J Shoulder Elbow Surg (2010) 19, 937-943

ELSEVIER

Journal of Shoulder and Elbow Surgery

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REVIEW ARTICLES

# Rotator cuff tears with cervical radiculopathy

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## Introduction

Shoulder pain is commonly attributed to rotator cuff tears, with an estimated 4.5 million US physician visits in 2002 for cuff problems.[51] Although the tear may be treated conservatively at times, surgical repair is also a treatment option. The timing of such surgery and a reasonable estimation of the chances of success of such surgery are important considerations for the surgeon and patient. Shoulder pain can also be produced by an extrinsic cause such as cervical radiculopathy. Such a source of pain can coexist with a rotator cuff tear and have some influence on the treatment process for the cuff tear. The purpose of this review is to examine the overlap of these 2 problems and their interactions.

## Anatomy

The cervical spine is composed of 7 cervical vertebrae. Whereas the first (the atlas) and second (the axis) cervical vertebrae are quite distinct in their appearance, the remaining third to seventh vertebrae are similar to each other. They articulate anteriorly via the intervertebral disks. Posteriorly, these vertebrae articulate through the facet joints, also known as zygapophyseal joints. The uncovertebral joints, or joints of Luschka, are found more laterally on the vertebral bodies and also articulate with the superior facet. The foramina for the nerve roots are formed by the facet posterolaterally and uncovertebral joints anteromedially, the pedicles, and the edge of the intervertebral disk and vertebral end plates.[14,53] There are 8 cervical nerve roots; they exit superior to their respective vertebral body, with the exception of the eighth nerve root, which exits inferior to the seventh cervical vertebral body. The fifth through eighth cervical roots, together with the first thoracic nerve root, combine to form the trunks, divisions, and cords of the brachial plexus and, ultimately, the peripheral nerves of the upper extremity.

The rotator cuff is composed of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles.[18] After originating from the subscapular fossa on the scapula, the subscapularis inserts on the lesser tuberosity of the proximal humerus. The supraspinatus originates in the suprascapular fossa, the infraspinatus in the infrascapular fossa, and the teres minor from the lateral border of the scapula. These 3 muscles all insert on the greater tuberosity.

The nerve supply to the rotator cuff muscles includes the upper and lower subscapular nerves, which innervate the subscapularis muscle. The suprascapular nerve passes under the suprascapular ligament into the suprascapular fossa to innervate the supraspinatus muscle and then around the spinoglenoid notch to supply the infraspinatus muscle. The teres minor is supplied by the axillary nerve. These nerves receive fibers from the C5 and C6 spinal roots (Figure 1).

The rotator cuff muscles assist in shoulder movement. The subscapularis is an internal rotator of the glenohumeral joint, the supraspinatus is an abductor, and the infraspinatus and teres minor are external rotators. In addition, the rotator cuff muscles act in concert to stabilize the glenohumeral joint and provide an effective center of rotation for the deltoid and other shoulder girdle muscles.[9,10]

## Rotator cuff tears

The prevalence of rotator cuff tears increases with the age of the examined population.[47,60,61,65,67] Tempelhof et al,[61]

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1058-2746/$ - see front matter 
doi:10.1016/j.jse.2010.05.007

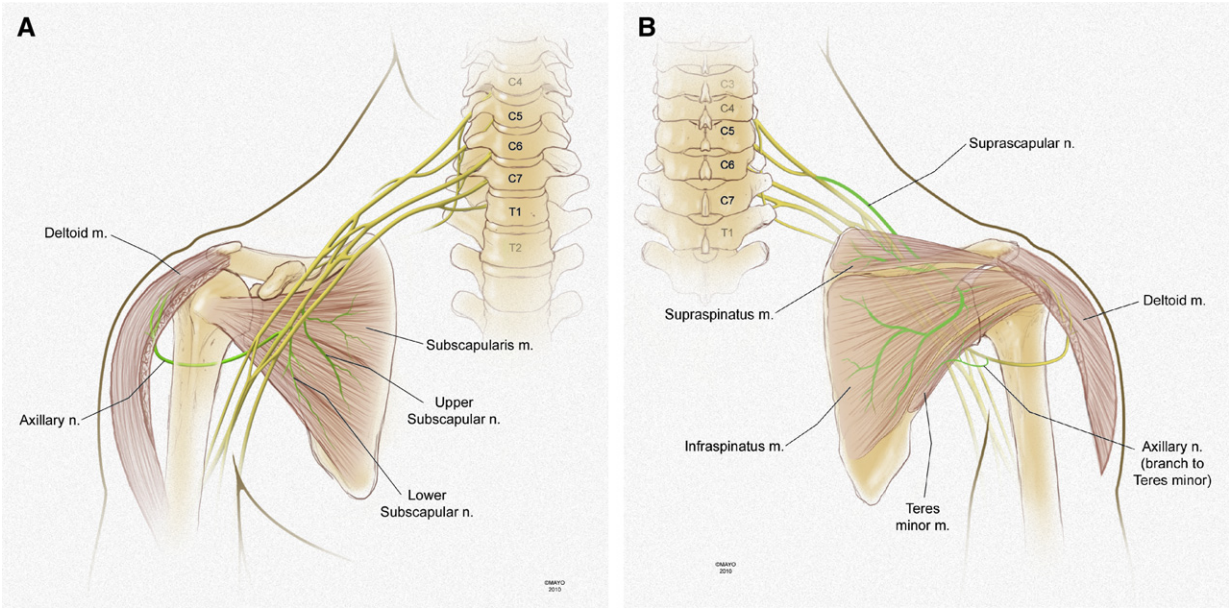


**Figure 1** Anterior (**A**) and posterior (**B**) views of shoulder muscles and their nerve supply. The deltoid and teres minor muscles are innervated by the axillary nerve, a branch of the posterior cord of the brachial plexus. The subscapularis is supplied by the upper and lower subscapular nerves. The supraspinatus and infraspinatus muscles are innervated by the suprascapular nerve, which is a branch of the upper trunk of the brachial plexus. These nerves all contain fibers from the fifth and sixth cervical nerve roots.

in a study of asymptomatic volunteers, reported the frequency of a tear at 13% in the sixth decade of life, 20% in the seventh decade, 31% in the eighth decade, and finally, 51% in the ninth decade. Moosmayer et al[47] similarly examined the age-related frequency of full-thickness rotator cuff tears in asymptomatic volunteers. The overall prevalence was 7.6%, increasing from 2.1% at age 50 to 59 years, to 5.7% at 60 to 69 years, and to 15% at 70 to 79 years. Worland et al[65] reported a much higher prevalence of full-thickness tearing, at 40%, over the age of 50 years.

The presentation of a rotator cuff tear can be quite variable. Some patients are asymptomatic with preserved function and little if any pain.[42,51,56] At the other extreme, patients may have severe pain with use, sleep disturbance, and profound dysfunction. Irrespective of symptoms, the presence of a rotator cuff tear has been associated with both muscle atrophy and fatty infiltration.[28,48] These factors have been shown by Gerber et al[23] to be inversely related to loss of strength in the shoulder. Successful repair of the cuff tear has been shown only to retard the advancement of fatty infiltration and modestly improve the degree of muscle atrophy.[23,24] Conversely, both conservative management of the tear and failure of the surgical repair lead to increased atrophy and degeneration.[23,69] Although patients tend to have superior outcomes if the repair heals, patients are still often clinically improved with unsuccessful rotator cuff repair.[31,35] Nevertheless, fatty infiltration of the supraspinatus and infraspinatus, atrophy of the supraspinatus, and glenohumeral osteoarthritis all worsen after a failed repair.[24,35] Increased atrophy and fatty infiltration are in turn related to estimates of residual muscle function based on motor unit amplitude on electromyograms (EMGs).[49]

The increased prevalence of tears over time, the common finding of an increase in tear size, and the worsening of the muscle functional capacity with progressive atrophy and fatty infiltration have led some surgeons to believe that rotator cuff tears should be repaired early in their course.[24,66] Ellman et al[22] showed poorer results with surgery with increased preoperative weakness of the shoulder, less active range of motion, and narrowing of the acromiohumeral distance suggestive of a larger tear. Burkhart et al,[11] while finding that patients with advanced fatty infiltration of the cuff muscles can often benefit from rotator cuff repair, also found that the improvement was not nearly as good in the patients with more advanced fatty infiltration. Other authors have believed that the symptoms from rotator cuff tears, especially from chronic tears, can often be successfully treated with nonoperative measures.[42,43,51,56,69] As noted previously, progressive deterioration of the torn musculotendinous unit will continue.

## Cervical radicular disease

Similar to rotator cuff disease, degenerative disk disease is age related.[44] Beginning in the third decade of life, the hydration of the nucleus starts to diminish, accompanied by fissuring of the annulus.[1,42,50] Subtle instability of the disk–vertebral body complex can result, followed by development of osteophytes in the facet joints and joints of

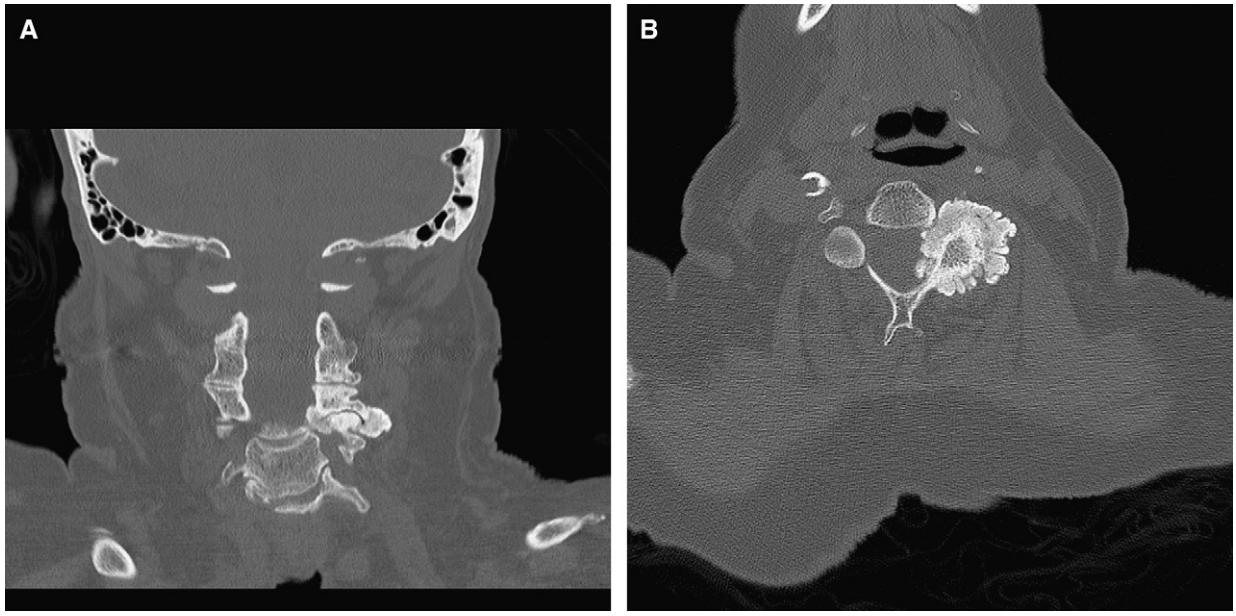


**Figure 2** Anteroposterior (**A**) and lateral (**B**) computed tomography images of this cervical spine show unusually prolific hypertrophic arthrosis of the facet joint producing severe narrowing of the left C4-5 foramina consistent with a C5 radiculopathy.

Luschka and, ultimately, narrowing of the spinal foramina. The sum of these age-related degenerative changes in the spinal column is termed ''spondylosis.''[55] It is extremely common, evidenced in approximately 80% to 85% of individuals as they approach the mid-sixth to seventh decade of life.[37,39,44] Degenerative disk disease is most commonly found at the C5-6 interspace.[39]

Spondylosis can result in axial neck pain, as well as cervical radiculopathy and cervical myelopathy.[55] ''Radiculopathy'' refers to the presence of pain, sensory changes, or motor deficits in a dermatomal distribution and can exist with or without neck pain. Myelopathy is diagnosed when long track signs in the upper and lower extremities are present. Radiculopathy is generally produced by 1 of 2 mechanisms.[1,50] Most commonly, disk herniation occurs through an annular fissure, typically through the posterior lateral disk.[50] Alternatively, foraminal stenosis due to the degenerative changes can impinge on the nerve root (Figure 2). Other potential etiologies of compressive radiculopathy include trauma, synovial cyst, tumor, meningeal cyst, and arteriovenous fistula.[1]

The clinical presentation of cervical radiculopathy was examined by Henderson et al.[33] After analyzing over 700 patients, they found that arm pain was present in 99%, sensory changes in 85%, and neck pain in 80%. In addition, reflex changes were present in 71% and motor deficits in 68%. The localization of the arm pain is related to the level of root compression. A C4 radiculopathy can produce pain radiating from the neck to the superior aspect of the shoulder and posteriorly to the scapula.[1] Motor findings can be difficult to detect with this level of a lesion. Rotator cuff disease is more commonly mimicked by a C5 radiculopathy. Pain in this situation is commonly localized to the shoulder and weakness found in abduction and external rotation of the shoulder.[14] Weakness from cervical radiculopathy is usually incomplete; profound weakness and atrophy are uncommon except in chronic neglected cases.[45] This pattern of pain and weakness can also be produced by a suprascapular neuropathy.[21,57]

The diagnosis of a radiculopathy can be made with well-defined symptoms and neurologic examination with a corresponding structural lesion on an imaging study, generally a magnetic resonance imaging study.[1,6] Electrophysiologic studies can be useful to confirm the diagnosis and to exclude other neurologic conditions.[14,45,46,55] In a radiculopathy, fibrillation potentials and positive sharp waves will typically be present in the paraspinal muscles and the muscles of the involved myotome. Alrawi et al[3] showed that the use of neurophysiologic testing led to superior results when the clinical and imaging examinations were inconclusive. Nerve conduction and electromyographic studies can also be useful to detect the presence of coexisting nerve entrapment such as carpal tunnel syndrome. Described by Upton and McComas,[62] this ''double-crush'' phenomenon results from increased sensitivity of a nerve to compression injury distal to a more proximal condition.

Although the presence of spondylosis becomes progressively more common through life, the peak incidence and prevalence of cervical radiculopathy are both in the sixth decade of life and then decline.[54,59] Researchers at the Mayo Clinic found the annual incidence of radiculopathy to be 83 per 100,000 population in a study of Olmsted County, Minnesota.[54] The most common level of radiculopathy was found to be at the C7 root, followed by

the C6 nerve root. A group of researchers carried out a door-to-door survey in a Sicilian municipality, with a population of 7,653, and found a prevalence of cervical radiculopathy of 3.5 per 1,000 individuals.[59]

## Natural history of cervical radiculopathy

Cervical radiculopathy is commonly treated nonoperatively, at least initially, with measures such as analgesics, anti-inflammatory medication, muscle relaxants, corticosteroids, injections, and physical modalities including traction.[12,15,17,34,52,55,64] At long-term follow-up of 10 to 25 years, Gore et al[27] reported that nonoperative management was associated with complete symptom resolution in 43% of patients, partial resolution in 25%, and continued moderate to severe pain in the remaining 32%. In another long-term study, by Lees and Turner,[38] of 51 patients followed up for 2 to 19 years, 43% of the patients had only a single episode of radicular pain, 29% had mild symptoms, and the remaining 27% had more substantial symptoms.

Surgical treatment for cervical radiculopathy is typically indicated for persistent, disabling radicular pain, progressive motor deficit, or disabling motor loss.[55,58] In the epidemiologic study of the Mayo Clinic, 26% of patients underwent surgery within 3 months of the diagnosis.[54] Rapid improvement of symptoms is typical, and prolonged relief of symptoms can be expected in approximately 70% to 90% of patients after either anterior or posterior surgery.[4,7,15,25,26,33,40] Henderson et al[33] described 91% excellent and good results with posterior-lateral foraminotomy in 846 cases. Relief of arm pain and paresthesia were achieved in 96% of patients and resolution of the motor deficit in 98%. Arnasson et al[4] found that axial neck pain persisted in roughly one-half of patients irrespective of conservative or surgical treatment, but radicular symptoms responded substantially better to surgery, with over 70% of patients having improved. After anterior surgery, Lundsford et al[40] found that 77% of patients had complete relief of symptoms initially, yet 38% had recurrent symptoms at some time during the 1 to 7 years of follow-up. At a mean follow-up of 6 years after anterior diskectomy and fusion, Bohlman et al.[7] found that all patients had improvement or resolution of their preoperative motor deficit. Of 55 patients, 53 had complete resolution. Sensory deficits resolved in 71 of 77 patients. Only 6 of the 122 total patients had persistent radicular pain to any degree, but neck pain was present in 37.

The study in Olmsted County, Minnesota, found that the C5 nerve root was involved in a monoradiculopathy in 6.6% of cases and combined in a C5-6 radiculopathy in another 10.3% of patients.[54] In an earlier study, Yoss et al,[68] examining radiculopathy from cervical disk protrusion, reported that the C5 nerve root was involved in only 2% of their cases. Chang et al[16] reviewed the results of surgical treatment of 14 patients presenting with deltoid weakness from a C5 radiculopathy. Responsible lesions were found at the C3-4, C4-5, and C5-6 levels. Improvement was consistently noted, with muscle strength improving from a mean grade of 2.57 to 4.14 and the mean score for radicular pain on a visual analog pain scale decreasing from 7.64 to 3.21.

## Rotator cuff tearing and nerve injury

Given the high prevalence of rotator cuff tears, it should not be surprising that tears may coexist with nerve injuries as well. Suprascapular neuropathy, especially in the patient with larger cuff tears, is well recognized.[2,5,41] This neuropathy may be related to increased tension on the suprascapular nerve from muscle retraction.[2] Improvement of suprascapular neuropathy after cuff repair is common.[19] Rotator cuff tearing has also been described with brachial plexopathy, particularly in patients with a shoulder dislocation leading to cuff tearing and a plexopathy.[29,30,36] Other possibilities include more distal compression neuropathies such as carpal tunnel syndrome and, of course, cervical radiculopathy. It is important to be aware of these possibilities to formulate an appropriate treatment plan.

Information in the literature regarding the incidence of musculoskeletal shoulder disorders in combination with neurologic conditions is otherwise relatively limited. Vad and a group from the Hospital for Special Surgery examined 25 patients with full-thickness rotator cuff tears and significant shoulder muscle atrophy with electromyography.[63] In this select group, 28% of patients also had a neurologic condition. Four patients had an upper trunk or axillary neuropathy, two had a suprascapular neuropathy, and the final patient had a C6 cervical radiculopathy. These authors point out that the need to properly and preoperatively diagnose any nerve lesion as a neuropathy may well lead to a slower recovery and poorer outcome.

Date and Gray[20] examined 33 patients with a total of 38 upper extremity EMGs. All patients had been initially diagnosed with shoulder impingement syndrome. No instances of suprascapular neuropathy were found. In this study, 2 patients (5.3%) were believed to have a C5/6 radiculopathy, and 9 more patients (23.7%) were considered to have a possible radiculopathy. The neurologic examination was normal in 7 of these 11 cases. In their examination of suprascapular neuropathy in conjunction with massive rotator cuff tearing, Costouros et al[19] reported 14 positive EMGs out of the 26 massive tears. Seven of these showed suprascapular neuropathy; four, axillary neuropathy; two, brachial plexopathy; and one, cervical radiculopathy.

Cannon et al[13] reviewed the incidence of 4 specific musculoskeletal disorders (myofascial pain, impingement syndrome, lateral epicondylitis, and de Quervain tenosynovitis) in patients referred for electrodiagnostic testing for suspected cervical radiculopathy. Musculoskeletal diagnoses were based on physical examination, and imaging studies for rotator cuff tearing were not performed. Given

these limitations, they found an incidence of musculoskeletal disorders of 29% in those patients with a documented cervical radiculopathy.

Although the information in the literature on the prevalence of a combined disorder of rotator cuff tearing and cervical radiculopathy is limited, any discussion of treatment is even more so. Hawkins et al[32] did investigate this complex problem of neck and shoulder disorders in 13 patients who underwent a combined 26 shoulder procedures and anterior cervical fusions. This study has significant limitations. Only 3 of the 13 patients had a rotator cuff tear; the remainder had impingement syndrome treated with subacromial decompression. All patients had an anterior cervical fusion, but electromyography results for documentation of actual cervical radiculopathy were not provided. Given these study limitations, 9 of the 13 patients (69%) had excellent to good results overall at last follow-up.

Brown et al[8] reviewed their results for rotator cuff repair in patients with coexisting infraclavicular nerve injuries. They identified 15 patients, 13 of whom had surgical repair. The nerve injuries found on electromyography were 12 axillary lesions, 4 suprascapular lesions, and a single musculocutaneous lesion. Eight patients had complete and seven had incomplete nerve recovery. Satisfactory pain relief was achieved in 87% of patients, with good to excellent function in 60%. The authors concluded that patients responded well to rotator cuff repair with expectant management of the nerve lesion, yet the results were inferior to those of isolated rotator cuff repair. Favorable results in other cases of rotator cuff repair with acute brachial plexopathy have also been separately reported by several authors.[29,30,36] Güven et al[30] recommended early repair of the cuff tear because of the good prognosis for the plexus lesion. A case reported by Kay et al,[36] however, still had limited elevation of 140° at 1 year of follow-up, with grade 4+/5 strength, suggesting lesser results than with an isolated repair.

## Recommendations for treatment

It is clear that any recommendations for the treatment of an individual with a rotator cuff tear and concomitant cervical radiculopathy are based on expert opinion or level V evidence. There are no randomized or cohort studies currently present in the literature. The single retrospective case series study regarding the management of the patient with cervical spine and shoulder problems published by Hawkins et al[32] is severely limited in its value by the small number of included patients with rotator cuff tearing and with radiculopathy. The surgeon at this time is therefore left with making an educated decision after review of related information in the literature.

This literature informs us that rotator cuff tears are more prevalent with increasing age of the patient and many of the tears become larger over time. Rotator cuff tears are associated with progressive atrophy and fatty infiltration of the cuff muscles, and these changes are only stabilized by successful repair of the tendons but not reversed. Furthermore, anatomic healing of repaired tendons becomes less common with increasing size of the tear. Thus repair is often considered appropriate to recommend to patients for reasons beyond symptom relief.

Whereas cervical spondylosis is similarly age related, cervical radiculopathy is most prevalent in the sixth decade of life. Similar to rotator cuff tearing, cervical radiculopathy can produce shoulder pain, weakness, and muscle atrophy. Severe pain or muscle weakness will lead many patients to undergo surgical decompression with or without fusion. Pain relief with restoration of strength is typically rapid, although many patients will have some recurrence of symptoms later in life.

The approach to the management of the patient with both rotator cuff tearing and cervical radiculopathy must begin with the appropriate diagnosis. Recognition of the dual nature of the source of the patient's disability will aid in the establishment of a treatment plan and the recognition that more than 1 procedure may be necessary for a satisfactory outcome. Although an EMG is not routinely indicated in patients with rotator cuff disease, those patients with more advanced degrees of atrophy for the size of their tear are at a relatively high risk for a coexisting neuropathy and an EMG should be considered as part of their workup. Additional signs and symptoms that should raise the clinicians' index of suspicion for a radiculopathy and consideration of an EMG include an unusual intensity of the shoulder pain, abrupt and atraumatic onset of symptoms, non-mechanical features, dermatomal sensory changes, and associated muscle weakness (eg, biceps weakness). Further imaging studies such as cervical spine magnetic resonance imaging are chosen based on the results of the EMG.

Repair may be considered for most active patients with a full-thickness rotator cuff tear; conversely, most patients will be successfully treated nonoperatively for a cervical radiculopathy. Because surgery for radiculopathy is carried out for neurologic compromise or for unremitting pain, this procedure would generally take priority over the rotator cuff repair. After satisfactory resolution of this situation, then the decision on proceeding with cuff repair should take place. There is no information in the literature to suggest whether these patients can anticipate as satisfactory an outcome from their cuff repair as the patients without neurologic lesions. However, the work by Chang et al[16] on the results of treatment for C5 radiculopathy indicated that some residual weakness may persist. Muscle strength in their patients improved only from a mean grade of 2.57 to 4.14. Patients were improved but not to normal strength on average. The recovery of patients from rotator cuff surgery with cervical radiculopathy, particularly a C5 radiculopathy, may well be similar to the lesser results achieved from cuff repair in patients with brachial plexus. Nevertheless, it remains that this question has not been addressed and answered in the literature.

## Conclusion

Although an examination of the independent prevalence rates of rotator cuff tearing and cervical radiculopathy indicates that these are both common problems, the information in the literature on coexisting lesions is sparse and describes only occasional cases. The diagnosis of the presence of both lesions is important for proper treatment planning and guidance of the patient. If surgical treatment of the radiculopathy is indicated, this surgery should take priority, followed by rotator cuff repair after recovery from the cervical surgery. Outcomes from rotator cuff repair in this setting may well be inferior to the results of isolated cuff repair, but this has not yet been documented in published studies.

## Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article and have no potential conflicts of interest related to this manuscript.

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