Chronic occupational repetitive strain injury

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**OBJECTIVE** To review common repetitive strain injuries (RSIs) that occur in the workplace, emphasizing diagnosis, treatment, and etiology of these conditions.

**QUALITY OF EVIDENCE** A MEDLINE search from January 1966 to June 1999 focused on articles published since 1990 because RSIs are relatively new diagnoses. MeSH headings that were exploded using the thesaurus included “cumulative trauma disorder,” “overuse injury,” and “repetitive strain injury.” The search was limited to English articles only, and preference was given to randomized controlled trials.

**MAIN MESSAGE** Repetitive strain injuries result from repeated stress to the body’s soft tissue structures including muscles, tendons, and nerves. They often occur in patients who perform repetitive movements either in their jobs or in extracurricular activities. Common RSIs include tendon-related disorders, such as rotator cuff tendinitis, and peripheral nerve entrapment disorders, such as carpal tunnel syndrome. A careful history and physical examination often lead to the diagnosis, but newer imaging techniques, such as magnetic resonance imaging and ultrasound, can help in refractory cases. Conservative management with medication, physiotherapy, or bracing is the mainstay of treatment. Surgery is reserved for cases that do not respond to treatment.

**CONCLUSION** Repetitive strain injury is common; primary care physicians must establish a diagnosis and, more importantly, its relationship to occupation. Treatment can be offered by family physicians who refer to specialists for cases refractory to conservative management.

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Cet article a fait l’objet d’une évaluation externe.
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Repetitive strain injuries (RSI) can be defined as injuries caused or aggravated by repetitive or sustained submaximal exertion of the body’s soft tissue structures including muscles, tendons, ligaments, and nerves. Of particular concern is the increasing prevalence of RSI in the workplace. Not only are these injuries associated with personal morbidity and direct costs to the health care system, but considerable loss of productivity and disability claims are associated with substantial indirect costs to society.

According to the 1995 United States Bureau of Labor Statistics, approximately 60% of all occupational injuries were caused by repetitive strain. Further, the average number of workdays lost because of RSI is three times the average number of workdays lost for all other types of work-related injuries, and total direct and indirect costs to society were estimated at $1 trillion in 1995. The rate of upper extremity disorders in the United States has tripled between 1986 and 1993, and during a similar period in Ontario, the rate doubled. This paper aims to review current diagnosis and treatment of common chronic RSIs related to occupation. The paper focuses on the common tendon injuries and peripheral nerve entrapment syndromes seen and managed by family physicians.

Quality of evidence
The search strategy for this paper included a MEDLINE search using the thesaurus to explode the heading “cumulative trauma disorders” and the key words and phrases “repetitive strain injury” and “overuse injury.” The search was narrowed to English-language articles in which RSI was the major subject. Bibliographies of articles were used to find additional articles. Preference was given to articles based on randomized controlled trials and clinical trials published since 1990.

The level of evidence upon which this paper is based is predominantly level 1 for diagnosis and treatment of RSIs. Few available level 1 studies examined etiology of RSIs. When no randomized controlled trials were available, recommendations were based on level 2 and 3 evidence. Overall, this paper concentrated on disorders for which there were published randomized controlled trials of treatment; however, some papers were anecdotal case reports. Many other RSIs exist, but they are rarely discussed in the literature.

Common repetitive strain injuries
Diagnosis of occupational RSI is a great challenge to physicians, because some patients present with few objective findings. Also, the injury must be caused by patients’ occupations in some way. When making a diagnosis, it is often helpful to classify RSI in terms of the tissue involved and the underlying pathophysiologic mechanism of injury (Table 1).

Table 1. Common repetitive strain injuries

<table>
<thead>
<tr>
<th>DISORDERS</th>
<th>COMMENT</th>
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<tr>
<td>TENDON-RELATED DISORDERS</td>
<td></td>
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<tr>
<td>Tendonitis and tenosynovitis</td>
<td>Most common tendon disorders involve inflammation of tendon and sheath</td>
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<tr>
<td>De Quervain’s stenosing tenosynovitis</td>
<td>Pain and tenderness along anatomical snuffbox</td>
</tr>
<tr>
<td>Epicondylitis (medial epicondylitis or golfer’s elbow; lateral epicondylitis or tennis elbow)</td>
<td>Pain and tenderness over unsheathed tendons of either flexor (medial) or extensor (lateral) compartment of the forearm</td>
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<tr>
<td>Rotator cuff tendonitis</td>
<td>Impingement of the supraspinatus tendon (usually) on the acromion causing pain during overhead activities</td>
</tr>
<tr>
<td>PERIPHERAL NERVE ENTRAPMENT DISORDER</td>
<td></td>
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<tr>
<td>Carpal tunnel syndrome</td>
<td>Most common; compression of median nerve; pain, paresthesia on lateral aspect of palm with mild weakness, usually worse at night</td>
</tr>
<tr>
<td>Cubital tunnel syndrome</td>
<td>Second most common; similar symptoms to carpal tunnel; due to compression of ulnar nerve in cubital tunnel at elbow</td>
</tr>
<tr>
<td>Guyon tunnel syndrome</td>
<td>Impingement of ulnar nerve as it passes through Guyon’s canal in wrist, producing numbness and tingling in ulnar nerve distribution distal to wrist</td>
</tr>
</tbody>
</table>

Data from Schwartz, Downs, Melhom, Yassi, and Millender and colleagues.
**Diagnosis.** Diagnosis of RSI should be made from a careful occupational history, physical findings, and accurate diagnostic testing when possible. Onset of symptoms and signs of RSI should always follow and not precede repetitive motion in the workplace. Onset of pain or numbness should be noted in relation to any change in work habits or other behaviours. Details of the patient’s occupation should be listed including the ergonomic situation and the task performed, along with the frequency, duration of exposure, and forces or vibrations experienced. Any sports or hobbies should also be noted.6

Physical examination focuses on the soft tissues, beginning with inspection for signs of inflammation or muscle wasting, such as thenar wasting seen in advanced carpal tunnel syndrome (CTS). Both passive and active range of motion should be assessed, and palpation will reveal areas of tenderness. Detailed neurologic examination (particularly in cases of peripheral nerve entrapment disorders) is necessary and should involve muscle strength testing, sensory examination, and investigation of deep tendon reflexes.7 Some special tests aid in diagnosing these disorders (Table 219).

Several ancillary diagnostic tests help confirm diagnoses suspected during clinical examination. The most useful tests for diagnosing peripheral nerve entrapment syndromes are electrophysiological studies, such as electromyography (EMG).10,11 Because soft tissues are involved, radiographs are often unhelpful, but arthrograms can reveal a full-thickness rotator cuff tear.10 Magnetic resonance imaging has greatly enhanced our ability to view soft tissues. Research has shown sensitivity and specificity near 95% using MRI to diagnose epicondylitis and rotator cuff tendonitis.12-16 but MRI is not universally available. Many Canadian centres have turned to ultrasound instead for diagnosing rotator cuff tears; its sensitivity is nearly 95% but specificity is only 70%.15,17

**Etiology.** There is considerable debate in the medical community regarding the causality or etiology and pathology associated with RSI.18 Essentially, neuromuscular disorders have several possible influences, which include the amount of tissue damage and patients’ age, health status, and psychosocial status.19 The repetition, duration, and force of occupational tasks and the ergonomics of the work environment contribute to soft tissue damage. It is difficult, however, to separate the effects of factors outside the workplace from the cause.20,21 Patients could have had previous injuries or have medical conditions predisposing them to RSI.22

| Table 2. Special clinical tests for chronic repetitive strain injuries |
|-----------------|-----------------|-----------------|
| **TEST** | **DISORDER** | **TEST DESCRIPTION** |
| Cozen’s | Epicondylitis | Resistance to wrist extension and radial deviation while the forearm is pronated. Positive test if pain at lateral or medial epicondyle |
| Finkelstein’s | De Quervain’s disease | Ulnar deviation of hand with thumb flexed against palm, fingers flexed over thumb. Positive response is pain at radial styloid |
| Tinel’s sign | Carpal tunnel syndrome | Tapping of the median nerve as it passes through the carpal tunnel. Positive test if pain and tingling in the median nerve distribution |
| Phalen’s | Carpal tunnel syndrome | Flexing of both wrists 90° with dorsal aspects of hands held together for 60 s. Positive test if pain in median nerve distribution |
| Pressure and Flexion test | Cubital tunnel syndrome | Maximum elbow flexion while applying pressure on the ulnar nerve just proximal to the cubital tunnel. Symptom response within 30 to 60 s |

Data from Novak and associates8 and Hoppenfeld.9

Repetition of movements does not allow muscles, tendons, or ligaments sufficient recovery time and, therefore, can damage these structures.19,21 Local ischemia in the muscles of the upper limb and a resultant accumulation of lactic acid is believed to occur from holding the upper limb in a certain position for prolonged periods. Damage occurs when inflammation results in tissue remodeling and scar formation. Tendons can incur damage as a result of repeated failure at loads below their maximal tensile strength, which is probably the case in RSI.19,20

Flexed- or extended-wrist positions increase pressures applied to the median and ulnar nerves, and finger flexion places these nerves at risk of compression. Posture can increase pressure in nerves at entrapment sites or can shorten muscles to cause an adaptive short-
ening and secondary nerve compression. Also, muscles can be elongated into a weakened position, leading to overuse of other muscles, and ultimately contributing to the muscle imbalance cycle and to secondary nerve compression.23

Psychological and social factors (such as stress both at home and in the workplace) or mood disorders (such as depression) have key roles in RSI.24-27 A study by Helliwell and colleagues24 showed a significant relationship between both anxiety and depression scores and incidence of upper extremity pain in a group of factory workers who performed repetitive tasks. It remains unclear, however, whether increased anxiety and depression among RSI sufferers is due to their symptoms or is a predisposing factor to development of upper limb pain.25,26 Other theories suggest that RSI results from a sensory dysfunction27 rather than from pure tissue disorders or that it is a physiologically learned phenomenon.28

**Prognosis and treatment.** A retrospective follow-up study of a population-based case series showed that the mean duration of symptoms of CTS was between 6 and 9 months, with 22% of patients reporting symptoms for 8 years or more.29 According to a meta-analysis of the literature, prognosis for RSI sufferers is poorer with longer duration of symptoms.30

Treatment of chronic tendon injuries: Treatment of chronic RSI includes both conservative and surgical interventions. Traditional treatment for chronic tendon injuries is similar to acute strain injuries with rest, ice, compression, and elevation (RICE) for the first 48 hours after an exacerbation. If there is minimal swelling, these modalities are of little aid in treating chronic injuries. Patients should reduce their workload, perhaps performing light duties or different tasks in the same workplace. Ergonomic adjustments should be made to decrease repetition of tasks and correct poor posture.31,33 Limb immobilization is commonly prescribed but must be used with caution because it can result in muscle atrophy and joint stiffness. In fact, early initiation of eccentric exercises, those that allow the muscle-tendon unit to lengthen against resistance, have been described as a preferred method of treatment for refractory chronic tendonitis.34 Adjunctive drug therapy with NSAIDs and analgesics can provide some symptom relief and make exercising more bearable.

For treatment of medial and lateral epicondylitis, randomized controlled trials have shown steroid injections at the site of inflammation to provide short-term relief.35 Topical 2% diclofenac or 10% ketoprofen applied to the elbow has also been shown to provide effective short-term relief compared with placebo, and represent an alternative to oral NSAIDs.36 Bands worn on the proximal forearm for epicondylitis could relieve or reduce symptoms, as they redirect contractile forces away from the muscle attachment to the humeral condyle.37 Shock wave therapy has not been shown to improve epicondylitis.38 Surgical treatment is considered only for refractory cases and includes newer surgeries, such as arthroscopic release of the extensor carpi radialis brevis tendon for lateral epicondylitis.39

Treatment for chronic rotator cuff tendonitis beyond RICE and NSAIDs can include local corticosteroid injections for short-term relief of pain.40 Periarticular injection of 20 mg of tenoxicam, a relatively new treatment, was shown by a double-blind placebo-controlled trial to be as effective in relieving pain and improving shoulder mobility as a lidocaine-steroid injection.41

Injection of a steroid-lidocaine combination has been shown to provide complete relief of symptoms for most patients with de Quervain’s disease, provided the injection is accurately placed between the tendons of abductor pollicis longus and extensor pollicis brevis (Figure 1).42,43 Surgical management includes decompression of the extensor pollicis brevis tendon subcompartment. It provides relief to most patients but is reserved for refractory cases.44

Treatment of nerve entrapment syndromes: Treatment of CTS should include ergonomic adjustments in the workplace.45 A randomized controlled trial by Rempel et al45 showed that an alternative computer keyboard applied to the elbow has also been shown to provide effective short-term relief compared with placebo, and represent an alternative to oral NSAIDs.36 Bands worn on the proximal forearm for epicondylitis could relieve or reduce symptoms, as they redirect contractile forces away from the muscle attachment to the humeral condyle.37 Shock wave therapy has not been shown to improve epicondylitis.38 Surgical treatment is considered only for refractory cases and includes newer surgeries, such as arthroscopic release of the extensor carpi radialis brevis tendon for lateral epicondylitis.39

**Figure 1.** Injection site for de Quervain’s tenosynovitis within the first dorsal compartment (anatomical snuffbox) containing the tendons of extensor pollicis brevis and abductor pollicis longus: Care should be taken not to inject the tendons directly.
design, which differs in the force-displacement characteristics of the keys, significantly reduced hand, forearm, and arm pain.\textsuperscript{35,45} Steroid injections have been shown to reduce pain in CTS.\textsuperscript{46} A randomized controlled trial of oral therapies for CTS showed that corticosteroids provided greater benefit than NSAIDs and diuretics, which showed no improvement over baseline.\textsuperscript{47}

Exercises have led to better outcomes than splinting.\textsuperscript{46} Rozmaryn et al.\textsuperscript{48} showed that patients treated with nerve and tendon gliding exercises with the wrist held in six different positions for 7 seconds at a time helped tendons in the carpal tunnel and the median nerve function freely. Only 43% of patients performing these exercises underwent surgery compared with 71% of the group not performing the exercises.\textsuperscript{48}

A randomized controlled trial by Spence et al.\textsuperscript{49} showed that both EMG biofeedback alone or applied relaxation training alone provided significant short-term reductions in pain and pain-related depressed mood among patients with chronic upper extremity RSIs.\textsuperscript{48} Electromyographic biofeedback involved auditory feedback regarding muscle tension levels to train patients to minimize such tension. Relaxation training involved a psychologist teaching patients a range of relaxation techniques to be used when conducting activities that involve physical or emotional stress and muscle tension. Ultrasound therapy was shown by a randomized controlled trial to have no effect on RSI recovery compared with placebo.\textsuperscript{50}

An elective surgical procedure successfully relieves pain in most patients within 6 weeks of surgery and has a high rate of patient satisfaction according to a prospective trial by Katz et al.\textsuperscript{51} Improvement in function after carpal tunnel release can take up to 2 years.\textsuperscript{51} Carpal tunnel release can be done using intraoperative ultrasonography to minimize exposure and dissection. Several randomized controlled trials, however, show no significant difference between conventional carpal tunnel release and ultrasonographically assisted surgery.\textsuperscript{52}

Treatment of cubital tunnel syndrome is similar in principle to CTS treatment. Conservative treatments with proven efficacy include splinting and steroid injection.\textsuperscript{53} Surgical management of proven benefit for severe and refractory cases includes partial medial epicondylectomy, cubital tunnel release, and anterior transposition of the ulnar nerve.\textsuperscript{54,57}

**Conclusion**

Repetitive strain injury continues to be an important health problem, and the epidemic shows no signs of slowing down. It causes a dilemma for physicians and the general public because rising social and financial costs are associated with RSI. Preventing these injuries by ensuring ergonomically sound work environments...
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...and adequate time away from work is important for decreasing incidence.

Diagnosis of RSIs should be based on history and objective physical findings as well as electrodiagnostic tests when possible. Physicians might not be able to determine a work-related cause but might determine an association with tasks performed on the job. Initial treatment should involve conservative measures such as RICE, NSAIDs, steroid injections, appropriate exercises, and modification of the inciting repetitive tasks. Surgery is reserved for those with persistent symptoms despite maximal non-surgical therapy.

Competing interests
None declared

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