Headstand for Rotator Cuff Tear: *Shîrshâsana* or Surgery

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Abstract

Objective: *Pilot study to demonstrate and explain the enabling effects of headstand and chair-supported headstand in the clinical management of patients with rotator cuff tear, also known as rotator cuff syndrome (RCS).*
Design: *Prospective, unblinded single exposure study with repeated-measures design.*
Setting: *Private outpatient medical office.*
Participants: *Ten patients meeting clinical criteria for rotator cuff syndrome (RCS). MRI confirmed severe or total thickness tear of either the supraspinatus or infraspinatus muscles or both.*
Intervention: *Participants were taught a version of* shîrshâsana *(headstand), and remained in the inverted position for 30 seconds. Participants practiced the inversion for 30 seconds once a day for six weeks thereafter.*
Data: *Patients were tested for maximal voluntary abduction and flexion of the neutrally positioned arm, then rated their pain on maximal abduction before and after being taught a version of headstand, and at a six-week follow-up.*
Outcome Measures: *Immediate (post-headstand) and six-week change in function, measured by active range of abduction and flexion of the neutrally positioned arm. Immediate (post-headstand) and six-week change in pain during abduction, measured by a 10-point visual analogue scale (VAS).*
Results: *Mean voluntary abduction and flexion increased from 85 degrees each to 158 degrees and 162 degrees respectively. Mean VAS pain rating during abduction fell from 4.8/10 to 1.2/10.*
Further Investigation: *Electromyographic (EMG) interference pattern changes showed that the subscapularis, anterior and lateral deltoid, and rhomboid major were significantly more active electrophysiologically during headstand, and in abduction and flexion following headstand, than in abduction and flexion performed prior to headstand. MRI confirmed subscapularis activation in post-headstand shoulder abduction.*
Conclusions: *Headstand and a chair-supported version of headstand appear to improve function in the upper extremity after rotator cuff injury. EMG suggests that the subscapularis holds down the head of the humerus while the deltoid abducts the shaft. Using these two muscles together for abduction and flexion, in place of the supraspinatus, appears to be learned through brief exposure to a version of headstand.*

Introduction

The muscles that make up the rotator cuff (the supraspinatus, infraspinatus, teres major, teres minor, and subscapularis) attach to a common tendon, covering the anterior, superior, and posterior aspects of the shoulder joint. Rotator cuff syndrome commonly arises from trauma, heavy lifting, repeated throwing, or other types of forward motion.[1] While tears occur most commonly in the supraspinatus tendon,[2,3] a tear in any of the other muscles involved may be termed a rotator cuff tear.[4,5] This article focuses on supraspinatus tears, though several other injuries were present in some of the patients whose treatment is reviewed and analyzed here.

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Causes of Rotator Cuff Syndrome

Carrying, throwing, or even catching anything weighing more than a few pounds, with elbow straight and the shoulder between 80 and 120 degrees of flexion or abduction, can tear the supraspinatus muscle or its tendon. Poorly or hastily done adho mukha *shvanâsana* (downward facing dog), some versions of *vasisthâsana* (side plank), or more advanced poses such as *tittibhâsana* (dragonfly) and other arm balances can also cause a rotator cuff tear.

Assessing Rotator Cuff Syndrome

Rotator cuff syndrome is clinically identified by significant pain while actively abducting and/or flexing the arm beyond 80 degrees, and sometimes the inability to complete these movements. For both movements, passive range of motion is painless and complete.[6] Rotator cuff syndrome is also clinically identified by significant pain during both active and passive internal rotation of the arm.

If there is numbness, other weakness, strange sensory complaints, or pain that radiates down the arm, especially with changes in position, there may be vascular entrapment or neurological pathology either at the shoulder or the neck. Duplex Doppler exam and EMG will identify these causes. Other orthopedic issues, such as dislocations, sprains, and fractures may also resemble rotator cuff syndrome. Imaging studies, including X-rays, MRI, and ultrasound generally confirm these diagnoses.[7-16]

Standard Care for Rotator Cuff Syndrome

There are two standard treatments for RCS, depending on the severity of the tear and the preferences of the patient. Commonly, a severely torn supraspinatus or infraspinatus muscle is reattached or repaired surgically. The recovery time is generally 18 weeks, with physical therapists providing six weeks of passive range of motion, six weeks in which the patient increasingly participates in moving the arm, and six weeks for building strength. The second treatment is to forego the surgery and participate in physical therapy only. Non-surgical patients are cautioned to immobilize the affected arm as much as possible by using a sling. A third approach is to take non-steroidal anti-inflammatory medication, try to use the arm as little as possible, and hope for the best. This method, if it can be called that, is generally favored by people with mild tears and low levels of pain, particularly very busy people. The medical consensus favors surgery for moderate to severe tears.

Headstand as a Therapy for Rotator Cuff Syndrome

The current study is based on an accidental discovery that headstand, practiced in the method promoted by B.K.S. Iyengar,[17] relieved most of the pain and disability of the first author's own rotator cuff tear (confirmed by MRI to be a severe and complex rotator cuff tear, see Figure 1). This observation occurred when the author practiced headstand during the month-long wait for surgical consultations. Upon righting himself, he found that he could raise his arm painlessly and completely. In the weeks that followed, he had three electrodiagnostic examinations, two while inverted, in an attempt to understand his evident improvement. Subsequently, he described his experience to his next ten patients with MRI-confirmed rotator cuff tears, and invited them to try a suitable inversion under his supervision.

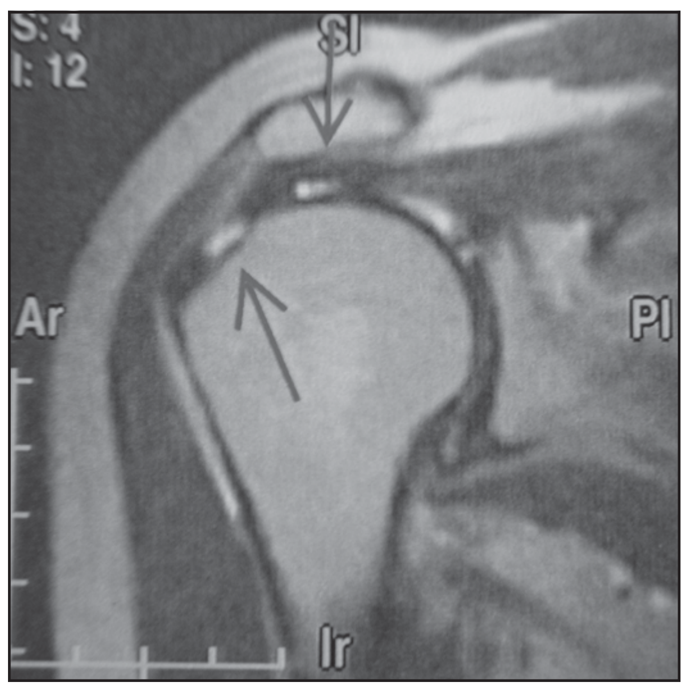


Figure 1. *MRI confirming a complete tear of the supraspinatus, with retraction of the tendon. Distal and proximal fragments indicated by arrows.*

The Present Study

Participants

Ten patients (seven males) with clinical signs of RCS, confirmed by MRI, were invited to participate in learning headstand. Mean patient age was 56 years (range 42-81; SD = 11.91). See Table 1. Five participants had left rotator cuff tears, and five had right rotator cuff tears. Six patients had full thickness tears, three had partial thickness tears, and one had a high-grade tear of the supraspinatus. Two patients had full thickness tears of the infraspinatus (both with partial thickness tears of the supraspinatus), two patients had teres minor atrophy, two had bursitis, and one had a possible superior labral tear. For two participants, the MRI also suggested impingement. Mean symptom duration was 27 months (range 1-120, s.d. = 38). This distribution was similar to the patient groups in other studies worldwide.[2, 4, 7-10, 18-21] Three participants had some previous experience with Yoga. *See Table 1.*

Name	Age	Side	0/S	MRI	Yoga Experience
LF	63	L	1	FTT, TM atrophy	30
IB	53	R	60	FTT, TM atrophy	10
AL	54	L	9	PTT	0
ML	81	R	6	FTT, LHB	0
SW	42	R	1	PTT/FTT, Tendinosis	0
AF	60	R	2	FTT/IST	0
ER	67	R	24	PTT/FTT	0
JB	42	L	120	FTT/A-C DJD	0
KW	51	L	36	FTT	0
CC	50	L	6	HGT	3
Mean	56.3		27		4.3
S.D.	11.9		38		9.569

Table 1. *Participant and injury characteristics.*

Legend:
O/S = Onset of symptoms before treatment, in months
A-C DJD = Acromioclavicular degenerative joint disease
FTT = Full thickness tear
HGT = High grade tear
PTT = Partial thickness tear
TM = Teres major muscle
LHB = Long head of the biceps muscle
Yoga Experience = Months of Yoga experience prior to treatment

Materials and Methods

Full medical histories were collected and physicals were performed for all participants. Each participant's active and passive ranges of motion in abduction, flexion, and adduction were determined with goniometer and by sight. Clinical tests included the supraspinatus muscle strength test, cross-body adduction test, and the drop-arm sign.[11,12] Each participant's pain was rated on the visual analogue scale (VAS), and level of pain and angle when abducting maximally were recorded.[13] The participants were individually informed of the nature of their injuries and introduced to the idea of exercise as a treatment. They were then told the author's response to headstand, and invited to learn headstand and an inverted posture in which their legs were supported on the seat of a chair, also known as *urdhva dandâsana*.[17] *See Figure 2.*

Directions given to the patients were:

1. Stand with your back to a chair.
2. Place your right shin on the seat of the chair.
3. Bend forward, placing your palms on the (carpeted) floor, fairly close to the chair.
4. Raise the left shin to the chair seat, so that you are now kneeling on the chair with your hands on the floor.
5. Bend your elbows as you lower your head to the floor. After your head is securely planted on the floor, center it between your hands. Be careful not to place your weight either on the forehead or the back of your head, but rather at the fontanelles, the spot that is soft in babies.
6. Make an equilateral triangle on the floor with the little finger side of your forearms by clasping your hands. Place the heels of your hands, not the palms, in contact with the back of your head.
7. At this point, with your weight chiefly on your head, widen and raise your shoulders further from the floor.

At times, it was necessary to add an eighth step: "Raise your entire body somewhat by lifting your shoulders," to effectively communicate the proper shoulder motion. The maneuver described in the seventh and eight

Figure 2. *Cycle of* shîrshâsana *(headstand) or* urdhva dandâsana *(assisted headstand). Drawings 6 and 7 are different angles of the same position, illustrating that the torso should be as vertical as possible in this position. In drawing 8, the dotted lines are intended to suggest symmetrical shoulder*

steps is part of B.K.S. Iyengar's method for headstand,[17] but is not universal among other Yoga methods. It seems to be crucial for the benefits reported in this paper. The seven steps outlined here were not put together by Mr. Iyengar, and he is not responsible for its use by the author or others.

It is important that the torso be fairly close to vertical, which translates into its being close to the chair. The emphasis is on safety. The authors demonstrated the method to participants as necessary. Participants with cervical pathology, orthostatic hypotension, glaucoma, berry aneurysms, wet macular degeneration, and other contraindicated conditions should be carefully screened. Rotator cuff injuries are a more frequent cause of shoulder pain in individuals over 60 years of age,[6] a population that is also at greater risk for the above contraindicated conditions. However, the headstand procedure outlined here was not contraindicated for any of the initial ten candidates for the procedure. Although three of the patients were Yoga practitioners, all patients were taught the *urdhva dandâsana* (assisted headstand) version, for which instructions are given above. Both people who were familiar with Yoga graduated to *shîrshâsana* (headstand) within the first six weeks of practice.

Participants remained in the inverted position for thirty seconds, the amount of time that we found both effective and harmless. After that period, they were helped down by returning first one leg and then the other to the floor, kneeling, and raising their heads while unclasping their hands. After thirty seconds on all fours (long enough to avoid lightheadedness, but brief enough to keep the current exercise in mind), they were helped to their feet. The range of motion and pain scale testing were repeated exactly as had been done pre-headstand.

Name	Abd 0	Abd 6	Flex 0	Flex 6	I-Rot 0	I-Rot 6	Pain 0	Pain 6
LF	20	170	35	165	60	60	7	0.5
IB	40	150	45	160	45	45	5	0.5
AL	80	140	70	150	40	45	4	1
ML	75	180	80	180	35	35	7	1
SW	75	170	65	175	40	40	5.5	0.5
AF	70	150	65	150	45	45	7	2
ER	75	120	80	115	40	40	6	4
JB	180	170	175	175	30	30	0	0
KW	65	160	70	175	30	35	4.5	0.5
CC	170	170	170	170	40	40	2	2
Mean	85	158	85.5	162	40.5	41.5	4.8	1.2
S.D.	51.045	18.1	48	19.4	8.644	8.18	2.3	1.18

Table 2. *Changes in participant function and in pain during maximal abduction following headstand procedure and after six weeks of intervention. Abd = abduction; Flex = flexion; I-Rot = internal rotation; numbers (0, 6) relate to week after onset of treatment.*

Patients were asked to repeat the inverted posture procedure, on an empty stomach, for thirty seconds daily for six weeks. In several cases, further instruction on getting into and out of the position was needed and given. Every six weeks, patients were seen again to make sure that they were doing the posture properly and safely. Patients were first asked if any changes had occurred in the past six weeks, then tested for active painless ranges of motion in abduction, flexion, and adduction. They were then asked to repeat the inverted posture, and tested again for the same active painless ranges of motion.

Subsequent follow-up was done by telephone. We attempted to reach patients at two months, four months, six months, and annually thereafter. Not all could be reached at every interval, and the range of final follow-up was 4 months-51 months. At each follow-up point, each person was asked to reflect on the interim between the last follow-up call and the present call, and rate his or her typical experience of pain at rest and in abduction.

Results

Both *shîrshâsana* (headstand) and *urdhva dandâsana* (assisted headstand) improved function and pain after the initial 30-second session in 9 of 10 patients. Mean initial abduction was 85 degrees (s.d. = 51.05), which improved to 158 degrees (s.d. = 18.1) after the initial headstand. *See Figure 3.* Mean flexion rose from 85.5 degrees (s.d. = 48) to 162 degrees (s.d. = 19.4), and internal rotation changed from 40.5 degrees (s.d. = 8.6) to 41.5 degrees (s.d. = 8.18). Seven of 10 patients improved their ranges of motion in abduction and flexion by 75% or more. *See Table 2.*

At the final follow-up for all ten participants (mean of 4.9 months following treatment), mean levels of pain on the VAS had decreased from 4.8/10 (s.d. = 2.3) to 1.2/10 (s.d. = 1.18). Two participants were lost to follow-up after 4 months, but for the eight who continued participation (average final follow-up of 24 months), none went on to surgery.

Discussion

Comparison of Outcomes for Surgery and Headstand

An improvement in abduction and flexion, but not internal rotation, was accompanied by a 75% reduction in pain levels at a 4.9-month follow-up. *See Figure 3.*

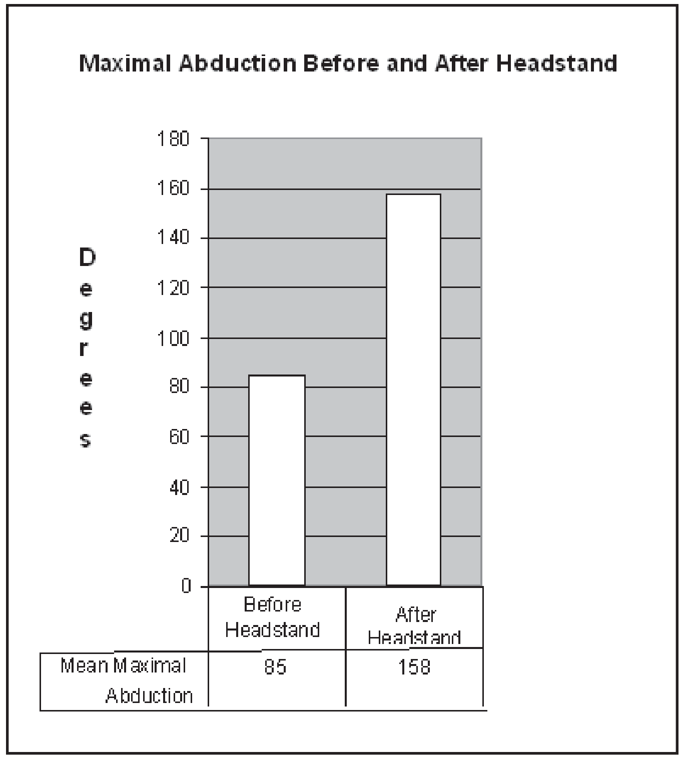


Figure 3. *Within one minute of the first attempt at headstand, mean patient abduction rose from 85 to 158 degrees.*

Comparison with successful surgical remediation[15] of the same condition may be informative. One study of 26 men and 24 women (mean age 58.52 years) with 12-month mean duration of symptoms (range 3-48 months) documented pain reduction on a three-point scale from 2.18 to .98. These cardinal values convert to 7.27/10 and 3.27/10 on a ten-point scale, or a 55% reduction in pain (compared to the 75% reduction in pain seen in the present study). In the study that saw a 55% reduction in pain, range of motion increased in only one quarter of patients at a six-year follow-up (compared to major improvement in 70% of participants in the present study after six weeks).

Outcomes of other recently published studies are in the range of this surgical study, some approaching our own level of improvement.[18-21] One study, in which arthroscopic surgery was performed on the long head of the biceps and not the torn rotator cuff, showed a 34-degree improvement in shoulder flexion.[19] But in spite of high patient satisfaction,[20,21] surgery has its hazards, including re-rupture of the repaired tendon, post-operative weakness, and infection.[19,20, 22,23] Surgery, even arthroscopic repair, is significantly less likely to succeed in patients over 65 years of age, or with boney defects.[6,11,19,22,23] An effective non-operative method would have great clinical value, provided it could be applied safely with predictable consequences.

Understanding the Headstand Intervention

To better understand what might be happening during the headstand intervention that would improve both function and pain, it is useful to examine the normal function of the muscles of the shoulder girdle. In abduction and in flexion, the deltoid raises the arm to approximately 80 degrees, at which point its force is directed nearly horizontally.[24] From this angle, the deltoid, working alone, would only serve to pull the head of the humerus further into its glenohumeral joint, and not further elevate it.[16,24] The action might be compared to pulling horizontally on a slack clothesline. As the pressure grows and the rope tightens, the clothesline will rise to just about horizontal. But no matter how hard you pull, it will never raise higher than a horizontal position. *See Figure 4.*

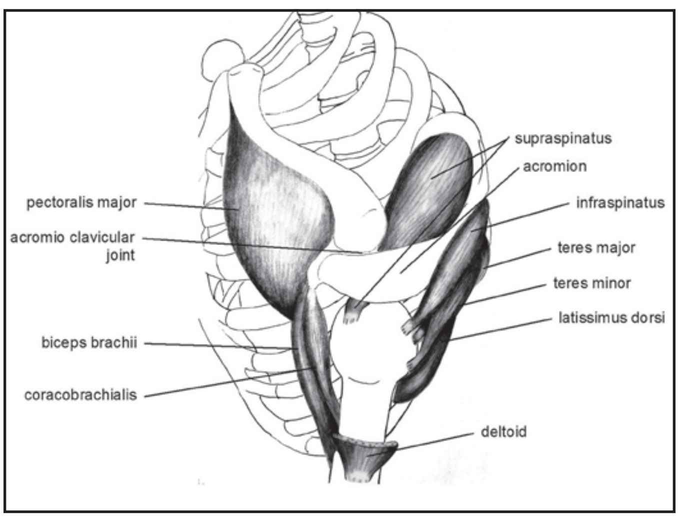


Figure 4. *The supraspinatus inserts at the greater tubercle, setting it at a vast mechanical disadvantage for abducting or externally rotating the long and heavy arm. A tear may be painfully worsened during abduction, flexion, resisted external rotation or forced internal rotation.*

In typical function, the deltoid relaxes somewhat and the supraspinatus generally begins to contract when the humerus is abducted or flexed 80 degrees. The supraspinatus raises the arm the next 30-40 degrees. From that point, the deltoid resumes the job of lifting the arm. *See Figure 5.*

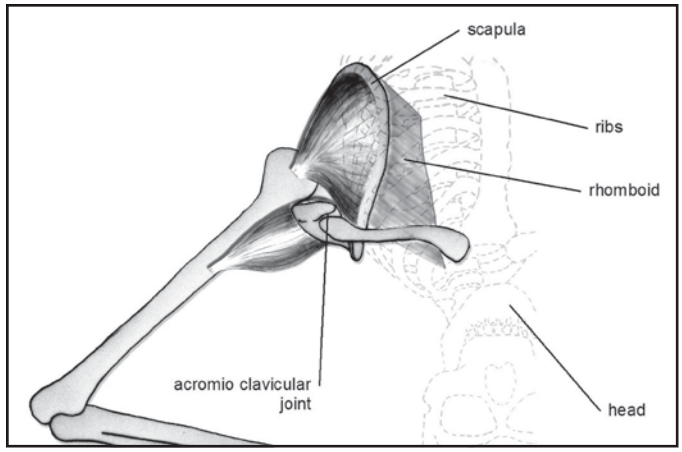


Figure 5. *The subscapularis lifts the humerus, and the rhomboids, serratus anterior, and superior trapezius maintain scapular (and glenoid) stability. As the deltoid contracts, the angle between the humerus and the acromion becomes more acute, tending to press the entire shoulder upward.*

When the supraspinatus is torn in a rotator cuff injury, the deltoid is generally activated beyond its usual 80 degrees, painfully compressing the humeral head into the glenoid fossa, and preventing further abduction.[24] Raising the shoulders away from the floor and keeping them retracted while in an inverted position requires action from the subscapularis in concert with the rhomboids and deltoid. The scapulae themselves are held fast to the spine in the midline by powerful contraction of the rhomboids.

To understand the nature of the change created by headstand, we performed needle EMG of the shoulder girdle muscles three times on one participant during inversion, and immediately following inversion. Extensive EMGs were done on each of the relevant muscles on three separate occasions, and the results of the tests were viewed by two physicians who agreed on scores (from 0 to 4+) for electrical activity in the relevant muscles. The single activity score assigned to each muscle reflects a combination of the number of motor units active and the frequency of their activity in a muscle, and is based on the results of all three studies.

Table 3 shows that on all three occasions, the same muscles (subscapularis, anterior and lateral deltoid, and rhomboid major) were activated in headstand and immediately following headstand, when the participant abducted the affected arm in an upright position.

There was notably greater activity in the deltoid and subscapularis muscles when the inverted participants' shoulders were raised away from the floor. The same pattern was also seen with non-inverted abduction and flexion afterwards. In an inverted person, the deltoid is presumably working

Muscle	Shoulders Down	Shoulders Up
Rhomb. Maj	3+	4+
Ant./Lat. Deltoid	1+	4+
Subscapularis	1+	4+
Serratus Ant.	2+	2+
Pect. Maj./Min.	2+	2+
Sup. Trapezius	1+	1+
Mid/Inf. Trapezius	2+	2+
Rhomb. Minor	1+	1+
Lev. Scapula	1+	1+
Lat. Dorsi	1+	1+
Teres Maj./Min.	1+	1+
Coracobrach.	1+	1+
Paraspinals CTL	0	0

Table 3. *Numbers represent the amount of electrophysiological activity seen 10 seconds after needle insertion into these muscles.*

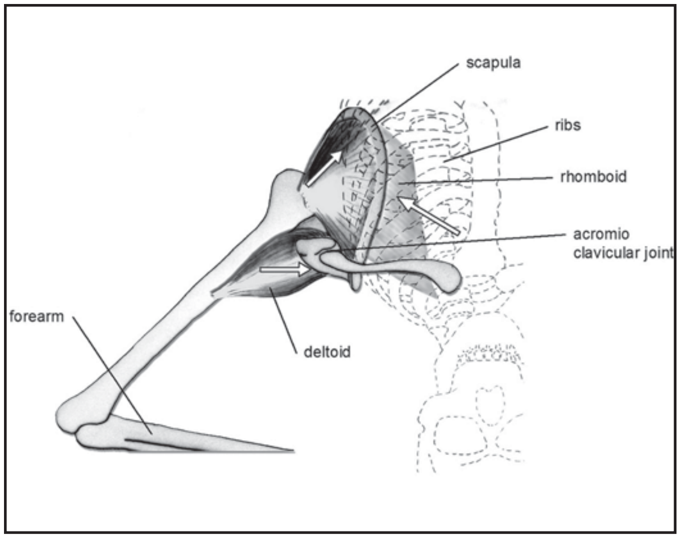


Figure 6. *The subscapularis pulls the head of humerus away from the acromion, and the rhomboids stabilize scapulae as the headstander raises both shoulders from the floor.*

to pull the humerus downward in space: away from the trunk and toward the head of an inverted person. Even in the upright person with a rotator cuff injury, this results in impingement, as the head of the humerus goes further into the glenoid fossa and superiorly against the acromion.[16,24] When standing on the head, gravity becomes an additional force pressing the humeral head against the acromion.

One might expect this to result in even more painful compression of the supraspinatus tendon. But that does not seem to happen. Rather, the EMG studies we performed indicate that when the headstander lifts his or her shoulders away from the floor, the subscapularis contracts, exerting lifting pressure on the head of the humerus, creating enough of an angle to enable the horizontal pull of the deltoid to further abduct the humeral shaft! This appears to allow the head of the humerus to remain far enough away from the glenoid fossa and the acromion to allow the deltoid to raise the humeral shaft painlessly.

The activity of the rhomboid minor muscles seems to reflect their anchoring the scapulae to the vertebral column to stabilize them during subscapularis contraction. *See Figure 6*. It is by this action that one might, for example, lift his or her head off the floor in headstand. The levator scapula muscle does not seem to be involved in this lifting task. Rather, the scapula and the head of the humerus are uniquely linked here. *See Figure 7*.

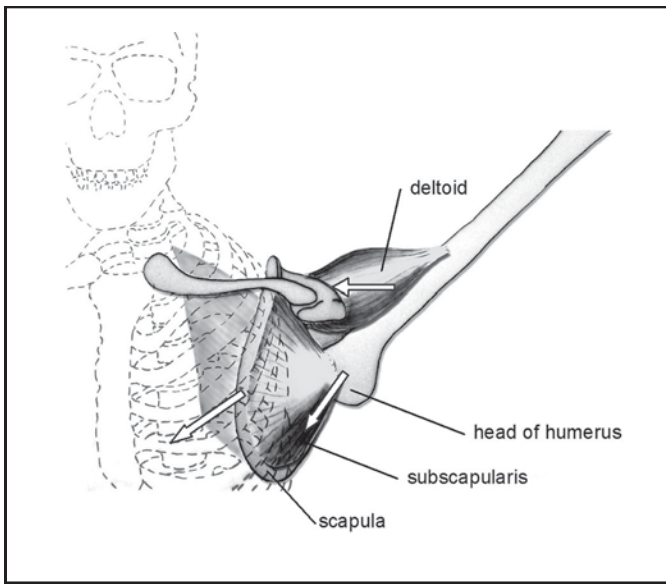
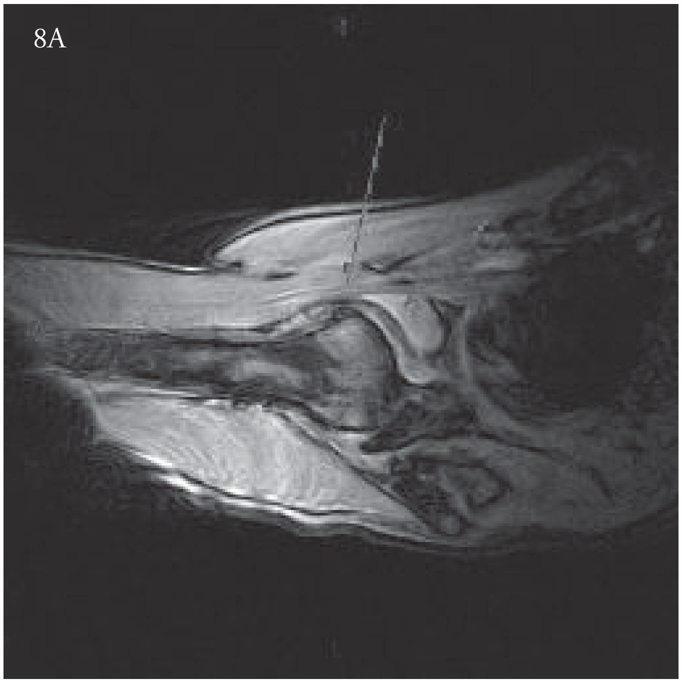
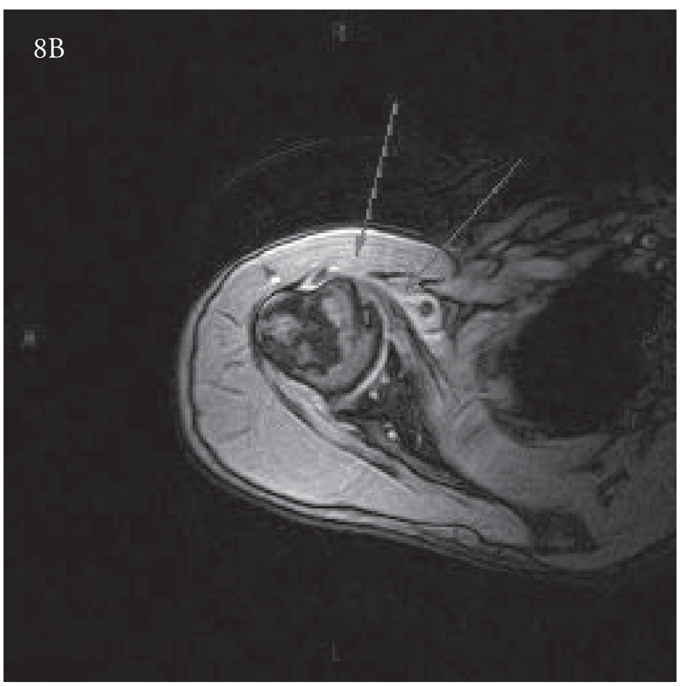


Figure 7. *With one's feet on the ground, depressing the head of the humerus increases the angle of the bone's shaft above horizontal and avoids impingement, permitting deltoid contraction to raise it still further.*

We conducted MRI studies in a horizontal-field 0.6 tesla Fonar scanner to confirm the activity of the subscapularis in painless abduction of the shoulder of a patient with proven full rotator cuff tear. The subject was unable to lift the arm before headstand, and subsequent MRI confirmed that the tear had not healed. *See Figures 8A and 8B*.





Figures 8A,B. *MRI photos of a patient post-headstand intervention. The narrow, sharp-outlined subscapularis is much more active in abduction (A) than when the arm is at rest (B).*

The superior movement of the shoulders originating at the deltoid would actually pull the acromion further into the head of the humerus unless other forces—namely, the greater subscapularis activity seen in the EMG and MRI—prevented this.

Standing on one's head in the way described here seems to be a kind of neuromuscular training. When the patient leaves the inverted pose, returns his or her feet to *terra firma*, and is asked to abduct the injured arm, the newly acquired coordination of the subscapularis and deltoid replaces the painfully impaired deltoid-supraspinatus combination. This appears to happen without any further conscious effort on the patient's part, but when it happens, the patient's face registers a combination of delighted relief and surprise. The best scenario, which could not be confirmed in this pilot study, would be that the headstand method would bypass the supraspinatus in arm abduction and flexion, permitting its tendon to remain relaxed and thus to heal.

Following surgery for RCS, the usual physical therapy is 9 to 18 weeks long: three to six weeks of passive range of motion, three to six weeks of active assistive range of motion, in which the patient and therapist move the shoulder together, and three to six weeks of progressively strengthening active range of motion.[20] This lengthy course is required by the triphasic nature of tendon healing. The newly forming tendon is quite vulnerable at this point, particularly so when considering the mechanical disadvantage of the supraspinatus tendon in lifting weight held in the hand. The six weeks of passive range of motion do not disturb this process, and prevent joint contractures during that period. It is possible that substitution of the rhomboid-subscapularis-deltoid mechanism for the supraspinatus-deltoid means of abducting an affected arm allows for this healing without surgery, and without the disability that comes from 6 to 12 weeks of relative immobility. However, this, along with flexion and abduction strength, must be tested with post-Yoga MRIs or arthrograms, which was not done in this preliminary study.

Limitations

Weaknesses of this study include a relatively short follow-up time for some patients, the small number of patients, absence of a control group, and failure to obtain post-intervention MRIs. Post-intervention MRIs and longer follow-ups could determine whether healing took place in the supraspinatus muscles after their function was supplanted by the subscapularis and rhomboid muscles. If healing does not take place, then cartilage loss in the glenohumeral joint may rival what is seen in delayed surgery of the knee,[25-26] and arthritic changes might render the joint inoperable.[27] This is a potential risk of using headstand as a rehabilitation strategy instead of surgery.

Conclusion

It is beyond the scope of this study to establish what takes place in the central nervous system that enables a new and painless, but not conscious, sequence of muscle contractions to replace another not conscious set of muscle contractions. The supraspinatus–deltoid synergy has probably been active in most people since infancy, yet the rhomboid-subscapularis–deltoid combination is adopted with stunning speed, once the patient has been more or less forced into using it through the inverted posture and the direction "lift your shoulders." This is perhaps similar to the subconscious way in which other aspects of Yoga practice affect more momentous aspects of a practitioner's life.

The described inversion, *shîrshâsana*, appears to reduce pain and improve range of motion, with some data suggesting that the patient almost instinctively uses different muscles to abduct and flex the arm once he or she is exposed to that combination of muscle use in *shîrshâsana*. This pilot study suggests the value in future prospective randomized, controlled, and double-blinded investigations that may verify a non-surgical, low-cost, and virtually painless means of treating some cases of RCS.

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