

Prolotherapy for Golfing Injuries and Pain

An effective non-surgical treatment option for golf-related injuries, including low back pain, lateral and medial epicondylitis, wrist ligament injuries, shoulder injuries, and other musculoskeletal joint pain.

by Donna Alderman, DO



Golf is a very popular sport in the U.S. and many other countries. This is, in part, from the non-contact nature of the sport, allowing many different age groups to play, both older and younger participants. Golf is a sport where high performance and skill are not limited by age.¹ Surveys estimate anywhere from 28.7 million² to 37 million³ golfers in the U.S. alone, with golfers' reported annual spending estimated at 24 billion dollars per year on equipment and fees.⁴ Despite the low impact nature of the sport, several studies over the years have shown that golf has its share of injuries resulting in musculoskeletal pain in the amateur as well as the professional golfer.⁵⁻⁹

Prolotherapy is a non-surgical procedure which stimulates repair of musculoskeletal injuries. This treatment has received increased attention over the last few years, and made its way into the sports world, as well as The New York Times which reports: "Unlike many drugs and surgery, prolotherapy has minimal side effects when performed by an experienced practitioner..."¹⁰ The purpose of

this article is to explore common golf injuries, contributing factors, diagnosis, prevention and non-surgical treatment options with prolotherapy.

Prolotherapy Review

Prolotherapy is a method of injection treatment designed to stimulate healing.¹¹ Many different types of musculoskeletal injuries and pain lend themselves to prolotherapy treatment including low back and neck pain, chronic sprains and/or strains, whiplash injuries, tennis and golfer's elbow, knee, ankle, shoulder or other joint pain, chronic tendonitis/tendonosis, and musculoskeletal pain related to osteoarthritis. Prolotherapy works by raising growth factor levels or effectiveness in connective tissue ligaments and tendons to promote repair or growth.¹²

Prolotherapy lends itself very well to sports injury and pain because most sports related injuries involve ligaments and tendons. Prolotherapy can be used years after the initial pain or problem began, as long as the patient is generally healthy.

Significant athletic injuries that hinder

a person in playing their sport are almost always ligamentous or tendonous in nature, not muscular.¹³ This is because ligament and tendon tissues have a poor blood supply, as opposed to muscles which have a large blood supply and so that they take longer to heal than other tissues—usually four to six weeks. Since the ligaments are the main stabilizing forces in the joints, these are the structures that take the bulk of the forces while the athlete is playing his/her sport.¹⁴ Unfortunately, incomplete healing is common after injury to those structures.^{15,16} In fact, it has been estimated that the usual best result of a completed connective tissue repair process is a return to normal connective tissue length, but only 50% to 60% of pre-injury tensile strength.¹⁷ Over time, and multiple injuries, this can result in laxity and connective tissue insufficiency.¹⁸ In repetitive trauma, common in golf related injuries,¹⁹ each individual trauma may be insufficient to provide enough stimulus to prompt complete healing, so that even minor injury may be enough to accumulate damage to the point of initiating chronic pain.²⁰

Prolotherapy works by causing a temporary, low grade inflammation at the site of ligament or tendon weakness (fibro-osseous junction) thus "tricking" the body into initiating a new healing cascade. Inflammation activates fibroblasts to the area, which synthesize precursors to mature collagen, and reinforce connective tissue.²¹ This inflammatory stimulus raises the level of growth factors to resume or initiate a new connective tissue repair sequence to complete one which was prematurely aborted or never started.²² Prolotherapy is also known as "regenerative injection therapy (RIT)," "non-surgical

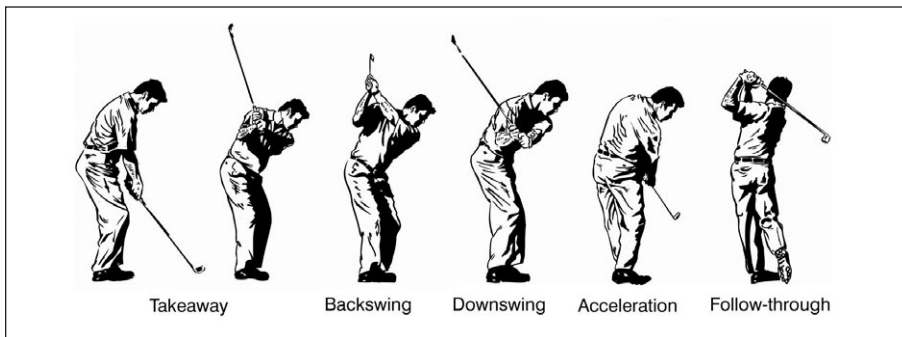


FIGURE 1. The 5 phases of the golf swing. 1. *takeaway*: from address until the club is horizontal; 2. *backswing*: from horizontal to top of backswing; 3. *downswing*: from top of backswing until the club is horizontal; 4. *acceleration*: from horizontal club to impact; and 5. *follow-through*: from ball contact until end of swing.

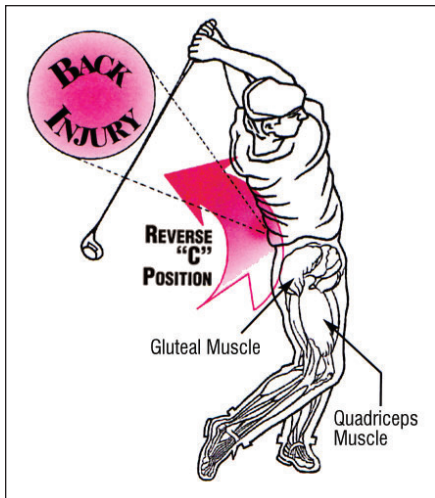


FIGURE 2. The golf swing causing injury to the low back in follow-through.

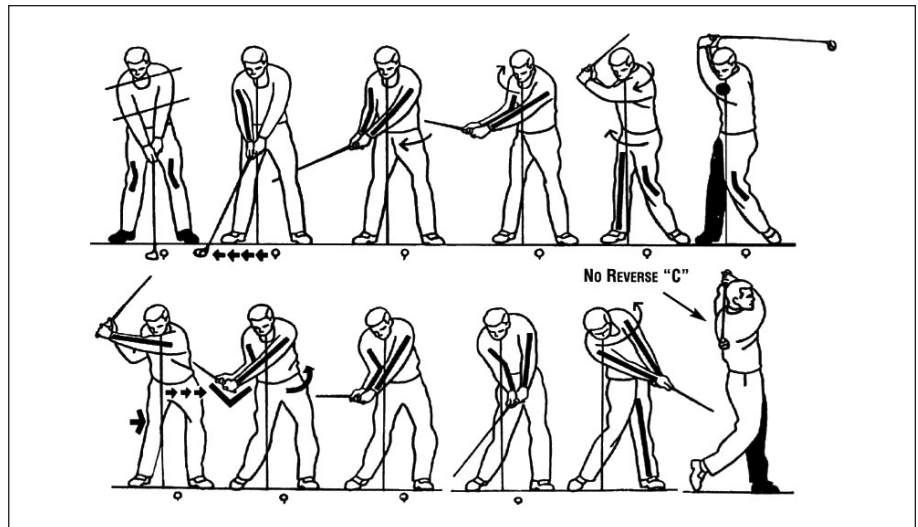


FIGURE 3. The golf swing with correct mechanics in follow-through.

tendon, ligament and joint reconstruction” and “growth factor stimulation injection therapy.” “Sclerotherapy” is an older, inaccurate term for prolotherapy, based on the original theory that scar formation was the treatment mechanism. However biopsy studies have not demonstrated scar formation with prolotherapy agents currently in use.²³ Rather, studies have shown a proliferation of new, normal, thicker and stronger connective tissue after Prolotherapy injections (thus “prolo” for proliferation).²⁴ A typical course is four to six treatments, spaced from two to six weeks apart.

Common Injuries in the Amateur and Professional Golfer

The most common injury reported by the amateur and professional golfer alike is in the low back/lumbar spine/sacroiliac region pain.²⁵⁻²⁸ This makes sense when looking at the powerful rotation and extension motion in the golf swing.²⁹ In the professional golfer, the second most commonly injured area is the wrist or hand, followed by the shoulder.^{30,31} For the amateur, the second most commonly injured area is the elbow, followed by the wrist or hand, and then the shoulder.^{32,33} Overuse is a large component of injury both in the professional and the amateur golfer and, more often, the cause of injury than direct trauma.³⁴ One study reports 82.6% of all reported injuries involve overuse, with more than 90% of low back injuries attributed to overuse. Only 17.4% of injuries reported in that study were attributed to single trauma events.³⁵ Another report found that professional golfers’ injuries oc-

curred primarily from overuse during practice (68%) with only 7% during competition.³⁶ Wrist injuries occur most commonly in the lead wrist (left wrist in right handed golfers). This is also true of shoulder injuries where 90% of shoulder injury involve the lead shoulder.^{37,38}

The Golf Swing

In order to correctly analyze golf injuries, it is important to understand the components of the golf swing itself. Golfers may give a history of symptoms that occur only during one specific phase of the swing and an understanding of the swing components will help in diagnosis.³⁹ Problems with swing mechanics have been blamed for many of the injuries seen in golf,⁴⁰ especially low back pain⁴¹ and shoulder injuries.⁴² The swing requires a coordinated and synchronized effort of muscle strength, timing and coordination on the part of the golfer to generate clubhead speeds often over 100 mph.⁴³ It is no wonder then that many injuries are reported to occur during the golf swing, most commonly at ball impact, as well as follow-through and the backswing^{44,45} (see Figure 1).

Contributing Factors

Since overuse is a large factor in golf injuries, there is a correlation between playing and practice time and injury, with significantly more injuries in golfers who play four or more rounds a week and hit at least 200 balls in one week. Since professionals spend more time doing both these activities, it is not a surprise that professional golfers suffer more injuries than amateurs despite having a better swing

technique.⁴⁶ It has also been found that golfers who carry their bag on a regular basis suffer significantly more injuries to the low back, shoulder, and ankle.⁴⁷ There is also a correlation between stretching and warming up and injury. Amateur golfers who warmed up for at least 10 minutes were found to have less injuries than those amateurs that did not warm up prior to practice or play.⁴⁸ However, even though professional golfers routinely stretch, they also spend so much more time playing that the positive impact of stretching did not appear to be as much of a factor as with amateurs.⁴⁹

Low Back Pain

As noted above, low back injuries account for the highest percentage of reported golfing injuries. The most obvious contributing factor for low back injury is poor swing technique and mechanics. This is more often a problem in the amateur golfer.⁵⁰ This is because these golfers tend to have erratic muscle control and do not duplicate the swing with each shot, versus professionals who tend to consistently activate the same muscles each time they swing.⁵¹ Hyperextending the back during follow-through is a common problem in amateurs and can result in a low back/sacroiliac ligament injury⁵² (see Figure 2). Superior swing mechanics in the professional golfer result in increased power generation from hips and legs with less stress on the low back⁵³ (see Figure 3). Prolotherapy is very effective in treating low back pain, sacroiliac injury, sciatica, and even disc disease because weakening of the spinal ligaments precedes disc herni-

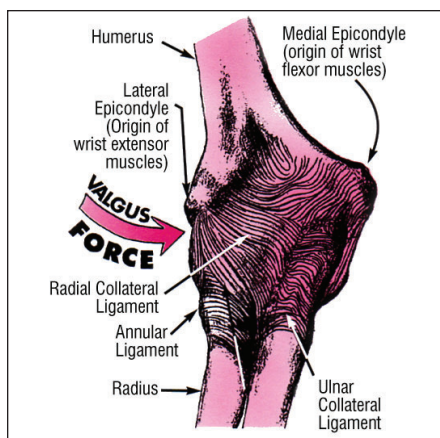


FIGURE 4. Ligaments and tendons of the elbow. Force exerted on the elbow can injure ligamentous or tendonous structures.

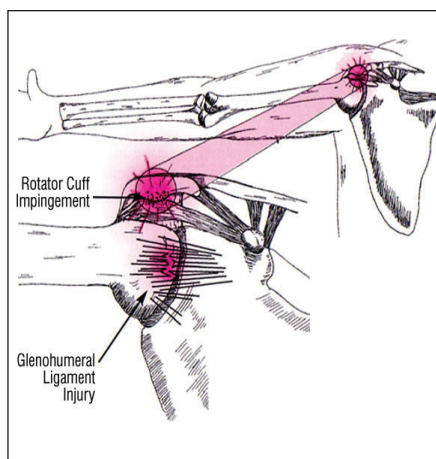


FIGURE 5. Glenohumeral ligament instability leading to impingement syndrome.

ations.⁵⁴ For a disc to herniate, there must first be a primary ligament weakness and a deteriorating disc.⁵⁵ While disc problems have gotten much of the credit for low back pain, ligament injury is a more important source of back pain.⁵⁶ In fact, it has been reported that only 4 percent of low back pain is due to a herniated disc.⁵⁷ Prolotherapy strengthens the ligamentous tissue around the disc, thus stabilizing and supporting that region. Prolotherapy is also very effective for sacroiliac ligament strain and sciatica (leg pain coming from the back). In fact, it has been stated that ligament laxity in the sacroiliac joint is the number one reason for sciatica and is one of the most common reasons for chronic low back pain.⁵⁸

Elbow Injuries

Medial elbow pain, known as medial epicondylitis, has historically been referred to as “golfers elbow.” However, lateral elbow

pain was found to be more common in the amateur golfer by a 5:1 ratio by one investigator.⁵⁹ Other investigators found the occurrence to be equal.⁶⁰ Both medial and lateral elbow pain is thought to occur as a result of poor swing mechanics, and are much more common in amateurs, with one study showing 25% of amateurs and 4% of professionals complaining of this problem.⁶¹ Medial injuries are thought to occur as a result of hitting shots “fat” (hitting the ground first), or sudden impact loading such as can occur by taking repetitive strokes that leave large divots.⁶² Lateral injury occurs with over-swinging with the right hand (in right handed golfers), and repetitive forceful extension of the forearm accompanied by a twisting motion, especially if associated with excessive gripping of the golf club.⁶³ Both of these problems increase with age and frequency of play.⁶⁴ There are ligamentous and tendonous complexes on both the medial and

lateral aspects of the elbow. The medial aspect of the elbow is stabilized by the ulnar collateral ligament, while the lateral side is stabilized by the radial collateral and annular ligaments (see Figure 4). The extensor tendons attach at the lateral epicondyle while the flexor tendons attach medially. Prolotherapy is an effective treatment for these ligamentous and tendonous injuries, as

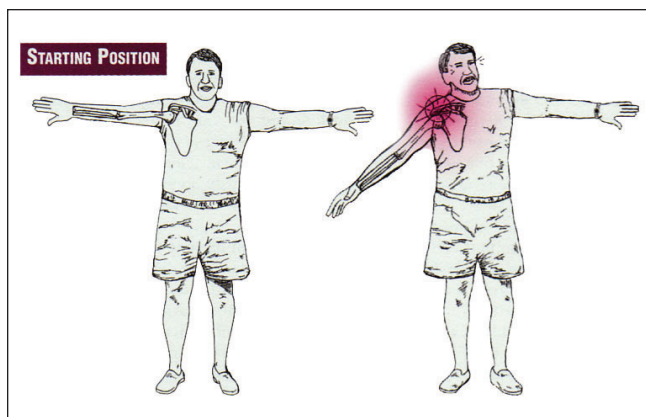


FIGURE 6. Hauser Thumbs-Down Test: A person with early impingement of the rotator cuff will not be able to hold this position without experiencing shoulder pain and weakness.

long as there is not a complete rupture present. In the case of a complete rupture, surgery may be needed, however this is much less common than tendonitis, tenosynovitis, or ligamentous sprain.

Shoulder Injuries

The shoulder is another common area of injury for the golfer, with the lead shoulder (left shoulder in the right handed golfer) particularly vulnerable to injury.⁶⁵ Understanding the biomechanics of the golf swing is especially helpful in diagnosis of shoulder injuries and sometimes modifications to the swing can be helpful in preventing further injury.⁶⁶ Symptoms of shoulder pain or instability usually occur at the extreme of range of motion (top of backswing or end of follow-through). Those with rotator cuff disease may display weakness during initial take-away, leading to poor swing mechanics. Rotator cuff disease and subacromial impingement involving the lead shoulder are among the most common problems in golfers.⁶⁷ Acromioclavicular joint disease is another common problem affecting this population. With acromioclavicular problems, symptoms will usually be experienced at the top of the backswing.⁶⁸

Glenohumeral Instability. The glenohumeral ligament is a stabilizing ligament of the anterior portion of the shoulder and is important in the overhead portion of the golf swing. Injury to this ligament—specifically the superior band—predisposes the shoulder to instability.⁶⁹ In order to generate power during the swing, golfers attempt to maximize their shoulder turn relative to their hip turn.⁷⁰ Unfortunately this degree of shoulder rotation done repetitively can create microtrauma on capsular and labral structures, affecting the glenohumeral joint ligaments, and creating laxity and instability.⁷¹ The patient will complain of pain and instability at the top of the backswing.

Instability of the glenohumeral ligament then leads to rotator cuff injury and subsequent impingement syndrome⁷² (see Figure 5). A simple test for early impingement syndrome is the “Hauser Thumbs Down” test.⁷³ The person holds their arms at 90 degrees to the body with the thumbs pointed down to the ground for 2 minutes. A sensation of a definite weakening or pain in the shoulder is a positive sign (see Figure 6). A positive test means that prolotherapy should be considered to correct existing weakness and prevent further

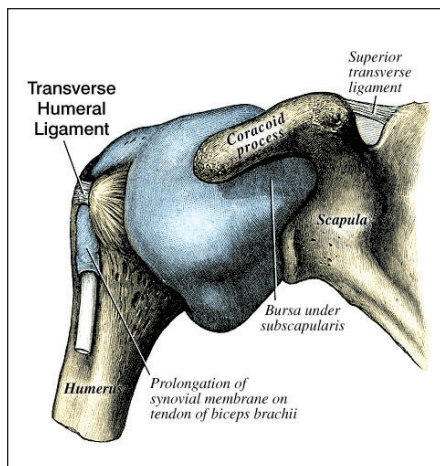


FIGURE 7. Transverse humeral ligament. This small but important ligament stabilizes the position of the tendon of the long head of the biceps within the bicipital groove.

damage to the glenoid labrum.⁷⁴

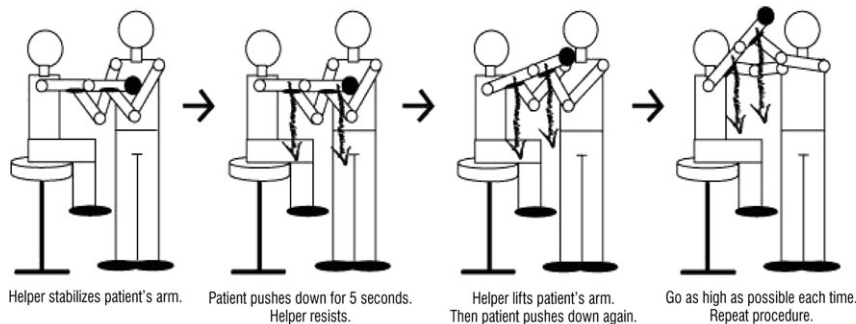
SLAP Lesions Biceps Tendonitis/Tendonosis. Superior labral (SLAP) lesions also occur in golfers. These patients complain of pain affecting the lead shoulder during the end of the backswing or beginning of the downswing. Sometimes there are complaints of clicking or catching or subjective weakness at ball contact during the swing. For isolated biceps tendonitis/tendonosis, anterior shoulder pain is most marked during the latter part of the follow-through phase.⁷⁵ No definitive studies have been done on prolotherapy and SLAP lesions, although some clinical experience has demonstrated improvement with prolotherapy treatment (see Case Report 3). Bicipital tendonitis/tendonosis lends itself well to prolotherapy treatment and this should be tried prior to surgery unless there is a rupture or detachment requiring surgery.

Transverse Humeral Ligament. Often forgotten is the small but important transverse humeral ligament (THL). The THL is a small ligament holding the long head of the biceps tendon in its groove. It is described in Gray's Anatomy as: "a broad band of fibrous tissue passing from the lesser [tuberosity] to the greater tuberosity of the humerus, which maintains the position of the tendon of the long head of the biceps within the bicipital groove" (see Figure 7). With repetitive use and or trauma, the THL may become stretched and lax, causing excessive biceps tendon motion.⁷⁶ The patient will complain of a twinge-like feeling anteriorly and pain during motions that use the biceps, such

Shoulder Range of Motion Exercises

Two people are needed to do this exercise.

1. The helper stands to side of the patient and supports the patient's arm, which is placed straight ahead.
2. The Helper holds the patient's arm while the Patient pushes down, counting to 5 and the Helper supports and resists the motion.
3. Then the Helper lifts the patient's arm up a little and repeats.
4. Keep going as high as possible.



Do this in the following 3 positions, 3 times per day.

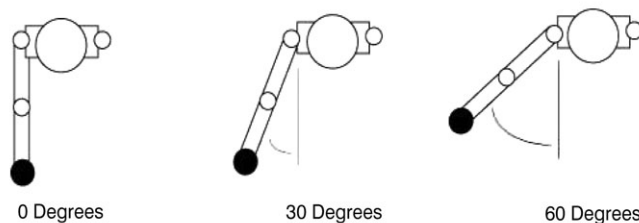


FIGURE 8. Shoulder range of motion exercises.

as anterior pain during portions of the golf swing. Prolotherapy is very effective in stimulating the repair of this small ligament, stabilizing the biceps tendon, and resolving pain.

Adhesive Capsulitis. Adhesive capsulitis (frozen shoulder) is another shoulder presentation that may occur when the golfer has suffered an injury, then limited shoulder motion afterwards. This can be particularly troublesome if it has advanced. However, if caught early, aggressive physical therapy to break the adhesions and restore range of motion, followed by prolotherapy on a subsequent visit for the underlying injured tendon, is effective. Initially, local anesthetic to the shoulder joint can be used in the office and manipulation/stretching of the joint done there to start the process of breaking the adhesions.^{77,78} Exercises based on osteopathic muscle energy technique for this purpose can also be helpful (see Fig-

ure 8). The patient should be instructed to do these exercises two to three times daily, and should also be sent for aggressive physical therapy to continue mobilization of the joint where possible. Followup visits include reevaluation of range of motion, and continued prolotherapy treatments to the underlying injury, with many patients resolving within the typical four to six treatment average.

Wrist and Hand Injuries

The wrist is a sea of ligaments (see Figure 9). These ligaments are injured most typically by hyperextension of the wrist during the golf swing and occur most commonly in the left (leading) wrist or hand. Stability of the wrist is dependent on the stability of the wrist ligaments. Overuse or poor wrist control during the swing can cause excessive joint movement leading to wrist ligament injury.⁷⁹ Wrist ligamentous injuries can be successfully treated with prolother-

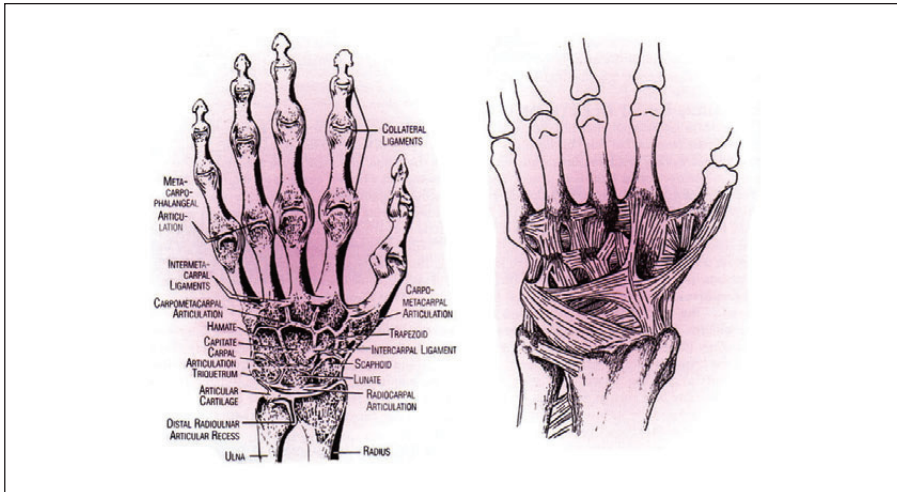


Figure 9. *Anatomy of the Wrist. A “Sea of Ligaments.”*

apy. Common areas treated with prolotherapy include the distal radioulnar joint, dorsal intercarpal ligaments, and ulnar collateral ligaments (see Figures 10-12).

Unusual Causes of Wrist or Hand Pain. While fractures are uncommon, the physician should consider the possibility of a hamate fracture (the bone behind the ring and little finger) as these type of fractures are a golfing specialty.⁸⁰ Often overlooked, damage to the hook of the hamate is caused by a direct blow from the handle of the golf club during a “fat shot” (hitting the ground). Patients complain of vague, deep-seated pain or weak grip. There is local tenderness and pain to resisted flexion of the little finger. A carpal tunnel X-ray view or a CT scan is necessary to show the fracture radiographically⁸¹ and should be ordered if there is a suspicion of this injury. Surgery is needed to remove the hook bone fragment. To prevent these types of fractures, the butt of the club should be of appropriate size and length, extending beyond the palm of the leading hand.⁸²

Clinical Evaluation

As with any physical evaluation, a thorough and careful history and exam of the golfing injury are important in making an accurate diagnosis. Having the golfer explain during which phase of the swing the symptoms are worst can be helpful in diagnosis.⁸³ For example, with shoulder injuries, pain during the backswing can exacerbate subacromial impingement or acromioclavicular issues because of the positioning of the leading arm (internally rotated, forward flexed and abducted). If pain occurs during the follow-through

where the leading arm is abducted and externally rotated, a diagnosis of anterior instability or biceps tendonitis/osis is supported.⁸⁴ Before a diagnosis is made, standard orthopedic testing should be done, along with a thorough history of the injury, exacerbating or mitigating factors, and review of previous treatments and success of those treatments.

MRI’s

MRI’s may sometimes be useful but, as discussed in previous articles, may also be misleading in diagnosing musculoskeletal pain. As many pain practitioners know, an MRI may show nothing wrong and yet the patient is still in pain. And, because MRI’s may also show abnormalities not related to the patient’s current pain complaint, these MRI findings should always be correlated to the individual patient’s presentation. Many studies have documented the fact that abnormal MRI findings exist in large groups of pain-free individuals.⁸⁵⁻⁹¹ A study published in the *New England Journal of Medicine* showed that out of 98 pain-free people, 64% had abnormal back scans.⁹² Many other studies have also shown abnormal neck MRI scans in asymptomatic subjects.^{93,94} A study of elite athletes performing repetitive overhead activity also demonstrates this point. At the study’s start, none of the athletes had any shoulder pain or problems. Yet on MRI, 40% showed partial or full thickness tears of the rotator cuff, and 20% showed other abnormalities. After five years, none of the athletes interviewed had any complaints or had had any evaluation or treatment for shoulder-related problems during the previous five years. The conclusion



FIGURE 10. *Prolotherapy injection of the distal radioulnar joint.*



FIGURE 11. *Prolotherapy injection of the dorsal intercarpal ligaments*



FIGURE 12. *Prolotherapy injection of the ulnar collateral ligament.*

of the study was that an MRI alone should not be used for diagnosis.⁹⁵

Conclusion

Prolotherapy is an effective non-surgical treatment option for golf related injuries, including low back pain, lateral and medial epicondylitis, wrist ligament injuries, shoulder injuries as well as other musculoskeletal joint pain. Because many golf related injuries are a result of repetitive strain—where incomplete healing has occurred—prolotherapy makes even more sense as a treatment modality to stimulate connective tissue repair. Prolotherapy should only be done by a practitioner

CASE REPORTS

CASE REPORT 1

48-year-old male complaining of low back and neck pain. He is an avid golfer and has been playing a lot recently. His back pain has been an issue over the years and tends to come and go, with occasional flares. The last low back flare occurred while playing golf while “hardly bent over and then started to have extreme pain” in this low back. The pain has persisted. Regarding his neck, he was dragging his golf clubs recently and felt his hand tingling with right-sided neck and trapezius pain. An MRI of this cervical spine showed a ruptured disc. The neck tingling has gotten a little better but he is still bothered by neck pain and stiffness.

Past Medical History (PMH): No surgeries, no major illnesses.

Review of Systems (ROS): No other complaints.

Medications: Levothyroxine, Vitorin, Niaspan

Exam: Vital signs: Temp 98.0, Blood pressure: 124/70, Height 6'1", Weight 214, Pulse 66, Pulse oximetry 97% O₂. Gait antalgic, lumbar forward flexion 80 degrees, extension 10 degrees. Straight leg raising negative bilaterally. Tender to palpation at PSIA, ilio-lumbar and sacroiliac ligaments bilaterally. Cervical ranged of motion: right 50 degrees, left 40 degrees, restricted extension, flexion within normal limits, ear to shoulder 20 degrees bilaterally. Tenderness of cervical interspinous ligaments. Negative for muscular weakness or neurological signs in arms bilaterally.

Findings: Degenerative disc disease lumbar and cervical spine; lumbosacral sprain-strain, chronic; cervicothoracic sprain-strain, chronic.

Treatment and Outcome: The patient underwent a course of prolotherapy treatments, first to the lumbosacral spine, then to the cerviothoracic spine. After 4 treatments to the lumbosacral spine and sacro-iliac ligaments, the patient reports 95% improvement and is back to golfing. After 3 treatments to the cerviothoracic spine the patient reports 95% improvement. Motion testing shows increase in both lumbar and cervical range of motion.

CASE REPORT 2

60-year-old left-handed male complaining of right shoulder pain on and off for the past five years. He has been a golfer for many years, however he first noticed the pain while taking luggage off a train and also during weight training. In the past, his shoulder pain would go away but this time it has persisted. It has exacerbated to the point of waking him up at night and he has begun to feel it while playing golf during the follow-through phase of his swing.

PMH: No major illnesses or surgeries.

ROS: No other complaints.

Medications: None.

Exam: Vital signs: Temp 98.4, Blood pressure 100/60; height 5'8-3/4; weight 184; pulse 76; pulse oximetry 96%. Right shoulder abduction to 150 degrees and slightly “sticky”. Positive active compression test at 0 and 30 (biceps and rotator cuff). Tenderness to palpation at supraspinatus anteriorly and at transverse humeral ligament. No xrays or MRI's to review.

Findings: (1) Rotator cuff tendonitis/tendonosis with developing adhesive capsulitis; and (2) sprain of transverse humeral ligament.

Treatment and Outcome: Patient began prolotherapy treatment to right shoulder. He was also educated on shoulder exercises to increase range of motion and advised to do them three times daily. After three prolotherapy treatments he reports 90% improvement, and no pain while golfing. Range of motion was tested and back to abduction of 180 degrees.

CASE REPORT 3

(Note: this patient is not a golfer but noted here because of SLAP lesion improvement after treatment.)

62-year-old male complaining of left shoulder pain, aggravated after a fall. Pain was so severe at one point he could hardly move the shoulder and it became frozen. He has been undergoing physical therapy and improved his range of motion by 80%, but still feels some restriction, and also continual pain in the shoulder which he describes as being like “a toothache.” He has seen several other physicians including a neurologist and orthopedic surgeon. Neck origin was considered but ruled out. Patient complains of severe limitations of activities of daily living secondary to pain and restricted range of motion in this shoulder.

PMH: No surgeries, elevated cholesterol controlled with diet, no major illnesses.

ROS: No other complaints.

Exam: Vital signs: Temp 97.8, Blood Pressure 108/64, Height 6'3", Weight 188, Pulse 89, Pulse oximetry 98% O₂. Left shoulder exam shows abduction 160 degrees. Positive active compression test (biceps positive). Tenderness at ACJ. Apley scratch restricted at upper pole. Restriction with internal rotation.

MRI of left shoulder: (1) No rotator cuff tear; (2) Slap lesion; (3) Downsloping acromion, type 3; (4) Arthrosis of the acromioclavicular joint; (5) Impingement; (6) Anterior rotator interval capsulitis and sprain; (7) Anterior and posterior capsulitis and sprain; (8) Fluid in the shoulder joint; (9) Fluid in the subscapularis bursa; (10) 2mm cyst vs. varicose vein of the glenoid notch; (11) Two 2mm cysts in the humeral head which are considered to be benign simple cysts.

Findings: (1) Left shoulder adhesive capsulitis, resolving with physical therapy; (2) Bicipital/rotator cuff tendonitis/tendonosis; (3) SLAP lesion; and (4) Degenerative joint disease left shoulder.

Treatment and Outcome: The patient continued with his course of physical therapy and concurrently underwent a course of prolotherapy treatments. After 5 prolotherapy treatments, he reports restoration of range of motion, no pain, and overall rates his improvement at 95%. Range of motion was tested and found to be normal. MRI was subsequently repeated and as follows:

Followup MRI: Normal signal intensity and size of supraspinatus muscle and tendon. Infraspinatus, subscapularis and teres minor muscles reveal no tear or sprain. There is no subacromial or subdeltoid buras effusion and superior and inferior glenoid labrum are intact. The humeral head is smooth but there is type 3 acromioclavicular joint spurring causing mild acute supraspinatus muscle impingement; no tear or additional abnormalities.

trained in the procedure and any physician interested in learning the procedure should seek out appropriate instruction. Otherwise, the practitioner should refer to a physician thoroughly trained in the procedure. Prolotherapy can be a very effective option for the golfer who wants to play at peak levels unencumbered by musculoskeletal pain. ■

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References

1. Kim D, Millett P, Warner J, and Jobe F. Shoulder Injuries in Golf. *Am J Sports Med.* 2004. 32(5):1324.
2. National Golf Foundation. 2007 study. www.ngf.org/cgi/faq.asp. Accessed 6/9/08.
3. Beckwith R. The Golf 20/20 Industry Report for 2001. Saint Augustine, Fla. World Golf Foundation. 2002.
4. National Golf Foundation commonly asked questions. www.ngf.org/cgi/faq.asp. Accessed 6/9/08.
5. Batt ME. Golfing injuries: An overview. *Sports Med.* 1993. 16:64.
6. McHardy A, Pollard H, and Luo K. One-Year Follow-up Study on Golf Injuries in Australian Amateur Golfers. *Am J Sports Med.* 2007. 35(8):1354.
7. Ibid. ref 1.
8. Stockard A. Elbow Injuries in Golf. *JAOA.* 2001. 101(9):509.
9. Gosheger G, Liem D, Ludwig K, et al. Injuries and Overuse Syndromes in Golf. *Am J Sports Med.* 2003. 31(3):438.
10. Brody J. Injections to Kick-Start Tissue Repair. *The New York Times.* August 7, 2007. Personal Health Section, p D8.
11. Hackett GS, Hemwall GA, and Montgomery GA. *Ligament and Tendon Relaxation Treated by Prolotherapy.* (1956 First Edition Charles C. Thomas, Publisher), Fifth Edition Gustav A. Hemwall. Institute in Basic Life Principles. Oak Brook, IL. 1991.
12. Reeves KD. Prolotherapy: Basic Science, Clinical Studies, and Technique. In Lennard TA (Ed) *Pain Procedures in Clinical Practice, 2nd Ed.* Hanley and Belfus. Philadelphia. 2000. pp 172-190.
13. Hauser R and Hauser M. *Prolo Your Sports Injuries Away.* Beulah Land Press. Oak Park, IL. 2001. p 741.
14. Ibid. ref 13.
15. Ibid. ref 13.
16. Browner B. *Skeletal Trauma, Volume 1.* WB Saunders. Philadelphia, PA. 1992:87-88.
17. Andriacchi T, Sabiston P, DeHaven K, et al. Ligament: Injury and Repair. *Acta Rheum Scand.* 1956. 2:109-116.

18. Ibid. ref 12.
19. Ibid. ref 9.
20. Ibid. ref 9.
21. Ibid. ref 9.
22. Ibid. ref 12.
23. Ibid. ref 12.
24. Reeves KD. Prolotherapy: Present and Future Applications in Soft-Tissue Pain and Disability. Injection Techniques: Principles and Practice. *Physical Medicine and Rehabilitation Clinics of North America.* November. 1995. (6)4:917-923.
25. Ibid. ref 9.
26. Ibid. ref 6.
27. McHardy, A. and Pollard, H. Lower Back Pain in Golfers: a Review of the Literature. *J Chiro Med.* 2005. Vol 4(3):135.
28. Ibid. ref 13.
29. American Orthopaedic Society for Sports Medicine Sports Tips. *Golf Injuries.* 2008.
30. Ibid. ref 9.
31. McCarroll JR and Gloe TG. Professional golfers and the price they pay. *Phys Sportsmed.* 1982. 10:54.
32. McCarroll JR. The frequency of golf injuries. *Clin Sports Med.* 1996. 15:1.
33. Theriault G and Lachance P. Golf injuries: an overview. *Sports Med.* 1998. 26:43.
34. Wadsworth LT. When golf hurts: musculoskeletal problems common to golfers. *Curr Sports Med Rep.* Dec 2007. 6(6):362.
35. Ibid. ref 9.
36. Ibid. ref 5.
37. Mallon WJ. Golf. In: Hawkins RJ and Misamore GW, eds. *Shoulder Injuries in the Athlete: Surgical Repair and Rehabilitation.* Churchill Livingstone. New York. 1996.
38. Pink M, Jobe FW, and Perry J. Electromyographic analysis of the shoulder during the golf swing. *Am J Sports Med.* 1990. 18:137-140.
39. Ibid. ref 1.
40. Ibid. ref 29.
41. Ibid. ref 27.
42. Ibid. ref 1.
43. Ibid. ref 42.
44. Ibid. ref 6.
45. Ibid. ref 44.
46. Ibid. ref 9.
47. Ibid. ref 9.
48. Ibid. ref 9.
49. Ibid. ref 9.
50. Ibid. ref 34.
51. Ibid. ref 50.
52. Ibid. ref 13
53. Ibid. ref 13; p 531.
54. Alpers BJ. The problem of sciatica. *Medical Clinics of North America.* 1953. 37:503.
55. Hackett GS, Hemwall GA, and Montgomery GA. *Ligament and Tendon Relaxation Treated by Prolotherapy, 5th Ed.* Institute in Basic Life Principles. Oak Brook, IL. 1991. (commenting on work of Newman PH. p 9).
56. Ombregt L, Bisschop P and ter Veer HJ. A System of Orthopaedic Medicine, 2nd Ed. Churchill Livingstone. 2003. p775.
57. Hills EC and Wieting JM, et al, eds. Mechanical Low Back Pain. Updated 21 November 2004. available from <http://www.emedicine.com/pmr/topic73.htm>. Accessed 6/9/08.
58. Schwarzer A. The sacroiliac joint in chronic low back pain. *Spine.* 1995. 20:31-37.
59. McCarroll JR, Retig AC, and Shellbourne KD. Injuries in the amateur golfer. *The Physician and Sports Medicine.* 1990. 18:122.

60. Ibid. ref 5.
61. Kohn HS. Prevention and treatment of elbow injuries in golf. *Clin Sports Med.* 1996. 15:65.
62. Ibid. ref 61.
63. Ibid. ref 8.
64. Ibid. ref 29.
65. Ibid. ref 1.
66. Ibid. ref 65.
67. Ibid. ref 1.
68. Ibid. ref 67.
69. Turkel S. Stabilizing mechanisms preventing anterior dislocation of the glenohumeral joint. *The Journal of Bone and Joint Surgery.* 1981. 63A:1208.
70. Burden AM, Grimshaw PN, and Wallace ES. Hip and shoulder rotations during the golf swing of sub-10 handicap players. *J Sports Ci.* 1998. 16:165.
71. Jobe FW and Schwab DM. Golf for the mature athlete. *Clin Sports Med.* 1991. 10:269.
72. Ibid. ref 13; p 527.
73. Ibid. ref 13; p 668.
74. Ibid. ref 13; p 670.
75. Ibid. ref 1.
76. *Prolotherapy in Sports Medicine*, presented by Dr. Donna Alderman at Annual Conference of American College of Osteopathic Sclerotherapeutic Pain Management. Phoenix, Arizona. April 2008.
77. Ibid. ref 11.
78. Ibid. ref 76.
79. Chao EYS, Tamai K, Cahalan TD, et al. Biomechanics of the golf swing as related to club handle design. *Biomechanics in Sports: A 1987 Update*, 1987 DE-Vol 13/BED-Vol 6:107-111.
80. Gupta A, Risitano G, Crawford R, et al. Fractures of the hook of the hamate. *Injury.* 1989. 20 (5):284-286.
81. Bowen TL. Injuries of the hamate bone. *Hand.* 1973. 5:235-238.
82. Ibid. ref 79.
83. Ibid. ref 1.
84. Ibid. ref 83.
85. Ibid. ref 56.
86. MacRae DL. Asymptomatic intervertebral disc protrusion. *Acta Radiologica.* 1956. pp 46-49.
87. Hitselberger WE and Whitten RM. Abnormal myelograms in asymptomatic patients. *Journal of Neurosurgery.* 1968. 28:204.
88. Wiesel SW, et al. A study of computer-assisted tomography:1. The incidence of positive CAT scans in an asymptomatic group of patients. *Spine.* 1984. 9:549-551.
89. Powell MC, et al. Prevalence of lumbar disc degeneration observed by magnetic resonance in symptomless woman. *Lancet.* 1986. 13:1366-1367.
90. Boden SD, et al. Abnormal magnetic resonance scans of the lumbar spine in asymptomatic subjects. *Journal of Bone and Joint Surgery.* 1990. 72A:503-408.
91. Kaplan PA. MR imaging of the normal shoulder: variants and pitfalls. *Radiology.* 1992. 184:519-524.
92. Deyo R. Magnetic resonance imaging of the lumbar spine—terrific test or tar baby? *New England Journal of Medicine.* 1994. 331:115-116.
93. Matsumoto M, et al. MRI of the cervical intervertebral discs in asymptomatic subjects. *Journal of Bone and Joint Surgery (Br).* 1998. 80(1):19-24.
94. Humphreys SC, et al. Reliability of magnetic resonance imaging in predicting disc material posterior to the posterior longitudinal ligament in the cervical spine, A prospective study. *Spine.* 1998. 23(22):2468-2471.
95. Connor PM, et al. Magnetic resonance imaging of the asymptomatic shoulder of overhead athletes: A 5 Year followup study. *Am J Sports Med* 2003. 31:724-727.