The Practical Management of Swimmer's Painful Shoulder: Etiology, Diagnosis, and Treatment

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Abstract: Shoulder pain is the most common musculoskeletal complaint in competitive swimmers. Problems with the shoulders of swimmers resemble that of the disabled thrower's shoulder, but the clinical findings and associated dysfunctions are not quite the same. Therefore, swimmers with shoulder pain should be evaluated and treated as a separate clinical entity, aimed toward underlying pathology and dysfunction. Balanced strength training of the rotator cuff, improvement of core stability, and correction of scapular dysfunction is central in treatment and prevention. Technical and training mistakes are still a major cause of shoulder pain, and intervention studies that focus on this are desirable. Imaging modalities rarely help clarify the diagnosis, their main role being exclusion of other pathology. If nonoperative treatment fails, an arthroscopy with debridement, repair, or reduction of capsular hyperlaxity is indicated. The return rate and performance after surgery is low, except in cases where minor glenohumeral instability is predominant. Overall, the evidence for clinical presentation and management of swimmer's shoulder pain is sparse. Preliminary results of an intervention study show that scapular dyskinesis can be prevented in some swimmers. This may lead to a reduction of swimmer's shoulder problems in the future.

Key Words: swimmer's shoulder, scapula dyskinesis, instability, impingement, prevention

ETIOLOGY

Shoulder pain is the most common complaint for swimmers, the prevalence being reported to be between 40% and 91%.[1–5] The term "swimmer's shoulder" covers a spectrum of consecutive or coexisting pathologies, with rotator cuff–related pain to be the most common finding.[1–7] The etiology of swimmer's shoulder is set out in Table 1.

The main factor in the development of a swimmer's shoulder seems to be the high training volume during growth in the absence of a well-designed and balanced dryland training program. This affects the muscular balance of the core, the scapulothoracic articulation, the rotator cuff, and glenohumeral mobility. Swimmers start their intensive training early, typically at the age of 8 to 11 years, and the amount of training can be excessive. An elite swimmer older than 13 years typically performs between 0.5 and 1 million arm cycles per arm per year.[1,7] To increase resistance with the arm stroke, hand paddles are used. This increase in resistance leads to an increase in the load, which often results in pain.[3] Swimmers often report that their shoulder pain was related to an increase in the amount of training, typically during a training camp or in conjunction with advancement to a higher training level.

The introduction of high amounts of training during growth may induce changes in flexibility and stiffness around the shoulder and the trunk and may predispose the swimmer to shoulder pain. Multiple repetitions also affect the strength and the flexibility of the core.[8] Nearly all swimmers have an s-configuration of their back with an enlarged thoracic kyphosis and an enlarged lumbar lordosis. The enlarged thoracic kyphosis is an aggravating factor in the development of scapular dyskinesis and reduces the subacromial space even further.[9,10] Glenohumeral internal rotation deficit is a common finding in baseball players suffering from shoulder pain,[11,12] but in a comparative study of painful and pain-free swimmer's shoulders, no significant differences in internal rotation were found.[13]

Most swimming strokes consist of a pull-through phase that generates speed and a recovery phase where the arm is over the water. During the recovery phase, the body roll and the ability to repeatedly retract the scapula protects the subacromial bursa, the supraspinatus tendon, and the posterior–superior labrum. Yanai and Hay[14] showed that impingement on average occurred 24.8% of the stroke time. Tissues at risk during the swimming strokes are shown in Table 2.

Scapular dyskinesis is seen in the majority of the overhead athlete's shoulder with overuse pain syndromes and may be caused by an inhibition in activation patterns of the scapula-stabilizing muscles.[1,4,10,15] During activity, the scapula involved is placed in a more abducted, protracted, and laterally displaced position than in symptom-free subjects.[15] In this position, external and internal impingement is more likely to occur.[15,16] Swimmers are subject to early fatigue due to the high training volume. Dynamic electromyography studies have shown that the serratus anterior muscle is susceptible to fatigue and displays lower electromyographic activity than in pain-free swimmers.[17,18] In a study of 78 previous pain-free swimmers, scapular dyskinesis became increasingly more frequent throughout a swim training session, suggesting that scapular dyskinesis may be a primary etiological factor, with fatigue playing a contributing role.[19]

TABLE 1. Etiology of Swimmer's Shoulder

Extrinsic factors
Training volume—absolute and sudden increases
Technical errors
Hand paddles
Intrinsic factors
Excessive laxity/general joint hypermobility
Isolated joint hyperlaxity
Posture, core stability, and increased thoracic kyphosis
Scapular dyskinesis
Glenohumeral internal rotation deficit
Rotator cuff imbalance
Lack of flexibility/stiffness (posterior capsule, anterior capsule, anterior cuff, and pectoralis minor)

TABLE 3. Types of Swimmer's Shoulder

Type A	Isolated external impingement with subacromial bursitis and increased amount of fluid in the supraspinatus tendon. Normal morphology of acromion. Possible enlarged coracoacromial ligament. No hyperlaxity or instability. Scapular dyskinesis present in most cases.
Type B	Isolated internal impingement without instability. Labral wearing/fraying and minor partial articular side supraspinatus tendon lesions. Scapular dyskinesis present in most cases.
Type C	Complex impingement with both extra-articular and intra-articular pathology. Nearly always minor instability. Scapular dyskinesis present in all cases.
Type D	Isolated minor instability. Often with bilateral hyperlax shoulders. Rarely pain. Scapular dyskinesis is always present.
Type E	Other pathologies, that is, acromioclavicular joint meniscus tear/arthritis (may be related to weight training). Scapular dyskinesis may be present.

DIAGNOSIS

Since Kennedy cited subacromial impingement to be the main clinical presentation,[5] more studies have attempted to suggest other causes or aspects of the syndrome. Hawkins and Kennedy[20] described the apprehension shoulder in backstrokers and pointed to anterior instability. He particularly addressed the term to backstrokers, who bring their arm in the apprehension position at the initiation of the pull-through phase and during flip turns on the pool wall. Recently, Sein et al[6] concluded that rotator cuff tendinopathy is the major problem. However, it becomes a significant challenge to identify which of these is the root cause: scapular dysfunction, anterior instability, or tendinopathy.

My 20 years of experience in diagnosing and treating swimmer's shoulder have led to the identification of 5 main categories of swimmer's shoulder, which are summarized in Table 3. Types A, B, and C may represent different stages of the same condition. The first 4 types nearly always have scapular dyskinesis present.

Two studies on clinical findings in competitive swimmers found that impingement signs, anteroinferior instability, dysfunction of the scapulothoracic joint, and significant muscular imbalance of the rotator cuff were common in swimmers with shoulder pain.[1,4]

A swimmer displaying shoulder pain should undergo a thorough clinical evaluation (Table 4). The history is often a gradual onset of pain, located anterior or at the lateral aspect of the shoulder. Anterior shoulder pain may be located over the long head of the biceps tendon in the bicipital groove and may represent increased humeral head translation from scapular dysfunction. Sometimes, the swimmer reports a clicking sensation. This may come from a chronically inflamed subacromial bursa or from the glenoid labrum. Clicking over the shoulder may represent an acromioclavicular joint disorder. Clicking from the back of the shoulder may represent a posterior labral tear or a "snapping scapula." Dead arm sensation when using the arm overhead is often a symptom of a labral lesion.

The swimmer is examined standing, with shoulders, trunk, and scapula being visible. Active range of movement is assessed by asking the swimmer to move their arms repeatedly at a slow speed. The examiner asks the swimmer about a possible painful arc and observes the scapulas moving, assessing possible scapular dyskinesis.[1,21] The scapular assistant test and the scapular retraction test are valuable tools to show if pain can be relieved and active movement improved.[22] Load and shift test, as well as drawer sign, together with a sulcus sign can be graded in severity (0, +, ++, +++). More than 6 + of total anterior, posterior, and inferior laxity indicates hyperlaxity, but the observation may be

TABLE 2. Tissues Under Risk During Swimming

Recovery
Subacromial bursa
Supraspinatus tendon
Posterior–superior labrum
Early pull-through
Anterior capsulolabral complex
Posterior–superior labrum
Late pull-through
Supraspinatus tendon

TABLE 4. Diagnosis

Subjective pain: Is it deep in the shoulder (labrum, underside cuff, minor instability), on the lateral aspect (bursa, supraspinatus tendon), anterior (biceps tendon), on the back of the shoulder (posterior–superior labrum), or over the shoulder (acromioclavicular joint)?
Pain provocation: Hawkins impingement sign, O'Briens active compression sign, and dynamic labral shear test with reproducible pain (ie, to the area reported above).
Assessment of scapula kinesis: Assessment with scapula assistant test and scapular retraction test. Pectoralis minor tightness. Thoracic kyphosis and core stability (one-leg squat).
Evaluation of glenohumeral rotation: External rotation/internal rotation at 90 degrees of abduction in the supine position with the scapula fixed. GIRD and excessive external rotation.
Instability evaluation: Sulcus and anterior–posterior drawer test. A total of 6+ or more is severe hyperlaxity. Apprehension test provoking true anterior apprehension, not pain.

GIRD, Glenohumeral internal rotation deficit.

inaccurate and of limited clinical relevance. The contralateral shoulder may exhibit the same degree of laxity, and a painful shoulder maybe more apprehensive.[1,4]

Apprehension tests, relocation tests, and assessment of glenohumeral internal and external rotation are best performed in the supine position, with the affected shoulder brought to the edge of the examination table. The apprehension sign is more frequently positive in 135 degrees than in 90 degrees in swimmers with shoulder pain.[1] This reflects the true position of the arm at the initiation of the pull-through. Pain at the posterior aspect of the shoulder that is relieved by the relocation sign[23] indicates a posterior labral or cuff injury, whereas true apprehension anteriorly points to a minor instability.[23,24] Core stability can be assessed by the one-leg squat test.[8]

THE ROLE OF DIAGNOSTIC IMAGING AND ARTHROSCOPY

The most important role of diagnostic imaging studies might be to exclude other pathologies. Plain x-rays of the glenohumeral joint may show calcification in the supraspinatus tendon or in the subacromial bursa. Ultrasound is an easy and inexpensive diagnostic tool that has the added benefit of identifying cuff tears. Even though the diagnostic accuracy of partial cuff tears is low, it is at the same level as magnetic resonance imaging.[25] Magnetic resonance arthrography is the most precise diagnostic tool, although it is invasive and costly. Care should be taken to review the magnetic resonance arthrography because most swimmers have seemingly pathological findings, such as irregularity of the labrum and its attachment to the anterior glenoid. Additionally, asymptomatic swimmers may have an abundant capsular volume without having pathological instability.[26]

The understanding of shoulder joint pathology has improved with the use of arthroscopy. Swimmers and overhead athletes might suffer from the same injuries as a result of a similar movement pattern in the shoulder. Arthroscopic findings include labral tears, bursal-side tear of the supraspinatus tendon, excessive capsular redundancy, impingement of the posterior rotator cuff, and inflammation of the long head of the biceps tendon.[27–29]

TREATMENT

Swimmers at a high level with more than 5 swim training sessions a week should perform dryland exercises to prevent effects of swim training on their body posture, stability, and strength. The evidence on prevention is sparse, but more biomechanical studies point to possible risk factors. The excessive training exceeds most other sports, with an increased risk of overuse and fatigue, which increases susceptibility to technical mistakes. Preventive efforts are aimed toward avoiding collision of the rotator cuff and the subacromial bursa with the undersurface of the anterior acromion, as well as internal impingement of the labrum and attenuation of the capsule.

According to the findings of Yanai and Hay,[14] the goal is to (1) decrease the amount of internal rotation of the arm during the pull phase, (2) improve early initiation of external rotation of the arm during the recovery phase, and (3) improve the tilt angle of the scapula. In the recovery phase and early pull-through, coaches should encourage the following: increased body roll and scapula retraction, aiming at normal strength and endurance of the cuff and scapular stabilizers, as well as improving the flexibility of the anterior capsule, pectoralis minor, and the cuff.[7] During late pull-through, a smooth finish is encouraged to avoid repetitive blood depletion of the tendon end.[30]

In 2 unpublished studies,[19,31] we have shown that a pain-free swimmer develops scapular fatigue and dyskinesis during a swim training session. In the intervention study,[31] we showed that a scapular stabilizing exercise programme prolonged the time before scapular dyskinesis was seen compared with a control group. If these results can be reproduced, there is a chance that the prevalence of swimmers with shoulder pain can be reduced. Another factor that should be considered in prevention and for future intervention studies is improvement of core stability.[8,10]

The swimmer with a painful shoulder should be seen early by a qualified sports medicine professional. Long-standing symptoms tend to include more pathological findings and more pronounced dysfunction. This makes treatment more difficult and may prolong the absence from swimming. Keeping the above principles in mind, treatment of swimmer's shoulder pain can be divided into in 3 phases (Table 5).

- Phase 1 (first time pain experience related to swimming): Active rest and reduced amounts of training, ice packs after practice, technical stroke analysis, and correction.

TABLE 5. Treatment

Phase 1 (first time pain experience related to swimming)
Active rest and reduced training
Ice packs after practice
Technical stroke analysis and correction by coach
Assess instability of the core and scapular dyskinesis
Exercises directed toward the specific dysfunction
Low rows, lawn mover, robbery, shrugs, push-ups with plus
In cases of GIRD, stretching of the posterior capsule (sleeper's or swimmer's stretch)
Phase 2 (pain daily unrelated to swimming)
Exercises and restrictions as in phase 1
No swimming allowed for a period of 2 weeks at a time
Nonsteroidal anti-inflammatory drugs up to 1 week
Injection of corticosteroid in the bursa should be limited to swimmers with constant pain
Phase 3 (pain despite treatment and active rest for more than 3 months)
Continue exercises and restrictions as in phases 1 and 2
Surgical treatment
Type A: Arthroscopy with bursectomy and partial coracoacromial ligament release
Type B: Labral and/or PASTA debridement or repair
Type C: Labral and/or PASTA debridement or repair and capsular plication
Type D: Capsular plication
Type E: Directed toward pathology

GIRD, Glenohumeral internal rotation deficit.

The coach plays a major role in this phase of the treatment. If pain continues during activity, the swimmer should be referred for an examination. In almost all cases, concomitant instability of the core and scapular dyskinesis is found, and exercises should be applied and aimed toward the specific dysfunction. If a decrease in internal rotation is found (glenohumeral internal rotation deficit), stretching of the posterior capsule (sleeper's or swimmer's stretch) should be applied.[7,12,22] The best documentation of scapular stabilizing exercises are for the low rows, lawn mower, robbery, shrugs, and push-ups with plus.[10,32]

- Phase 2 (daily pain unrelated to swimming): Short course of nonsteroidal anti-inflammatory drugs up to 1 week may be prescribed. Injection of corticosteroid into the bursa is a controversial option and should be limited to swimmers with constant pain, with the goal of obtaining pain reduction so that the exercise program can continue. An injection should be followed by a careful explanation of possible temporary side effects (flare) and infection (very rare).

- Phase 3 (pain despite treatment and active rest for more than 3 months): Individuals with gradually subsiding pain should continue nonoperative treatment because the prognosis is good despite the lack of clinical trials to support this. However, an arthroscopy is recommended.

More continuous pain and vague response of nonoperative treatment may be explained by the inhibition of the scapular stabilizers with lower response of exercises. The rationale for surgical treatment is to repair labral or cuff tears, improve glenohumeral joint stability, and eliminate the pain that may cause afferent inhibition of the muscles.

Surgical treatment of swimmer's shoulder has included clavicle bone resection, coracoacromial ligament resection, or debridement or repair of labral tears and decompression. Return rates vary from 20% to 56%.[28,33,34] It seems that the prognosis is best if glenohumeral instability is the primary pathology. Open or arthroscopic inferior capsular shift procedures have been reported with good outcomes in athletes.[35,36] In 18 swimmers who underwent arthroscopic surgery for long-standing pain, operative procedures included debridement in 10 swimmers, partial release of the coracoacromial ligament in 4, and bursectomy in 4.[28] Fifty-six percent were able to compete at preinjury level after a median 4 months (range, 2-9 months) after surgery.[28]

CONCLUSIONS

Shoulder pain is a common musculoskeletal complaint for competitive swimmers. Clinical findings vary, and multiple etiologic factors may exist. Treatment must be aimed toward underlying pathology and dysfunction. Experience shows that improvement of scapular kinesis may prevent most cases. Technical and training mistakes, as well as high amounts of training in adolescents are still a major cause of shoulder pain, and intervention studies that focus on this are recommended. Traditional types of operations for swimmer's shoulder have only a fair outcome with regard to return to competitive swimming. Stabilizing procedures, which have shown encouraging results in other categories of overhead athletes regarding return rate and performance, may be the solution in cases with signs of subtle glenohumeral instability where rehabilitation has no effect.

REFERENCES

1. Bak K, Faunø P. Clinical findings in competitive swimmers. *Am J Sports Med*. 1997;25:254–260.
2. Ciullo JV. Swimmers shoulder. *Clin Sports Med*. 1986;5:115–137.
3. McMaster WC. Shoulder injuries in competitive swimmers. *Aquat Sports Inj Rehab*. 1999;18:349–359.
4. Rupp S, Berninger K, Hopf T. Shoulder problems in high level swimmers. *Int J Sports Med*. 1995;16:57–562.
5. Kennedy JC, Hawkins RJ. Swimmers shoulder. *Phys Sports Med*. 1974;2:34–38.
6. Sein ML, Walton J, Linklater J, et al. Shoulder pain in elite swimmers: primarily due to swim-volume-induced supraspinatus tendinopathy. *Br J Sports Med*. 2010;44:105–113.
7. Weldon EJ III, Richardson AB. Upper extremity overuse injuries in swimming. *Clin Sports Med*. 2001;20:423–438.
8. Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. *Sports Med*. 2006;36:189–198.
9. Gumina S, Di Giorgio G, Postacchini F, et al. Subacromial space in adult patients with thoracic hyperkyphosis and in healthy volunteers. *Chir Organi Mov*. 2008;91:93–96.
10. Ludewig PM, Reynolds JF. The association of scapular kinematics and glenohumeral joint pathologies. *J Orthop Sports Phys Ther*. 2009;39:90–104.
11. Nakamizo H, Nakamura Y, Nobuhara K, et al. Loss of glenohumeral internal rotation in little league pitchers: a biomechanical study. *J Shoulder Elbow Surg*. 2008;17:795–801.
12. Myers JB, Laudner KG, Pasquale MR, et al. Glenohumeral range of motion deficits and posterior shoulder tightness in throwers with pathologic internal impingement. *Am J Sports Med*. 2006;34:385–391.
13. Bak K, Magnusson SP. Shoulder strength and range of motion in symptomatic and pain-free elite swimmers. *Am J Sports Med*. 1997;25:454–459.
14. Yanai T, Hay JG. Shoulder impingement in front-crawl swimming: II. Analysis of stroking technique. *Med Sci Sports Exerc*. 2000;32:30–40.
15. Burkhart SS, Morgan CD, Kibler WB. The disabled throwing shoulder: spectrum of pathology part I: pathoanatomy and biomechanics. *Arthroscopy*. 2003;19:404–420.
16. Myers JB, Laudner KG, Pasquale MR, et al. Scapular position and orientation in throwing athletes. *Am J Sports Med*. 2005;33:263–271.
17. Pink M, Jobe FW, Perry J, et al. The painful shoulder during the butterfly stroke: an electromyographic and cinematographic analysis of twelve muscles. *Clin Orthop Relat Res*. 1993;288:60–72.
18. Scovazzo ML, Browne A, Pink M, et al. The painful shoulder during freestyle swimming: an electromyographic cinematographic analysis of twelve muscles. *Am J Sports Med*. 1991;19:577–582.
19. Madsen P, Jensen S, Bak K, et al. Training induces scapular dyskinesis in pain-free competitive swimmers. Paper presented at: International Society of Arthroscopy, Knee Surgery, and Orthopedic Sports Medicine (ISAKOS) congress; April 3–6, 2005; Hollywood, FL.
20. Hawkins RJ, Kennedy JC. Impingement syndrome in athletes. *Am J Sports Med*. 1980;8:151–158.
21. Uhl TL, Kibler WB, Gecewich B, et al. Evaluation of clinical assessment methods for scapular dyskinesis. *Arthroscopy*. 2009;25:1240–1248.
22. Kibler WB, Sciascia A, Dome D. Evaluation of apparent and absolute supraspinatus strength in patients with shoulder injury using the scapular retraction test. *Am J Sports Med*. 2006;340:1643–1647.
23. Jobe FW, Kvitne RS, Giangarra CE. Shoulder pain in the overhand or throwing athlete. The relationship of anterior instability and rotator cuff impingement. *Orthop Rev*. 1989;18:963–975.
24. Castagna A, Nordenson U, Garofalo R, et al. Minor shoulder instability. *Arthroscopy*. 2007;23:211–215.
25. Milosavljevic J, Elvin A, Rahme H. Ultrasonography of the rotator cuff: a comparison with arthroscopy in one-hundred-and-ninety consecutive cases. *Acta Radiol*. 2005;46:858–865.
26. Connor PM, Banks DM, Tyson AB, et al. Magnetic resonance imaging of the asymptomatic shoulder of overhead athletes: a 5-year follow-up study. *Am J Sports Med*. 2003;31:724–727.

27. McMaster WC. Anterior glenoid labrum damage: a painful lesion in swimmers. *Am J Sports Med*. 1986;14:383–387.
28. Brushøj C, Bak K, Johannsen HV, et al. Swimmers' painful shoulder arthroscopic findings and return rate to sports. *Scand J Med Sci Sports*. 2007;17:373–377.
29. Erikson E, Denti M. Diagnostic and operative arthroscopy of the shoulder and elbow joint. *Italian J Sports Traumatol*. 1985;7:165–188.
30. Ratburn JB, McNab I. The microvascular pattern of the rotator cuff. *J Bone Joint Surg (Br)*. 1970;52:540–553.
31. Madsen P, Jensen S, Bak K, et al. Training induces scapular dyskinesis in pain-free competitive swimmers. Poster presented at: International Society of Arthroscopy, Knee Surgery, and Orthopedic Sports Medicine (ISAKOS) congress; April 5–9, 2009; Osaka, Japan.
32. Kibler WB, Sciascia AD, Uhl TL, et al. Electromyographic analysis of specific exercises for scapular control in early phases of shoulder rehabilitation. *Am J Sports Med*. 2008;36:1789–1798.
33. Tibone JE, Jobe FW, Kerlan RK, et al. Shoulder impingement in athletes treated by an anterior acromioplasty. *Clin Orthop Relat Res*. 1985;198:134–140.
34. Albertsson M, Karlsson J, Peterson L, et al. Long-term results after resection of the coracoacromial ligament for shoulder impingement in athletes. *Scand J Med Sci Sports*. 1992;2:84–86.
35. Kim SH, Ha KI, Cho YB, et al. Arthroscopic anterior stabilization of the shoulder: two to six-year follow-up. *J Bone Joint Surg Am*. 2003;85-A: 1511–1518.
36. Rubinstein DL, Jobe FW, et al. Anterior capsulo-labral reconstruction of the shoulder in athletes. *J Shoulder Elbow Surg*. 1992;1:229–237.