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Yoga-Based Maneuver Effectively Treats Rotator Cuff Syndrome

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Objective: To measure efficacy of a simple maneuver in the conservative treatment of rotator cuff syndrome. **Design:** Before-and-after study with mean 30-month follow-up (range: 9 months–8 years). **Setting:** Private practice. **Participants:** Fifty consecutive outpatients with magnetic resonance imaging–confirmed partial or full-thickness supraspinatus tears. **Intervention:** A single partial weight-bearing maneuver involving triangular forearm support (TFS) was repeated in physical therapy for a mean 5 sessions (range: 1 session–24 sessions). **Main Outcome Measures:** Maximal painless active abduction and flexion before and after performing TFS, pain on maximal abduction and flexion before and after performing TFS, and at mean 2.5-year follow-up. **Results:** Mean painless active abduction increased from 73.7° to 162.8° ($P < .001$; SD = 32.3); mean painless active flexion increased from 84.1° to 165.4° ($P < .001$; SD = 36.7). In 2.5 years follow-up mean combined painless abduction and flexion active range of motion was 171.5 ($P < .001$; SD = 14.4). In immediate post-TFS testing and after 2.5 years mean visual analogue scale pain rating during maximal abduction and flexion fell from 5.46 to 0.97 ($P < .001$; SD = 2.6). **Conclusions:** These values compare favorably with most surgical and nonsurgical studies. Triangular forearm support plus physical therapy appear to improve abduction and flexion and reduce pain immediately and in the longer term after rotator cuff syndrome. **Key words:** conservative treatment, rotator cuff syndrome, triangular forearm support

Surgery is often recommended for rotator cuff syndrome (RCS), but enthusiasm drops off abruptly with massive tears, and in the elderly people. Cochrane studies find little evidence that either conservative or surgical remediation is entirely successful[1,2] though each method reports gains.[3-13] Because RCS is most common in the elderly people, and massive tears are frequently inoperable, an effective nonsurgical method is welcome. This study focused on patients with supraspinatus tears, though other injuries were sometimes present.

There is surprisingly little correlation between postsurgical tendon integrity and clinical improvement.[6,7,10,13-23] Physical therapy (PT) generally focuses on scapular stability, kinesiological, and modality-oriented means of healing. In this article, we condense these conservative strategies into a single exercise that was discovered serendipitously and is effective in 30 seconds. After magnetic resonance imaging (MRI) confirmation of a massive tear, one author briefly practiced headstand during the month-long wait for surgical consultation (see Figure 1). Upon righting himself, he experienced painless full abduction and flexion in the arm that previously had less than 60° of either motion.

Subsequent electrodiagnostic examinations found the subscapularis, rhomboides, serratus anterior, and pectoralis muscles significantly more active during headstand and in abduction and flexion immediately thereafter. A safer and simpler version of headstand, triangular forearm support (TFS), named the "Tova maneuver" after its physical therapist inventor, did the same thing (see Figures 2 and 3).

The maneuver is adapted from B. K. S. Iyengar's[24] method for headstand[25] but is not universal in Yoga. Subscapularis activity seems crucial for the benefits reported here. The steps in Tables 1 and 2 were not put together by Mr Iyengar; he is not responsible for their use. See his book for headstand itself.[24]

Inversion-positioning and muscular activation are well-established aspects of standard PT, and there was no human experimentation. Sound Shore Medical Center's institutional review board approved the larger study of which this is a part.

MATERIALS AND METHODS

Patient selection

Inclusion criteria:

1. Sudden reduction in painless range of abduction or flexion.
2. MRI-confirmed tear of the supraspinatus, with or without tear of the infraspinatus or teres minor.

Exclusion criteria:

1. Tear of the subscapularis.

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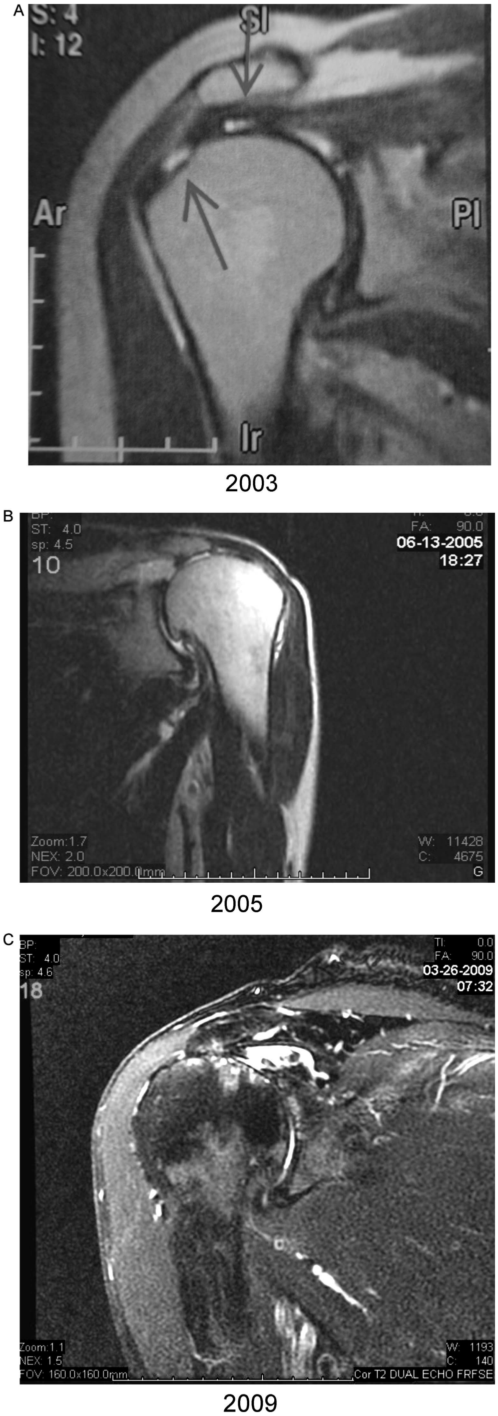


Figure 1. Magnetic resonance imaging confirming a complete through-and-through tear of the supraspinatus, with retraction of the tendon. Distal and proximal fragments indicated by arrows (A). Same patient unhealed 3 years after using triangular forearm support, but with continued full active abduction and flexion without pain (B). Progressive elevation of humeral head seen after 9 years, still with painless full active abduction and flexion (C).

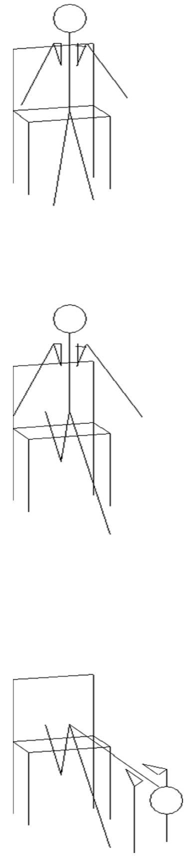


Figure 2. Cycle of chair-assisted headstand (*Urdhva Dandasana*), following the directions in the text. The emphasis is on safety. The torso must be fairly close to vertical, which translates into its being close to the chair. Patients with cervical pathology, orthostatic hypotension, glaucoma, berry aneurisms, and other conditions contraindicating inversion should use the Tova maneuver. See Figure 3.

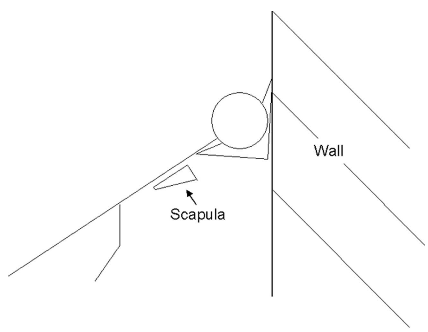


Figure 3. Hands are clasped behind head. The same concerted action of triangular forearm support may be recruited through resisting the horizontal vector generated by this slanted position.

TABLE 1	Verbal Directions for Inverted Triangular Forearm Support, Chair-Assisted
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 (blanketed or 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, press down with your forearms to lift your shoulders away from your ears. Widen and raise your shoulders further from the floor.	
8. Stay in this position for 30 seconds.	
9. Now bring first one knee, then the other to the floor, using your hands and arms for support as necessary.	
10. After 5 to 10 seconds, quit the position and stand up normally.	
11. Boldly raise your arms up to vertical. Do not stop at 90° and wait for it to hurt. Continue the motion as far as possible.	
12. Do the same with flexion.	

2. Paraesthesias, numbness, or pain radiating below the mid humerus.
3. Neuromuscular disease such as stroke, multiple sclerosis, or myopathy.
4. Previous shoulder injury or shoulder surgery.
5. Cervical pathology or other conditions contraindicating axial pressure.

Clinical management

Full medical histories and physical examinations included goniometric determination of painless active ranges of abduction and flexion.[26-28] Participants self-rated pain on the visual analogue scale (VAS) during maximal abduction and flexion.[28] Participants were introduced to the idea of exercise as treatment, and performed TFS during their first visit (see Figures 2 and 3).

Triangular forearm support

The authors and physical therapists demonstrated one or both forms of TFS to participants as necessary (see Figures 2, 3 and Tables 1, 2). Participants remained in the inverted or slanted position for 30 seconds, a period that was found both harmless and effective. After 30 seconds, the inverted patients returned one leg and then the other to the floor, and kneeling, raised their heads while unclasping their hands. After 5 to 10 seconds on all fours (long enough to avoid light-headedness, brief enough to keep the current exercise in mind), they were helped to their feet. Tova-maneuver patients had only a few seconds' delay between their exercise and their post-TFS abduction and flexion. Painless ranges of motion and pain at maximal ranges were then rerated. One post-TFS instruction was given to all patients for both abduction and flexion:

TABLE 2	Verbal Directions for Diagonal Triangular Forearm Support Against a Wall
1. Interlock your fingers, making an equilateral triangle with your forearms as you place them against a wall.	
2. Place the fontanelles in the center of that triangle.	
3. Walk away from the wall, so that your torso now slants toward the wall. Some weight is now on your head.	
4. Lower your chest and press your elbows and forearms into the wall, using the pressure to pull your shoulders far away from the wall.	
5. Draw your shoulder blades back, down and apart, still pressing against the wall with your elbows and forearms. Press your shoulders, but not your head, away from the wall.	
6. Stay like this for 30 seconds.	
7. Now come away from the wall and stand up straight.	
8. Boldly lift your arms up to vertical. Do not stop at 90° and wait for it to hurt.	
9. Do the same with flexion.	

TABLE 3 Demographics of Subjects

Demographics	Subjects (n)	Age[a]	Women	Right-Sided Tear	Dominant Sided Tear	Full-Thickness Tears	Other Pathology[b]	Months After Onset[c]	Previous Yoga
All patients	49	62.9	33	26	31	37	25	24.5	18
SD		14.29						50.56	
Range		32-97						1-268	

[a]When first seen.
[b]For example, Infraspinatus tear, other tendinoses, labral tear.
[c]Months after onset when first seen.

"Boldly lift your arms up to vertical. Do not stop at 90° and wait for it to hurt." Twenty-three patients were taught the chair-assisted headstand (*Urdhva Dandâsana*) version; 27 were taught the Tova maneuver.

Follow-up

Patients were prescribed 2 to 3 weekly PT sessions for 6 weeks, receiving standard PT for RCS as outlined on page 6, and daily TFS practice. Painless range of motion and pain at maximal ranges were examined weekly in PT and at medical visits at 6 weeks, 3 months, 1 year, and annually thereafter. Phone calls were used when necessary.

Statistical analysis

The statistical consultant used the Wilcoxon rank sum and signed-rank tests to compare initial ranges of abduction and flexion and VAS pre- and post-TFS and at final follow-up. These nonparametric tests were used to assess results in the advent of a nonnormal distribution of the data. Paired *t* tests and 2-sample *t* tests analyzed pre-TFS versus final ranges of motion.

Source of funding

There was no external source of funding for this study.

RESULTS

Patient data

Fifty patients qualified for the study. One patient elected to have surgery, leaving 49 patients. The group included 16 men (32.7%), 37 full-thickness tears (FTT) (75.5%), involving 26 (53.1%) dominant extremities. Mean initial age was 62.9 years (range: 32–97) (see Table 3).

There were 11 additional tears to other muscles of the rotator cuff; 7 patients had tendinosis, 3 had teres minor atrophy, 3 had labral tears, 2 had bursitis. For 4 patients, MRI suggested impingement.[29] Mean prior symptom duration was 24.9 months. These statistics are similar to other studies worldwide.[3-13,15–23,29-42] Eighteen participants (36.7%) had some previous experience with Yoga.

Mean painless and maximal abduction and flexion improved significantly immediately after the initial 30-second TFS (see Table 4).

1. Mean painless abduction, initially at 73.0° improved to 162° immediately after TFS ($P < .001$; SD = 32.7) (see Figure 4).

TABLE 4 Results

Rotator Cuff Study—Efficacy Measures

Total ROM	Active: Mean + SD	*t*	*P*[a]
Mean ROM When first seen	78.5 + 25.8 (n = 46)	0.30	.77
Best mean ROM in follow-up	171.5 + 14.4 (n = 48)	1.91	.09
Difference in ROM	94.0 + 27.4 (n = 46)	2.47	.02
P value[b] (before vs after)	<.001		
Abduction			
Abduction before	73.6 + 24.4 (n = 48)	0.30	.77
Abduction after	162.8 + 24.7 (n = 48)	1.58	.12
Abduction difference	89.3 + 32.3 (n = 47)	0.35	.73
P value[b] (before vs after)	<.001		
Flexion			
Flexion before	84.1 + 33.3 (n = 43)	0.06	.95
Flexion after	165.4 + 19.4 (n = 44)	0.80	.43
Flexion difference	81.7 + 36.7 (n = 42)	0.28	.79
P value[b] (before vs after)	<.001		
Pain with maximal abduction, flexion			
Pain before	5.5 + 2.4 (n = 43)		.005[c]
Pain difference	4.3 + 2.6 (n = 42)		.36 [c]
P value (before vs after)	<.001[d]		

Abbreviation: ROM, range of motion.
[a]*P value by 2-sample t test.*
[b]*P value by paired t test.*
[c]*P value by Wilcoxon rank sum test.*
[d]*P value by Wilcoxon signed rank test.*

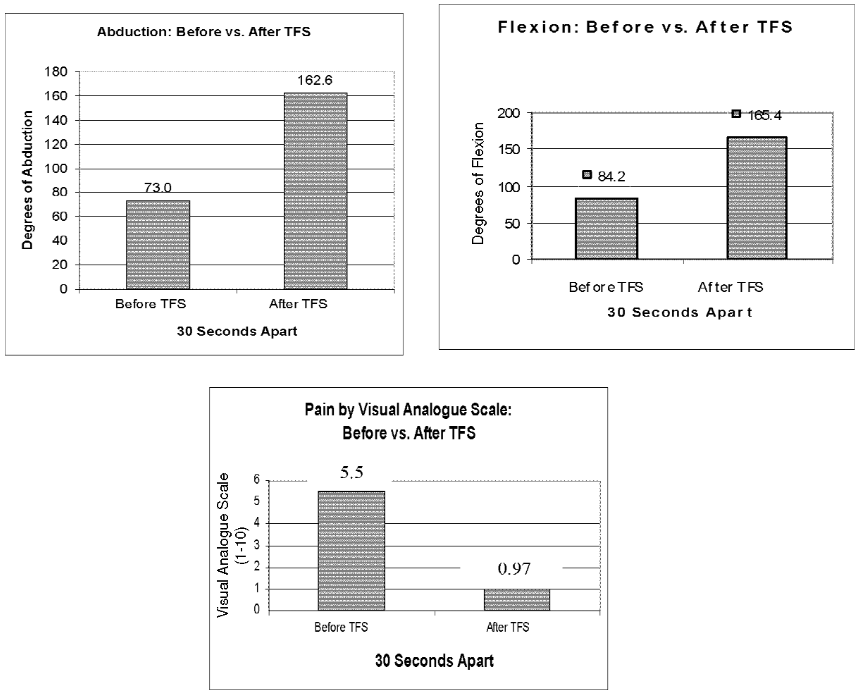


Figure 4. Active painless abduction and flexion ranges of motion before and after 30 seconds triangular forearm support (TFS), and visual analogue scale at maximal abduction and flexion before and after 30 seconds TFS.

2. Mean painless flexion rose from initial 84.2° to 165.4° immediately after TFS ($P < .001$; SD = 37.2) (see Figure 4).
3. Mean pain on maximal abduction and maximal flexion post-TFS (taking the higher score) dropped from 5.46 to 0.97 or 4.49 points on the VAS (81%), immediately after TFS ($P < .001$; SD = 2.6) (see Figure 4).
4. Painless range of motion improved 100% or more in 37 of 49 patients (75.5%) directly following TFS. Mean improvement was 150% (SD = 1.3; median improvement = 120%) (see Figure 5).
5. Gains were sustained in mean 2.5 year follow-up (see Figure 4).
6. Three patients did not improve.

DISCUSSION

In an immediately beneficial intervention such as this, the patients themselves supply the baseline and, in this sense, are their own controls. Other conservative and surgical

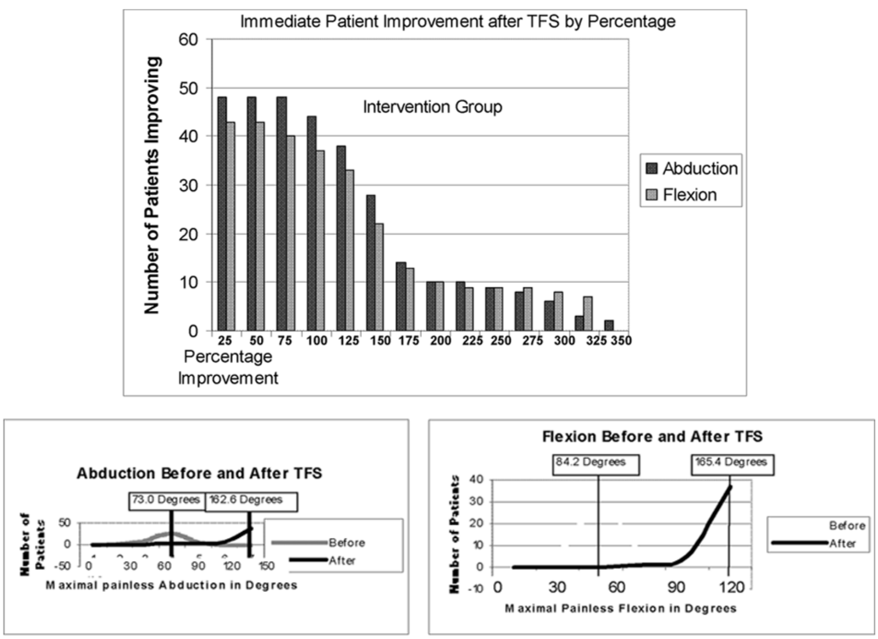


Figure 5. Percentage and distribution of improvement in abduction and flexion after 30 seconds triangular forearm support.

TABLE 5 Conservative Studies of Zingg and Baydar Measured Passive Ranges of Motion[a]

Study When Measured	Patients (n)	Abduction Before	Abduction After	% Change	Flexion Before	Flexion After	% Change	f/u Years	Tear Size	Pain Before	Pain After	Glenohumeral Distance	Fatty Change	Joint Degeneration
Zingg (passive ROM)[b]	19	118	139[c]	17.8	115	139[d]	20.9	4	Increased	NA	2.3	Decreased	Increased	Increased
Zingg (active ROM)[b]	19		No Change	0		No Change	0	4	Increased	NA	2.3	Decreased	Increased	Increased
Baydar (passive ROM)	Unknown	131.7	162	23	144.6	165.4	14.4	0.5	NA	NA	NA	NA	NA	NA
Current study (active ROM)	49	73	162.6[e]	123	84.2	165.4[e]	96.4	2.5	Unchanged	5.46	.97[e]	Increased[f]	Increased[f]	Increased[f]

Abbreviation: ROM, range of motion.

[a]Zingg et al[30] studied massive tears, found no change in active ranges of motion over 4 years.

[b]Six cases of flexion less than 90°.

[c]P = .07

[d]P = .047

[e]P < .001

[f]One patient studied serially more than 7 years.

investigations were reviewed to estimate the comparative efficacy of TFS over the longer term.

Conservative therapies

One recent conservative approach to FTT improved mean abduction and flexion by 23.7% and 14.4%, respectively, after 6 months of therapy.[14] Tears were less extensive than those of the current study, but end-stage improvement of 131.4 and 144.6 were less than our study's 162.5° and 165.4°, respectively[41] (see Table 5 and Figure 6).

Zingg et al[30] studied nonoperative care of massive RCS in 40 patients for 4 years. Mean age was 64 (54-79). Mean flexion improved from 115° to 139° (20.9%); mean abduction rose from 118° to 140° (18.6%). Converting from that study's 15-point VAS to the 10-point VAS, pain after 4 years averaged 3.5. No pretreatment values were given. Final VAS score in our 49 patients was 0.97 Mean glenohumeral separation decreased 2.6 mm in the study of Zingg et al; tear size and fatty infiltration increased significantly. The number of irreparable tears doubled from 4 to 8 in 4 years.

In 30 months' mean follow-up, our patients, including 3 with massive tears, had no new tears. Seven of 10 follow-up MRIs 0.3 to 6 years after treatment revealed accelerated degeneration of the humeral head, in our patients, but all maintained their original increases in degrees of painless abduction and flexion. Over the mean 30 months study period, VAS remained stable at 0.97 (see Table 5 and Figure 6).

Surgery

Open surgical and arthroscopic studies present inclusion criteria, measurement scales and time frames that are rarely comparable. One Swiss study[40] of 26 men and 24 women (mean: 58.5 years) with mean 12-month prior symptoms (range: 3-48 months) documented pain reduction that converts to 7.27 and 3.27 on the 10-point VAS, or 55% reduction in pain; our study saw 81% pain reduction (see Figure 7). This postsurgical study increased range of motion in 25% of patients at 6-year follow-up. The present study doubled mean painless active abduction and flexion in 82% and 75.5% of patients, respectively, immediately and after 2.5 years (see Figure 5). However, longer follow-up brings improvement in some studies and deterioration in others, discouraging strict comparison.

Other recent surgical studies[3,11] increased flexion 16% in 22 FTT, and 51% in 20 partial thickness tears, averaging 33.5% improvement to mean maximum in the high 150° range in 2-year follow-up.

Cole et al[7] studied arthroscopic repair of 49 rotator cuff tears with 2-year follow-up. Patient age averaged 57 years (range: 34-80 years), mean presurgical abduction and flexion was 121° and 136°, respectively. The 6 months' and 1 year's gains were below ours, but at 2-year follow-up, the mean abduction and flexion were 2.2° and 6.6° above our results (see Table 6).

TABLE 6	Improvement in 49 Rotator Cuff Tears After Arthroscopy						
	Ranges of Motion						
	Preoperative	6 mo	*P*	1 y	*P*	2 y	*P*
Flexion	136	159	0.15	162	.014	172	<.0001
Abduction	121	142	0.09	153	.006	165	<.001

Cole's rehabilitation was well-managed and extensive. Postoperative slings accompanied Codman exercises for the first 4 weeks. Passive range of motion to tolerance in flexion with internal rotation limited to 40° was done with elbow anterior to the midaxillary line, and active assisted range of motion at 4 weeks. Deltoid and biceps strengthening began after 6 weeks. Weeks 9 to 12 stressed scapular stabilization exercises and posterior capsule stretching. With the exception of Cole's patients abating sporting activities for 4 to 6 months, this therapy was similar to our own. However, our patients had no "down time" whatever, and most were able to pursue all normal activities 30 seconds after treatment onset.

Two other 2-year arthroscopic studies improved flexion and abduction from 135° to 149°[13] and from 142° to 174°,[10] respectively. The first study examined repair of FTT in patients of average age 60.7 years. The second study's patients averaged 58.3 years of age, with mean tear size of 2.47 cm, and had similar but more abbreviated postoperative rehabilitation (see Figure 8).

Many other published studies are in the low to middle range of these surgical studies.[8,10,13,15,21] Though high patient satisfaction is frequently reported,[8,10,11,15,29,33] also reported are rerupture of the repaired tendon, postoperative weakness, bone graft death, and infection.[7, 22, 33,35-38,42-44]

Puzzling consistent anomaly

Retear rates after surgery were generally in the 12% to 32% range but some papers describe them as "very high."[7,10,12,22,33,39,40,42-44] Curiously, satisfaction rates and actual ranges of motion do not correlate with these postoperative events. Many studies find no increased elevation of the humeral head, nor deficits in ranges of motion with retear,[7,10,17-20,39] except for large recurrent tears. One 32-patient, mean 31-month follow-up of bone graft surgeries for massive tears reported MRI-confirmed graft death in all 15 cases.[5] Nevertheless, patient satisfaction was high, and range of motion improved with mean 30° to 35°![5]

Again, arthroscopic and open surgery is significantly less likely to succeed in patients older than 65 years, or with boney defects.[3,5,7,10,14,15,20,22,34,] Yet, despite these histological failures, most patients with FTT or partial thickness tears seem to improve.[33,17-23,42] One study[42] with a high retear rate after massive tears had mystifyingly positive patient satisfaction. Many found little correlation between tendon integrity and patient satisfaction.[20,22,23,33,44]

Furthermore, this first study showed *less* improvement and *higher* percentages of retears when a *shorter* time period elapsed between tear onset and surgery.[45] Given increased fatty infiltration and tissue deterioration over time, one would expect just the reverse, unless more than physical structure is involved.[46] Something beside tissue health may be relevant here, something deeper beneath the surface even than the surgery.

It seems that RCS patients, with or without surgery, often inadvertently self-train to use a different set of muscles for abduction and flexion, sparing themselves the pain and disability that arises with contracting the torn supraspinatus muscle. Triangular forearm support may give that training to patients almost unknowingly in a very short period of time. Our electrodiagnostic studies seem to confirm this.

How does TFS work?

One TFS patient had previous RCS surgery on the contralateral shoulder. We performed 8-channel electromyography on both sides' shoulder girdle muscles during abduction. We also compared electromyography of the supraspinatus and subscapularis of 3 RCS patients' abduction before, during and after TFS. The results were viewed by 2 blinded physicians who scored electrical activity from 0 to 4+.

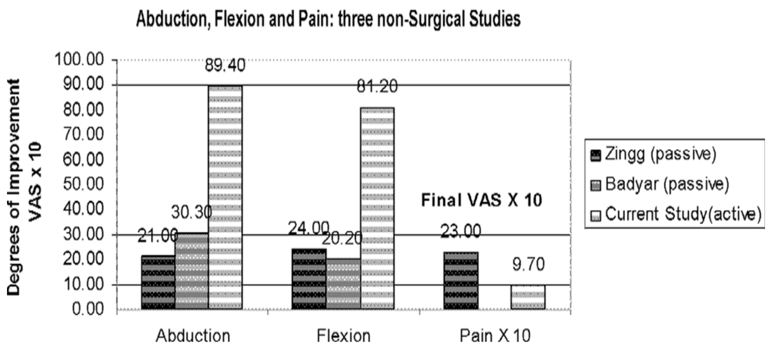
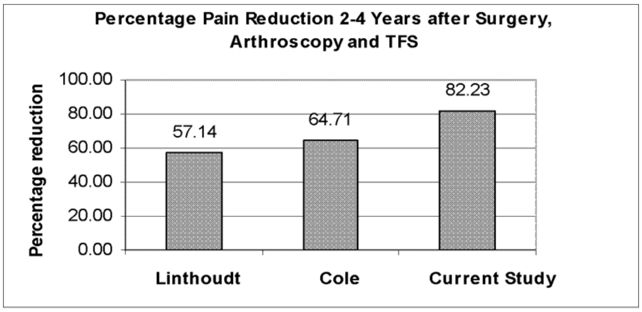


Figure 6. Comparison of current study with other conservative studies. Visual analogue scale multiplied ×10 for all studies to fit scale of graph.



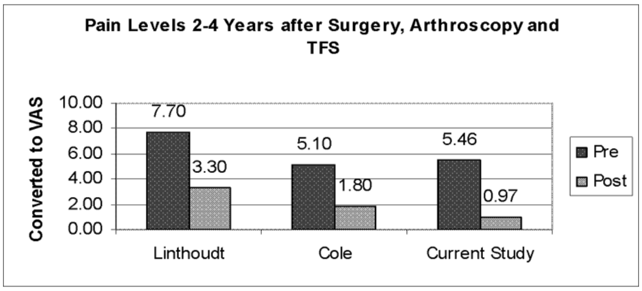


Figure 7. Comparison between surgical study (Linthoudt), arthroscopic study (Cole), and current study is only approximate due to different metrics and different scales.

On all occasions, the same muscles, the subscapularis, and to a lesser extent, the anterior and lateral deltoid, rhomboid major, serratus anterior, and pectoralis were additionally activated during TFS, and when the subject abducted the affected arm in an upright position immediately following TFS (see Table 7 and Figure 9).

During normal shoulder girdle abduction and flexion, the deltoid raises the arm to approximately 80°, at which point its force is directed nearly horizontally.[45-52] In typical function, the deltoid relaxes somewhat as humeral abduction or flexion approaches the 80° mark, when the supraspinatus begins raising the arm the next 20° to 40°. At that elevation, a sufficient angle above the horizontal is formed between the acromion and the humerus, creating a vertical vector in the deltoid's pull that is sufficient to resume lifting the arm[47-50] (see Figure 9).

When the supraspinatus is torn, the deltoid activity near 90° of abduction or flexion painfully compresses the head of the humerus into the glenoid fossa.[47,49-51] The action might be compared to pulling horizontally on a slack clothesline. As the rope tightens, the clothesline will rise nearly to 90°. Further pressure will tighten the line, but it will never rise beyond the horizontal.

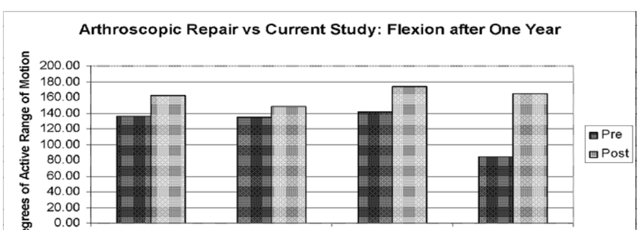


Figure 8. Active flexion after arthroscopy and triangular forearm support.

Several researchers have found major contributions of the subscapularis, infraspinatus, and teres minor during arm elevation.[48-51] Triangular forearm support, moving the shoulders caudad and retracting them, activates these muscles. How does that help abduction?

The subscapularis appears actually to lower the humeral head. The scapula itself is held fast to the spine by powerful contraction of the rhomboids and serratus anterior,[45-48,50,51] as the humerus approaches 80°. At that point the subscapularis, exerts downward force on the *head* of the humerus in the glenoid fossa, pulling it caudad, away from the acromion. Lowering the *head* tilts the *shaft* upward enough, creating a more acute angle with the acromion, enabling the deltoid to continue the abduction or flexion toward vertical. The teres minor balances the subscapularis's external rotation (see Figure 9).

Several studies report up to 85% greater subscapularis activity in abduction in RCS.[45,47,50,51] Opposing gravity with the inverted or slanting body's weight presents the subscapularis with a more challenging foil against which it may contract even more vigorously (see Figures 9A, 9B).

Triangular forearm support appears to reverse the roles of key muscles. Between 80° and 110° the deltoid stabilizes the humerus, rather than lifting it, while the subscapularis

TABLE 7 Numbers Represent Electrophysiological Activity in These Muscles During Abduction and Flexion Before and Immediately After Triangular Forearm Support[a]

Muscle Activity of Rotator Cuff Syndrome Patients During Abduction Before and Following TFS

Muscle	Abduction Before TFS	Abduction After TFS
Rhomboid major	3+	4+
Deltoid	4+	4+
Subscapularis	1+	4+
Rhomboid minor	1+	3+
Teres minor	1+	2+
Pectoralis major/ minor	1+	2+
Serratus anterior	1+	2+
Latissimus dorsi	0	0

Abbreviation: TFS, triangular forearm support.

[a]Numbers represent the amount of electrophysiological activity 10 seconds after needle insertion, at 90° abduction.

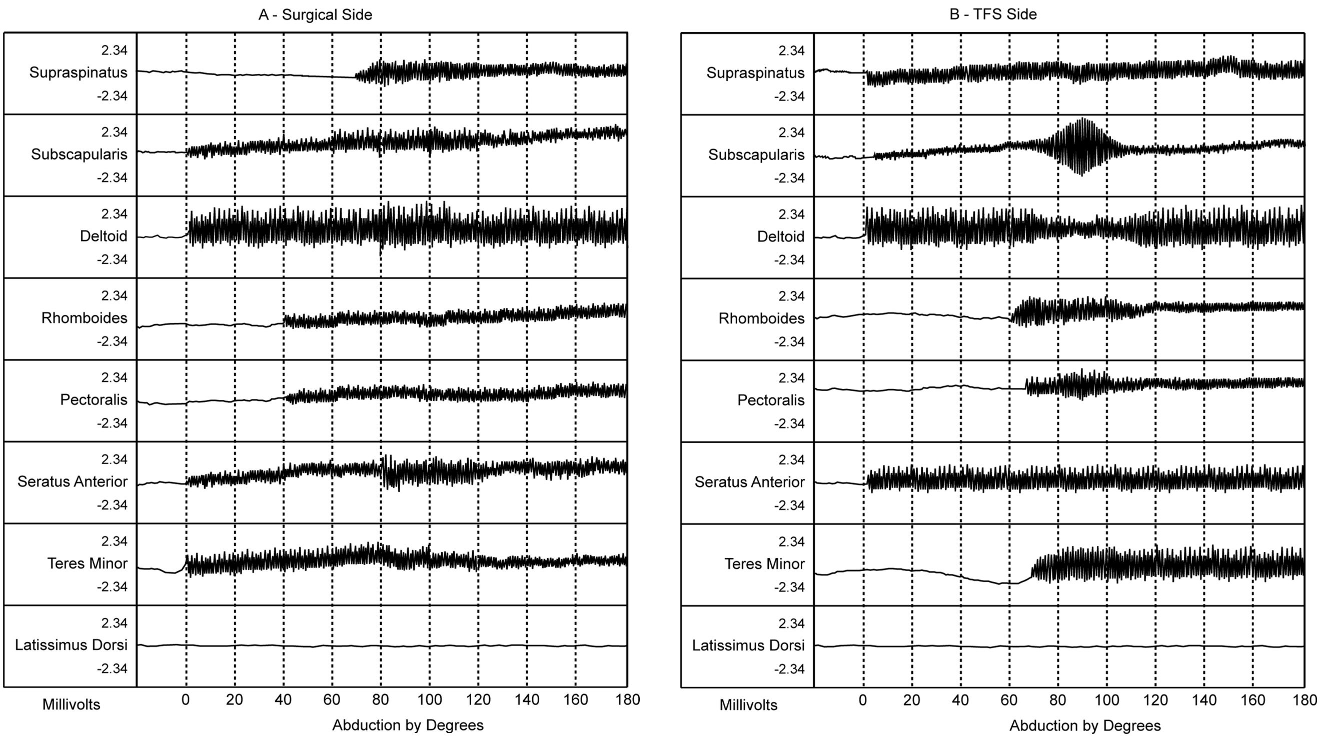


Figure 9. Composite of 10 trials: Note difference in subscapularis and deltoid activity from 70° to 110° in abduction after surgery (A) versus triangular forearm support (TFS) (B). C, The rhomboids stabilize the scapula as the subscapularis pulls the head of humerus away from the acromion in post-TFS abduction. The usual roles of some shoulder muscles reverse: the deltoid holds the humerus as a fulcrum while the subscapularis lowers the head, pivoting the humerus around the still point at the deltoid's insertion which, like a see-saw, lifts the arm until a sufficient angle forms to enable the deltoid to continue the abduction.

and other muscles elevate the humeral shaft by depressing the humeral head in a kind of see-saw motion. Caudad tension on the head of the humerus, learned in TFS, uses the deltoid as a dynamic fulcrum that briefly steadies the proximal humeral shaft, while the downward pull of the subscapularis lowers the humeral head enough to cantilever its shaft upward. Then, the deltoid resumes abduction and/or flexion. The suscapularis and other muscles continue to exert some caudad pressure on the humeral head, avoiding contact with the glenoid or acromion.

One successfully remediated patient remained in TFS for the duration of a horizontal field 0.6 T Fonar MRI. Subsequent computed tomography multidetector (64 detector) isotropic voxels in double angled multiplanar formatting with low table pitch (0.6 mm) confirmed the location and form of the subscapularis during the maneuver. It was read as extremely active.

Limitations and suggestions

Triangular forearm support

The best scenario would be if TFS rendered the supraspinatus completely inactive during abduction and flexion, enabling its tendon to heal. However, the tendons of the 10 patients having subsequent MRIs were not healed. Some showed substantial progressive arthritis. One patient with massive tear had MRI and computed tomography 6 years after TFS showing a high-riding humeral head with significant arthritis, but with visible lowering of the humeral head with (painless full) abduction (see Figures 1C and 10).

The idea that nonhealing is due to continued supraspinatus activation is supported in the literature.[45-51] If true, paralyzing the supraspinatus muscle while the subscapularis mechanism is at work may be clinically useful. We recently began administering botulinum neurotoxin to the supraspinatus after teaching TFS in the second phase of the institutional review board–approved study. Because the supraspinatus is not, apparently, useful in post-TFS abduction and flexion, nor in the puzzling studies reviewed earlier, temporary paralysis inhibits no function. As the paralytic effect of botulinum neurotoxin wears off after 8 to 12 weeks, a second MRI will confirm or disappoint the hope of healing.

This study

Study weaknesses include a relatively short follow-up time, small patient numbers, consecutive sample without randomized matched controls, few postintervention measures, and

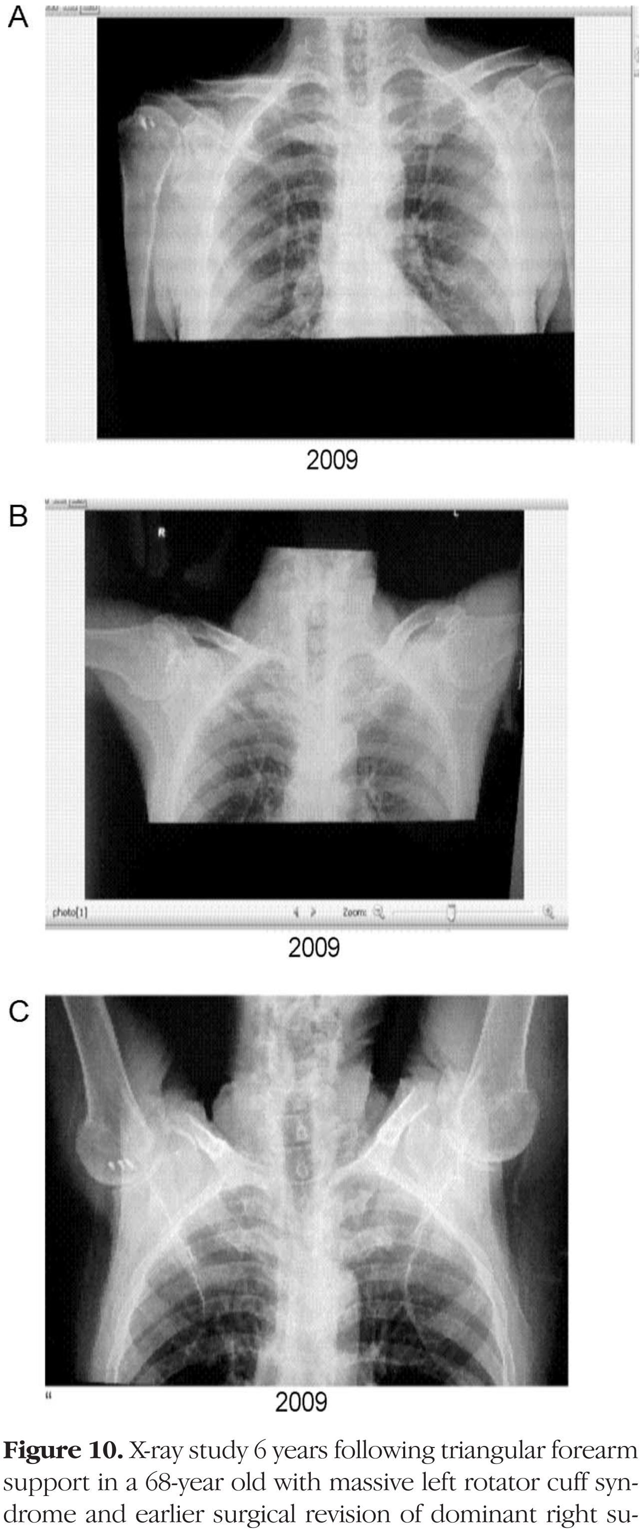


Figure 10. X-ray study 6 years following triangular forearm support in a 68-year old with massive left rotator cuff syndrome and earlier surgical revision of dominant right supraspinatus tear. High riding left humeral head and glenoacromial pseudoarthrosis (A) nevertheless allows painless full range of abduction through downward pull on humeral head with abduction. B, C, The deltoid raises the arm on the left to 90°, but the horizontal vector of the deltoid will not raise the arm on the right beyond 90° without help.

few postintervention MRIs. These flaws obscure undesirable consequences of TFS over the longer term. If healing does not take place, then glenohumeral joint degeneration may rival what is seen in delayed surgery of the knee,[52] possibly rendering the joint inoperable,[13,17,30,53] as Zingg et al found.[30] This is a potential risk of TFS but would be at least several years in the making.

CONCLUSION

The TFS appears to reduce the pain and disability of RCS quickly and permanently for some patients. This study suggests future prospective randomized, controlled, and double-blinded investigations that may verify a nonsurgical, low-cost, painless, and virtually immediate means of treating some cases of RCS.

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