluation of the adult with shoulder complaints" and "Physical examination of the shoulder" and "Overview of the management of overuse (persistent) tendinopathy" and "Presentation and diagnosis of rotator cuff tears" and "Rehabilitation principles and practice for shoulder impingement and related problems".)

TERMINOLOGY

Knowledge of the pathogenesis of tendon overuse disorders remains incomplete. Histopathological, biochemical, and molecular studies reveal a degenerative process with little evidence of inflammation, although inflammation may play a role initially, and inflammation following an acute injury can occur concomitantly with chronic tendon pathology. The pathophysiology of chronic tendon disorders is discussed separately. (See "Overview of overuse (persistent) tendinopathy".)

The term "tendinitis" came into common parlance to describe chronic painful tendon injuries before the underlying pathology was better understood. The terms "tendinosis" or "tendinopathy" may better

describe chronic tendon disorders. Despite support for the term "tendinopathy" among experts, the term "tendinitis" is deeply ingrained in clinical practice and the historical literature. In this review, we use the term "tendinopathy" to refer to symptomatic primary rotator cuff tendon disorders.

EPIDEMIOLOGY

The incidence of shoulder complaints is approximately 11.2 cases per 1000 patients per year [1]. Shoulder pain occurs more often in the elderly [2,3]. In working populations, the incidence of shoulder-related symptoms may be as high as 14 to 18 percent [4]. (See "Evaluation of the adult with shoulder complaints".)

The prevalence of rotator cuff disease, symptomatic or asymptomatic, that is identified by surgery or imaging, increases with age from 9.7 percent under age 20 to 62 percent over age 80 [5]. Rotator cuff disorders are a significant source of morbidity among manual laborers and those whose work involves a great deal of repetitive motion [4,6-8]. In the general population as well, rotator cuff disease is the most common cause of shoulder pain [1,3,4,6,9,10]. Any of the rotator cuff tendons may be involved, but the supraspinatus tendon is most frequently injured.

RISK FACTORS

Repetitive overhead activity, whether in sport or work, is a major risk factor for rotator cuff tendinopathy [1]. Other risk factors include anatomic variants that predispose to rotator cuff impingement, scapular instability or dyskinesis, and older age [11-13]. In the working population, problems in one shoulder can place the contralateral shoulder at risk [4]. There is preliminary evidence for genetic or familial predisposition to rotator cuff disease [14]. (See "Shoulder impingement syndrome".)

Athletes who perform overhead activity, such as swimming, tennis, throwing, golf, weightlifting, volleyball, and gymnastics, are at risk. Weakness or fatigue of the rotator cuff muscles or secondary supporting muscles is common and can lead to poor mechanics and dysfunction of the shoulder. Instability or hypermobility of the glenohumeral joint unrelated to muscle weakness also predisposes to rotator cuff injury [6,15].

Certain chronic diseases have been associated with an increased risk for rotator cuff tendinopathy, including increased body-mass index, diabetes, and hyperlipidemia [16,17]. Statin therapy may attenuate the risk among patients with hyperlipidemia [17].

CLINICAL ANATOMY

The clinical anatomy of the shoulder is discussed in detail separately (figure 1A-C). (See "Evaluation of the adult with shoulder complaints", section on 'Anatomy and biomechanics'.)

BASIC BIOMECHANICS

Clinically relevant shoulder motions involving the glenohumeral and scapulothoracic joints are more complex than previously appreciated [6]. Nevertheless, the function of the rotator cuff is relatively easy to understand and provides the basis for clinical testing.

Rotator cuff tendon pathology most often involves damage to the supraspinatus tendon. The supraspinatus muscle assists in abduction and external rotation of the shoulder. Researchers have tried to identify accurate clinical methods of assessing supraspinatus function [6]. According to one approach, the function of the supraspinatus can be tested in relative isolation with the arm abducted in the scapular plane (approximately 30 degrees of forward flexion) and the shoulder in full internal rotation (the so-called "empty can" position) [18]. Despite these efforts, it appears that supraspinatus function cannot be tested in isolation because of the inextricable role of other shoulder muscles in abduction and external rotation [19,20].

The infraspinatus muscle assists in external rotation and abduction of the shoulder. It is assisted in these motions by the deltoid, teres minor, and supraspinatus. Although some researchers advocate specific assessment techniques, attempts at isolating infraspinatus function for clinical testing have proved difficult [1,21]. The infraspinatus is commonly tested by having the patient isometrically resist external rotation with the elbow flexed at 90 degrees in a neutral rotation. This is thought to limit the assistance of the deltoid and supraspinatus.

The teres minor muscle also assists in external rotation and abduction of the shoulder. EMG studies indicate that the teres minor is especially active in external rotation when the arm is abducted to 90 degrees [21]. Biomechanical studies suggest that the teres minor contributes up to 45 percent of the power of external rotation. With hypertrophy the teres minor can exhibit sufficient strength to compensate for tears in the infraspinatus that might otherwise manifest during testing of external rotation against resistance [3].

The subscapularis muscle's primary function is to internally rotate the shoulder, but it also assists in abduction and adduction. EMG studies show that the pectoralis major, latissimus dorsi, and teres major assist in internal rotation and may confound clinical testing of the subscapularis [6,7]. The

subscapularis tendon helps to stabilize the long head biceps tendon and tears of the subscapularis can be associated with biceps tendon injuries. (See "Biceps tendinopathy and tendon rupture".)

In addition to its motor functions, the rotator cuff compresses the humoral head in the glenoid fossa, thereby stabilizing the glenohumeral joint. By means of this compression, the rotator cuff counterbalances the elevating forces of the deltoid, as well as the forces of other muscles acting on the humerus [22,23]. Weakness of the rotator cuff can lead to superior subluxation of the humeral head when the shoulder is abducted beyond 90 degrees, predisposing to impingement syndromes.

PATHOPHYSIOLOGY AND MECHANISM OF INJURY

The pathophysiology and the mechanism of injury for rotator cuff tendinopathy remain unclear, but researchers propose two theories: one emphasizes biomechanical factors and the other vascular factors [6,11,18,19,24]. Most likely, elements of both explanations play a role. An alternative approach to describing the mechanism of injury involves intrinsic factors, directly related to the tendon, and extrinsic factors, related to surrounding structures.

- Intrinsic mechanism – This mechanism emphasizes injury within the tendon from tendon overload, degeneration, or other insult [6,11,18,19]. A compromised microvascular system compounds the problem by creating a "critical zone" of avascularity at the site of injury. This proposed mechanism involving interplay between tendon injury and microvascular compromise remains controversial.

  Tensile overload during eccentric contraction (ie, muscle contracts while lengthening) with overhead activity is implicated in this mechanism. This is particularly true for the overhead athlete. As an example, when a pitcher's throwing arm decelerates after release of the ball, the lengthening posterior rotator cuff muscles contract to slow the arm. This eccentric contraction places a large tensile load on the posterior rotator cuff.

  Age and comorbidity can play a role in this mechanism. Aging tendons develop microtears, calcification, and fibrovascular proliferation. Comorbidities (eg, diabetes mellitus, rheumatoid arthritis, Marfan's or Ehlers-Danlos syndromes) can contribute to tendon pathology. (See "Overview of the musculoskeletal complications of diabetes mellitus".)

- Extrinsic mechanism – This mechanism emphasizes the role of compressive forces exerted by surrounding structures in causing rotator cuff injury [6,11,18]. Various structures may impinge the rotator cuff, including: the acromion, the coracoacromial ligaments, the coracoid process, and the acromioclavicular joint with osteoarthritic changes on its undersurface (figure 1A-C). Glenohumeral instability can also lead to secondary compressive forces. The mechanics of such

impingement is discussed elsewhere. (See 'Basic biomechanics' above and "Shoulder impingement syndrome".)

DIFFERENTIAL DIAGNOSIS

Rotator cuff tendinopathy may be a manifestation of shoulder impingement, but must be distinguished from other causes of shoulder pain (table 1 and table 2). A detailed discussion of the differential diagnosis and clinical assessment of shoulder pain is found separately. (See "Shoulder impingement syndrome" and "Evaluation of the adult with shoulder complaints".)

In particular, it is important to distinguish rotator cuff tendinopathy from cervical radiculopathy, acromioclavicular osteoarthritis, subacromial bursitis, bicipital tendinopathy, rotator cuff tear, glenoid labrum tear, and adhesive capsulitis [11].

CLINICAL PRESENTATION AND EXAMINATION

Clinical presentation — Patients with rotator cuff tendinopathy complain of shoulder pain with overhead activity. Painful daily activities may include putting on a shirt or brushing hair. Patients may localize the pain to the lateral deltoid and often describe pain at night, especially when lying on the affected shoulder. The history often reveals risk factors. (See 'Epidemiology' above.)

Overhead athletes often complain of pain while performing their sport (eg, pitching, freestyle swimming), weakness, or a decline in performance. Reduced performance generally manifests as diminished speed, accuracy, or endurance.

Physical examination — Performance of the shoulder examination is discussed in detail separately (see "Physical examination of the shoulder"). The portions of this examination of particular relevance to rotator cuff pathology are discussed briefly below.

Overall, examination techniques for rotator cuff pathology are moderately sensitive, but one small trial found that a battery of carefully performed physical examination tests for rotator cuff tendinopathy failed to diagnose a number of pathologic conditions identified readily by ultrasound [25]. (See 'Musculoskeletal ultrasound' below.)

Notable examination findings consistent with rotator cuff tendinopathy are described below:

- Inspection – With long-standing rotator cuff tendinopathy, atrophy of supraspinatus and infraspinatus muscles may be present. A sunken appearance is appreciable in the corresponding scapular fossa.

Movement of the scapula of the affected shoulder may demonstrate asymmetric motion compared with the unaffected side. Scapular motion asymmetries may be subtle and dynamic in athletes. The inherent strength of many athletes may produce a normal appearing scapular movement with a single abduction. Repetitive abduction with some resistance to near exhaustion may reveal subtle asymmetries of scapulothoracic movement. (See "Physical examination of the shoulder", section on 'Scapulothoracic motion and strength'.)

- Neck examination – Shoulder pain may be referred from the neck. It is important to examine the neck and perform a screening neurologic examination to rule out cervical spine pathology. (See "Evaluation of the adult patient with neck pain".)

- Palpation – Rotator cuff tendinopathy often creates tenderness over the affected musculature (supraspinatus, infraspinatus) or focal subacromial tenderness at the lateral or posterior-lateral border of the acromion. However, the location of the rotator cuff deep to the deltoid makes palpation difficult and unreliable. (See "Physical examination of the shoulder", section on 'Palpation'.)

- Range of motion (ROM) – Painful ROM above 90 degrees of abduction, or pain with internal rotation suggests rotator cuff tendinopathy (picture 1). Painful arc testing demonstrates greater specificity than sensitivity and is most useful when used in conjunction with the Neer and Hawkins-Kennedy tests. Pain that occurs between 60 and 120 degrees of active abduction marks a positive arc test. Abduction is performed with the arm at 30 degrees of horizontal adduction (ie, in the plane of the scapula). With rotator cuff pathology, passive ROM is usually greater than active ROM. (See "Physical examination of the shoulder", section on 'Range of motion'.)

- Strength testing – Supraspinatus strength is evaluated by performing the "empty can" (or Jobe's strength) test (picture 2). External rotation (infraspinatus) strength of the shoulder can be tested with the patient's arms at their sides and the elbows in 90 degrees of flexion (picture 3). Alternatively, external rotation can be tested against resistance with the shoulder abducted to 90 degrees and the elbow flexed to 90 degrees (Hornblower sign). The push-off (or Gerber's lift off) test can be used to assess internal rotation (subscapularis) strength (picture 4). Performance of these maneuvers is described in greater detail separately. (See "Physical examination of the shoulder", section on 'Examination for rotator cuff pathology'.)

- Special tests – The Neer and Hawkins-Kennedy tests are commonly used to diagnose impingement (picture 5 and picture 6). (See "Physical examination of the shoulder", section on 'Special tests for shoulder impingement'.)

Clinicians may want to perform an acromioclavicular (AC) compression or crossover test. This test may be positive due to AC joint or rotator cuff pathology, and therefore is most useful for ruling out AC injury when negative. (See "Acromioclavicular joint injuries ("separated" shoulder)", section on 'History and examination'.)

- Lidocaine injection test – A subacromial injection of lidocaine can be used to alleviate pain and to distinguish between rotator cuff tendinopathy and tear. Examination with adequate analgesia following injection provides a more accurate assessment of muscle strength. Patients with tendinopathy exhibit normal strength with pain relief; those with a large tear have persistent weakness.

RADIOGRAPHIC FINDINGS

Plain radiographs — Routine plain radiographs of the shoulder do not reveal signs of rotator cuff tendinopathy and are generally not indicated in patients suspected of such injuries. Plain films can be helpful to identify co-existing conditions or predisposing factors, and may be useful in the following clinical situations:

- Assessment when there is no response to conservative therapy and other pathology is suspected (eg, AC joint arthritis, glenohumeral joint arthritis, tendon calcification)
- Recurrent rotator cuff tendinopathy
- Anatomical evaluation prior to subacromial or glenohumeral joint injection (not essential prior to injection)

Musculoskeletal ultrasound — Many clinicians consider musculoskeletal ultrasound (MSK US) to be the gold standard for the initial evaluation of tendon disorders, including rotator cuff disease [26,27]. MSK US enables the trained clinician to evaluate tendons while they are in motion and to compare them with the contralateral shoulder at the bedside. Clinicians can then correlate MSK US and physical examination findings. Other advantages include ease of use, absence of radiation exposure, and relative low cost [26]. Performance of the shoulder MSK US examination is reviewed in detail separately. (See "Musculoskeletal ultrasound of the shoulder".)

Multiple studies demonstrate ultrasound's high sensitivity in diagnosing rotator cuff disease, particularly complete tendon tears [27-33]. Changes noted on ultrasound diagnostic for rotator cuff pathology include: tendon hypoechogenicity or thickening with or without internal hypo or hyperechoic foci [25,34].

MSK US has limitations. Occasionally it is difficult to visualize the entire rotator cuff, which can reduce the sensitivity for identifying partial rotator cuff tears. Sonographically identified neovascularization, seen in other pathologic tendons, is nondiagnostic within the rotator cuff tendons [35].

Additional ultrasound resources — Instructional videos demonstrating proper performance of the ultrasound examination of the shoulder and related pathology can be found at the website of the American Medical Society for Sports Medicine: sports US shoulder pathology. Registration must be completed to access these videos, but no fee is required.

Magnetic resonance imaging — Magnetic resonance imaging (MRI) is used to rule out rotator cuff tear when conservative therapy fails, to assess for tear suspected on clinical grounds, and to aid in diagnosis when shoulder pathology is unclear. MRI can also be used when diagnostic confirmation is needed to guide the patient's return to sport.

MRI findings must be interpreted in clinical context. An observational study of MRI performed in 96 asymptomatic individuals showed rotator cuff tears in 34 percent overall and 54 percent of patients over 60 years [13]. Rotator cuff degeneration produces a high-intensity signal on MRI [21].

INDICATIONS FOR ORTHOPEDIC REFERRAL

Many options for the medical treatment of rotator cuff tendinopathy exist. Orthopedic surgical referral is obtained if nonoperative therapy fails to provide relief within six to nine months or a diagnosis of rotator cuff tear is made (see "Presentation and diagnosis of rotator cuff tears"). Patients with adhesive capsulitis from longstanding rotator cuff disease that is refractory to conservative therapy need surgical referral.

The appropriate surgical intervention varies according to the patient's age, comorbidities, level of activity, and the location and type of rotator cuff pathology. Three basic surgical interventions exist: debridement, acromioplasty (ie, shaving of the acromion's undersurface to relieve impingement) with debridement, and rotator cuff repair [11].

TREATMENT

General approach — Many treatments for rotator cuff tendinopathy exist, but few are supported by strong scientific evidence. Below is a discussion of the general management of rotator cuff tendinopathy. Our suggested approach to the management of suspected rotator cuff injury is described below; a general discussion of treatments for tendinopathy is provided separately. (See

'Approach to management' below and "Overview of the management of overuse (persistent) tendinopathy".)

Acute treatment

Basic management — Initial therapy for rotator cuff tendinopathy consists of ice, rest, and nonsteroidal antiinflammatory drugs (NSAIDs) [6,11]:

- Cryotherapy – Despite a dearth of scientific research to support its use, cryotherapy is generally believed to decrease acute swelling and inflammation and to provide some analgesia [18]. Ice may be especially effective when tendinopathy is associated with surrounding inflammation [21].
- Rest – Rest means avoiding activities that aggravate symptoms, including all overhead activities.
- NSAIDs – For acute injuries, we give a short course (ie, 7 to 10 days) of scheduled NSAID therapy. Thereafter, patients may use an NSAID for occasional analgesia if they find the medication effective.

The use of NSAIDs for tendinopathy remains controversial [18,21]. During the period of acute injury, debate continues about whether blocking the inflammatory response inhibits healing. In the treatment of chronic tendinopathy, it is unclear what benefit NSAIDs provide without evidence of an inflammatory process. (See 'Pathophysiology and mechanism of injury' above.)

A review of 32 studies addressing the benefit of NSAIDs in tendinopathy identified only nine prospective, placebo-controlled trials [18]. Of these nine studies, five found some analgesic effect from NSAIDs; no study assessed tendon healing. A subsequent systematic review of 12 studies of limited quality concluded that NSAIDs provide short-term pain relief equivalent to injected glucocorticoid but no functional benefit [36].

Adjunct therapies — No high quality evidence exists to support the use of the modalities listed here and we do not routinely use them in the care of our patients [37]. Adjunct therapies may include:

- Electrical stimulation, phonophoresis, and iontophoresis – Electrical stimulation, phonophoresis, and iontophoresis are three therapeutic modalities used to aid in pain relief. Phonophoresis uses ultrasound to enhance the transdermal absorption of topically applied analgesics and antiinflammatory agents. Iontophoresis uses electrical charge for the same purpose.
- Therapeutic ultrasound – Ultrasound theoretically stimulates tendon healing via collagen production, thereby increasing tensile strength [6]. There is little evidence to support its use [18,38].

- Laser – A metaanalysis of studies of physiotherapy interventions for shoulder pain showed no benefit from laser therapy in the treatment of rotator cuff tendinopathy [38].

Physical therapy — A number of physical therapy techniques are used to rehabilitate patients with rotator cuff tendinopathy. For many patients, the biomechanical problems that have contributed to their rotator cuff tendinopathy are identical to the problems found in patients with shoulder impingement syndrome, and thus the physical therapy program prescribed for each patient group is often fundamentally the same. A detailed description of such a rehabilitation program is provided separately. (See "Rehabilitation principles and practice for shoulder impingement and related problems".)

Well-performed clinical trials of physical therapy programs for rotator cuff tendinopathy are scarce [39]; rehabilitation programs are based on the available evidence and the clinical experience of the treating physician and therapist. We typically prescribe the exercises described below.

- Range of motion exercises can help to prevent shoulder stiffness and the complications of adhesive capsulitis. Generally, full range of motion should be achieved prior to strengthening exercises [6].

- Stretching and strengthening of the muscles of the rotator cuff are basic components of physical therapy. A systematic review of physiotherapy interventions for shoulder pain found that such exercises are effective for short term recovery and long term function [38]. The combination of mobilization (ie, not keeping the arm in a sling) and exercise showed greater benefit than exercise alone.

- Rotator cuff rehabilitation that focuses on the restoration of proper muscle activation and appropriate strength balance among individual muscles of the rotator cuff is important [40,41]. Exercises to strengthen the scapular stabilizers and better integrate their function with the rotator cuff are emphasized. The restoration of range of motion, strength, and coordination (ie, kinetic chain restoration) marks completion of a rehabilitation program.

- Eccentric exercise is the application of a load (ie, muscular contraction) during the lengthening of a muscle. Several studies suggest that eccentric exercise stimulates healing and provides effective rehabilitation of tendinopathy. Preliminary trials in rotator cuff disease suggest that this approach is beneficial, but further study is needed [41,42]. Eccentric exercise and other rehabilitation techniques using heavy loads are discussed separately. (See "Overview of the management of overuse (persistent) tendinopathy", section on 'Heavy load resistance training'.)

- Manual therapy, which may consist of joint mobilization, soft tissue massage and manipulation, and neurodynamic interventions, may decrease pain, but it is unclear whether this is associated

with improved function [43].

- Aerobic fitness should be maintained by the athlete throughout the rehabilitation process and beyond.

- Once rehabilitation is complete, the need for ongoing exercises to prevent recurrence and maintain fitness should be emphasized [40]. Many sports place greater demands on the shoulder than activities of daily living. Rehabilitation and maintenance programs should incorporate exercises that simulate the specific demands of the athlete's sport. As examples, a tennis player may perform a service-type motion using a five pound dumbbell, while a pitcher may perform a throwing motion using a three pound dumbbell.

Subacute treatment — If no improvement is achieved within two to three months with conservative therapy other treatment options may be considered, including [11]:

Glucocorticoids — Although subacromial glucocorticoid injection is a common treatment for rotator cuff disorders [6], clear evidence of benefit is lacking. We believe it is reasonable to treat patients whose symptoms do not improve after several weeks of conservative management, including physical therapy, or whose pain prevents them from participating in physical therapy with a **single** injection of a glucocorticoid combined with an analgesic. The general role of glucocorticoids in the treatment of chronic overuse tendinopathy is discussed separately. (See "Overview of the management of overuse (persistent) tendinopathy", section on 'Glucocorticoids'.)

One systematic review found only a small benefit from injection at four weeks compared with placebo, and no benefit over NSAIDS [44]. Another systematic review confirmed these findings and concluded there is little evidence to support the use of steroid injection in rotator cuff tendinopathy [45]. Conversely, yet another systematic review found that subacromial injection for rotator cuff tendinitis was more effective than NSAIDS [46]. Authors of all these reviews found the available studies to be small and of variable quality, often lacking clear outcome measures, making it difficult to draw clear conclusions.

One double-blinded, randomized trial found no difference in function or symptoms in patients injected with betamethasone and xylocaine compared with those injected with xylocaine alone, suggesting that glucocorticoids provide no additional benefit [47].

A systematic review assessing the value of physical therapy in the treatment of shoulder pain found some evidence to suggest that glucocorticoids may provide greater benefit compared with physiotherapy alone [38]. Steroid injection may reduce pain, thereby enabling earlier participation in range of motion exercises and rehabilitation [6].

Topical glyceryl trinitrate — Topical nitrate therapy is thought to cause local vasodilation, increasing blood flow to the damaged tendon [18]. One randomized, double-blinded, placebo-controlled study of 53 patients with a clinical or MRI diagnosis of supraspinatus tendinopathy found significant improvement in symptoms and rotator cuff function at 24 weeks in those treated with topical nitrates [48]. The median duration of symptoms at the study's initiation was 14 months. Headache was the most common side effect. Clinicians should counsel patients that headache severity decreases over the course of treatment. Clinicians should exercise caution when considering the use of nitrates in patients with hypotension, pregnancy, migraine headaches, and diuretic therapy. Nitrates are relatively contraindicated in patients with ischemic heart disease, anemia, phosphodiesterase inhibitor therapy (eg, Viagra®), sensitivity to nitrate therapy, and angle-closure glaucoma [48].

Experimental treatments — Little evidence exists to support the use of the experimental treatments mentioned below. These treatment options include:

- Topical NSAIDs – Topical NSAIDs in the form of gels and patches provide some symptomatic relief in tendinopathy and osteoarthritis, and this method of drug delivery may limit systemic side effects. The use of topical NSAIDs is discussed separately. (See "Overview of the management of overuse (persistent) tendinopathy", section on 'Nonsteroidal antiinflammatory drugs (NSAIDs)'.)

- Hyperthermia – Hyperthermia machines use a microwave power generator at 434 MHz to provide deep-heating of muscles. Hyperthermia treatment is thought to increase local blood flow to damaged tissue. In one small prospective trial of athletes with supraspinatus tendinopathy, patients randomly assigned to treatment with hyperthermia had greater short-term reductions in pain compared with those treated with ultrasound or therapeutic exercise [49]. Further research is needed to confirm these results and to determine the appropriate role for this modality in the treatment of tendinopathy.

- Extracorporeal shock wave therapy (ESWT) – Randomized trials show that ESWT provides benefit when treating calcific tendinopathies, including the rotator cuff [50]. However, there is no evidence to support its use in noncalcific tendinopathy [18,51].

- Platelet rich plasma (PRP) has been proposed as a treatment for chronic, refractory, tendinopathy. However, evidence supporting its use as a treatment for tendinopathy generally and rotator cuff tendinopathy specifically is lacking. The evidence concerning the use of PRP to treat tendinopathy is reviewed in detail separately. (See "Overview of the management of overuse (persistent) tendinopathy", section on 'Dry needling and autologous blood/platelet rich plasma injection'.)