Citations Classics Shoulder & Elbow

Rotator Cuff Tears

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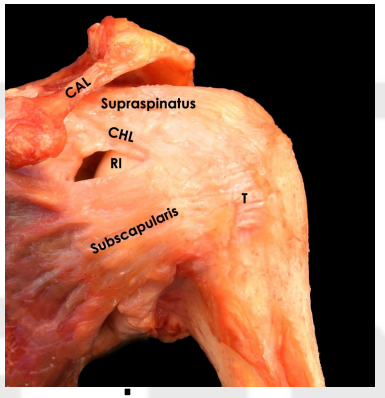
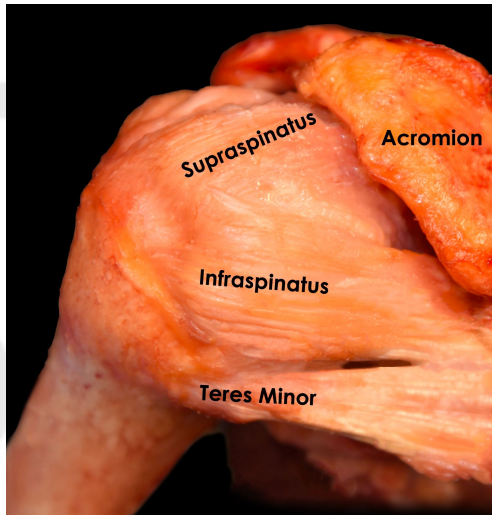
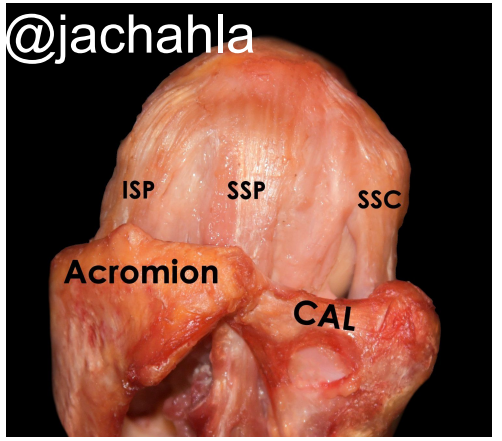
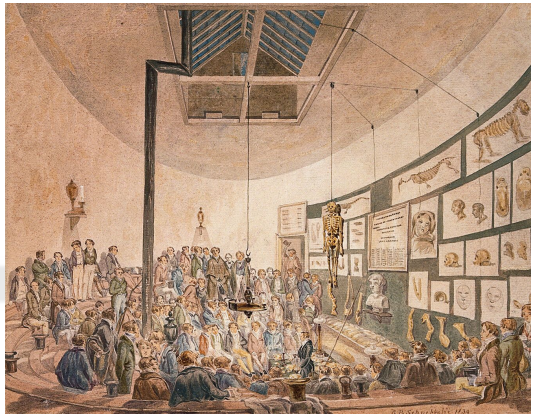
Intro

- RC is comprised of 4 muscles
  - Subscapularis, Supraspinatus, Infraspinatus, Teres minor
- Functions as a dynamic stabilizer of the glenohumeral joint
  - Balancing force couples in transverse and coronal planes.
- Approx. 30% of adults > 60 and 62% of adults > 80 have asymptomatic abnormalities, (Ring, 2014).
- Mechanism of tears described
  - Chronic degenerative tear, chronic impingement, acute avulsion and iatrogenic injury
- John Gregory Smith 1834 first described RC rupture
  - “Pathological appearances of seven cases of injury of the shoulder-joint: with remarks.” submitted to the *London Medical Gazette*
  - Theorized the tears were a result shoulder dislocation with direction of dislocation playing a key role in pathogenesis.









> Clin Orthop Relat Res. 1994 Jul:(304):78-83.

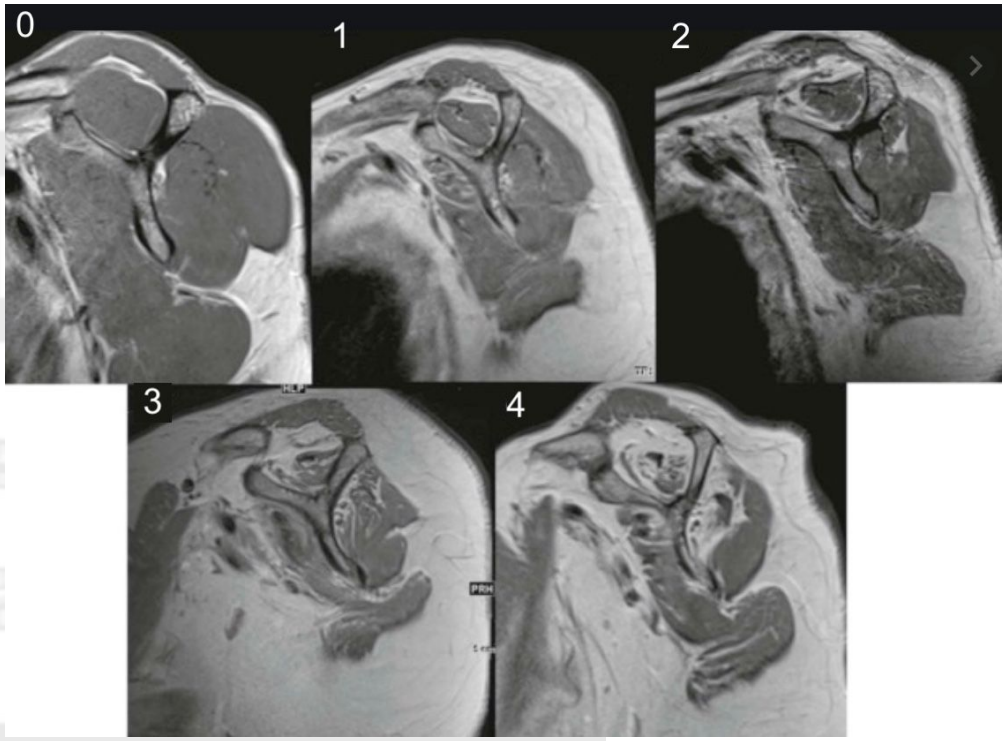
Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan

D Goutallier [1], J M Postel, J Bernageau, L Lavau, M C Voisin

Background

- 1994 study published in CORR
- Fat atrophy of torn rotator cuff muscle demonstrate earlier by way of CT scan and confirmed histologically
- This introduced the Goutallier classification, still in wide use today
- Authors noted infraspinatus (IS) tendon can have severe degeneration even if not torn, this is more often accompanied by combined ruptures of the supraspinatus (SS) and subscapularis (SSc)

Grade	Amount of Fat in Muscle
Grade 0	Normal muscle
Grade 1	Muscle contains some fatty streaks
Grade 2	Fatty infiltration, but still more muscle than fat
Grade 3	Equal amounts of fat and muscle
Grade 4	More fat than muscle is present



Research Questions

1. Is Fat Atrophy a static or progressive process following rupture of the rotator cuff?
2. Is Fat Atrophy reversible following repair, if so, is this influenced by quality of repair?
3. Is Fat Atrophy correlated with functional outcomes like muscle strength testing?

Study Design

- 63 patients with preoperative CT arthrography of rotator cuff tear who underwent rotator cuff tear between Sept. 1985 and Mar. 1991
- 62% male, mean age at time of surgery 57 years (39-70)
- 56 patients completed mean follow up of 17.7 months (4-60) with postoperative CT scan
  - 35 had “arthrotomoscan” and 34 had EMG performed postoperatively
- 36 (57%) of patients had “wide” tears
  - 17 involving SS/IS; 13 involved SS/SSc; 6 involved SS/IS/SSc
- Remaining patients had small, single tendon involvement (24/27 SS)
- 27 SS tears and 13 of SS/IS tears required some for of tendon advancement for footprint coverage

Results - Preop Fat Atrophy

- Infraspinatus atrophy when IS tendon intact noted to be significant (>Stage II) only present with SS/SSc combined tears

TABLE 1. Preoperative Fatty Degeneration of Supraspinatus, Infraspinatus, and Subscapularis According to the Extent of the Tear

Location of Degeneration	Supraspinatus	Infraspinatus	Subscapularis
24 Isolated supraspinatus			
Stage 0 to 1	19	16 (8)	22 (4)
Stage 1.5 to 2	5	8 (5)	2 (2)
17 Supraspinatous and infraspinatus			
Stage 0 to 1	2	3	16 (2)
Stage 1.5 to 2	10	7	1 (1)
Stage 2.5 to 3	4	2	
Stage 3.5 to 4	1	5	
13 Supraspinatous and subscapularis			
Stage 0 to 1	4	7 (1)	4
Stage 1.5 to 2	8	1 (1)	8
Stage 2.5 to 3	1	4 (3)	1
Stage 3.5 to 4		1	
Massive tears			
Stage 0 to 1	1	1	2
Stage 1.5 to 2	2	3	3
Stage 2.5 to 3	3	1	1
Stage 3.5 to 4		1	
Isolated subscapularis			
Stage 0 to 1	3	3	
Stage 1.5 to 2			1
Stage 2.5 to 3			2
Stage 3.5 to 4			

( ) = number of patients found with a partial thickness tear of the corresponding tendon at operation.

Results - Time of Onset vs. Atrophy

- Hard to characterize true time of onset without imaging of intact tendon, so veracity of results are limited
- Higher stage of atrophy noted after 6 months or greater of symptoms

TABLE 2. Stages of Fatty Degeneration of the Infraspinatus According to the Time Elapsed Between the Onset of Functional Impairment and Operation

Time	Stage 0 to 1	Stage 1.5 to 2	Stage 2.5 to 4
<6 months	1	2	
6 months to 1 year	2	1	2
1 year to 2 years		4	2
>2 years		2	5

Results - Postoperative Degeneration

- Infraspinatus
  - Infraspinatus fat atrophy did not improve, even among patients with athrographic evidence of watertight repair
  - Worsening of IS atrophy noted in 5 patients who required tendon advancement
  - Normal IS (Stage 0-1) showed no further degeneration in 25 of 26 cases
  - All 5 infraspinati staged at 2.5 or worse did not deteriorate
- <u>N.B.: Infraspinatus does not improve following surgery, advancement of tendon may be associated with deterioration of the tendon</u>

Results - Postoperative Degeneration

- Supraspinatus
  - 6 of 14 tendons Stage II improved to Stage I on follow up
  - One patient demonstrated severe deterioration following double advancement of SS/IS
    - Stage 3 → Stage 4 of SS and Stage 0 → Stage 2 of IS with EMG evidence of suprascapular nerve impairment
- <u>NB: SS tendon has some potential for improvement, but this is limited to otherwise presently healthy muscle</u>

Results - Muscle Fx vs. Atrophy

- Preoperative Active External Rotation vs. IS Fat Atrophy
  - Stage 0-2: 50°
  - Stage 3-4: 32° (not statistically significant)
- Postoperative Active ER vs. IS Fat Atrophy
  - 28 patients with documented high quality repair on arthrography
  - Preoperative Stage 1.5-2: 46° (Δ12°)
  - Preoperative Stage >2: 13° (not statistically significant)
- NB: Results attenuated by small sample size, but they suggest active ER is influenced by degree of atrophy and surgical results may be influenced by preoperative atrophy

Results - Rerupture

- 25% (14/56) of supraspinatus repairs failed and were associated with progression of fat atrophy
  - Fat atrophy progression more common in Stage 2 or greater

Conclusions

1. Is Fat Atrophy a static or progressive process following rupture of the rotator cuff?
    a. Atrophy of IS tendon may progress when symptoms are present beyond 6 months
2. Is Fat Atrophy reversible following repair, if so, is this influenced by quality of repair?
    a. Fat atrophy is not reversible for IS, and only modestly for SS
    b. Rerupture correlated with progression of fat atrophy disease
    c. Preoperative fat atrophy does not seem to progress postoperatively with adequate repair
3. Is Fat Atrophy correlated with functional outcomes like muscle strength testing?
    a. Yes, however, these results are limited by small sample size and therefore statistically significance was not reached

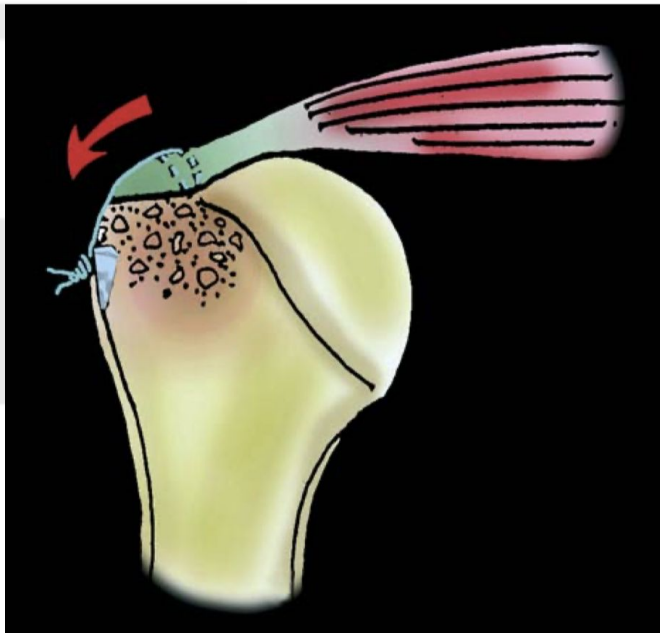
J Bone Joint Surg Am. 2005 Jun;87(6):1229-40. doi: 10.2106/JBJS.D.02035.

Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal?

Pascal Boileau [1], Nicolas Brassart, Duncan J Watkinson, Michel Carles, Armodios M Hatzidakis, Sumant G Krishnan

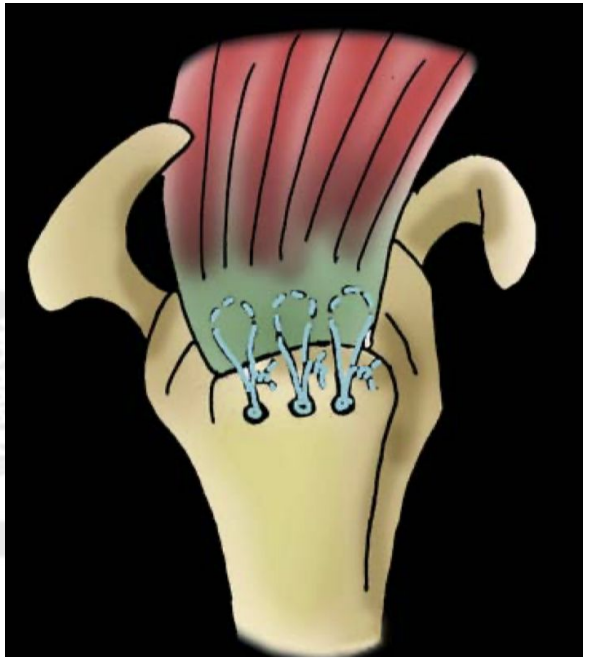
Background

- At time of study, arthroscopic rotator cuff repair still in the developmental phase - only short and mid-term data available



Surgical Technique

1. Superior capsule and rotator interval-coracohumeral ligament release
2. Creation of cancellous bone bed at greater tuberosity
3. Cuff repair with suture anchors placed lateral and sutures medial in inverted horizontal mattress
4. Subacromial decompression, acromioplasty
5. Biceps tenodesis with absorbable interference screw



Do rotator cuff tears heal after arthroscopic repair?

Study Design

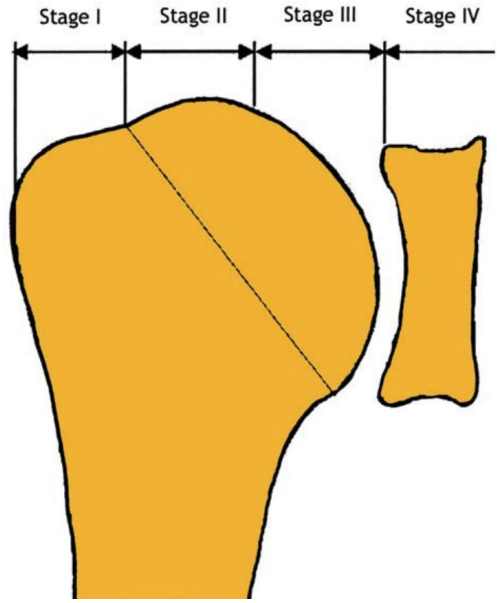
- Prospective study of 65 patients included if

  (1) presence of a chronic full thickness tear of supraspinatus with intact subscapularis, infraspinatus

  (2) treated with arthroscopic cuff repair

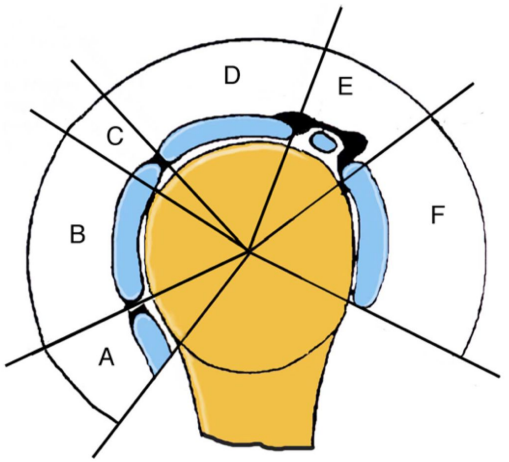
  (3) evaluation of tendon healing and cuff integrity via CT or MRI at >6 months after surgery

  (4) clinical examination performed at minimum 2 yrs after surgery
- Supraspinatus tear classified by retraction in the coronal and sagittal plane (Figure)



- Outcome measures with Constant Murley functional score, UCLA score, Simple Shoulder Test, satisfaction

- Postop CT, MRI with contrast reviewed by radiologist and two surgeons independently for contrast extravasation and thin tendon defined as <50% coverage of greater tub



Results

- Constant score - excellent 77%, good in 15%, fair in 6%, poor in 2%
- UCLA score - excellent in 61%, good in 31%, fair in 5%, poor in 3%
- Effective pain relief (>12 Constant) achieved in 88% shoulders
- Three patients (5%) disappointed because of persistent pain
- Cuff healed completely (71%), partially (5%), incompletely (25%)
- Postop strength, Constant score correlated with tendon healing
- 1 patient required an arthroscopic arthrolysis for persistent stiffness

TABLE I Functional Results According to the Constant Score*

Parameters	Preoperative Score *(points)*	Follow-up Score *(points)*	P Value†
Pain (maximum score, 15)	4.5 ± 2.4	13.8 ± 2	<0.001
Activity (maximum score, 20)	9.7 ± 2.9	18.5 ± 2.7	<0.001
Mobility (maximum score, 40)	34.2 ± 5.8	38.2 ± 2.8	<0.001
Strength (maximum score, 25)	3.2 ± 3.4	13.1 ± 5.8	<0.001
Absolute Constant score (maximum score, 100)	51.6 ± 10.6	83.8 ± 10.3	<0.001
Adjusted Constant score	64.6 ± 12.6	104.7 ± 12.9	

TABLE II Functional Results According to the University of California at Los Angeles (UCLA) Score*

Parameters	Preoperative Score *(points)*	Follow-up Score *(points)*	P Value†
Pain (maximum score, 10)	2.1 ± 1.2	9.1 ± 1.7	<0.0001
Function (maximum score, 10)	2.6 ± 1.2	9.1 ± 1.7	<0.0001
Active elevation (maximum score, 5)	4.5 ± 0.9	4.9 ± 0.5	0.001
Strength (maximum score, 5)	2.3 ± 0.5	4.4 ± 0.7	<0.001
Satisfaction		4.8 ± 1	
UCLA score	11.5 ± 1.1	32.3 ± 1.3	<0.001

Results cont.

TABLE III Assessment of Functional and Subjective Results at Latest Follow-Up Evaluation*

Follow-up Parameters	Patients with a Healed Tendon (N = 46)	Patients with a Partially Healed or Unhealed Tendon (N = 19)	P Value†
Age *(yr)*	57.8 ± 9.4	68 ± 7.6	<0.001
Pain *(points)*	14 ± 1.8	13.5 ± 2.6	NS
Activity *(points)*	18.8 ± 2.4	17.9 ± 3.3	NS
Mobility *(points)*	38.3 ± 2.3	38.1 ± 3.9	NS
Strength *(points)*	14.6 ± 5.8	9.4 ± 3.8	0.001
Absolute Constant score *(points)*	85.7 ± 9.7	78.9 ± 10.5	0.02
Patient satisfaction (rating of satisfied or very satisfied)	96%	95%	NS

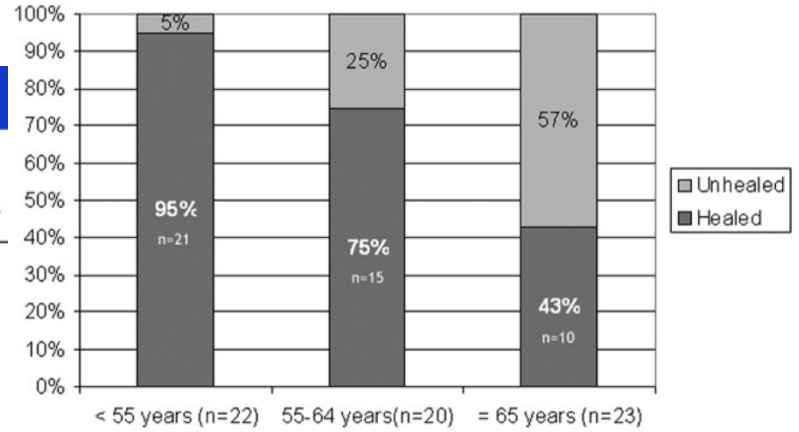
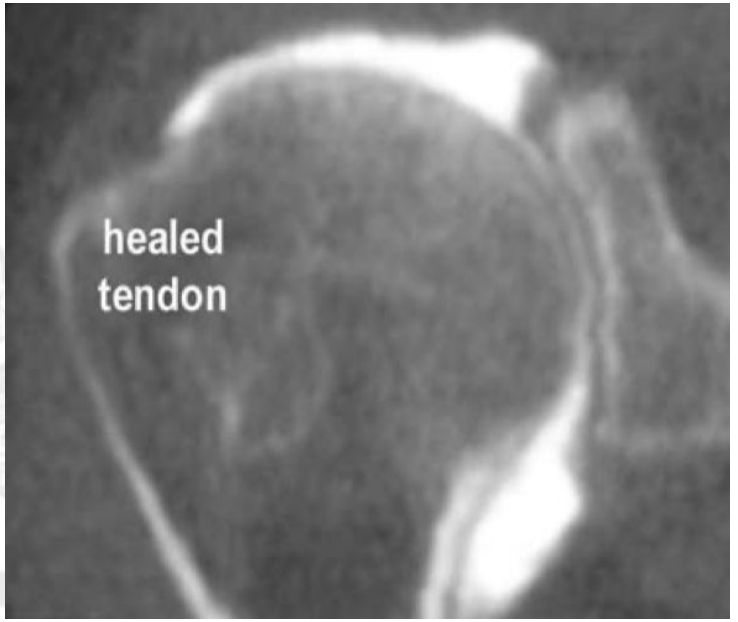


TABLE IV Prevalence of Tendon Healing According to the Size of the Cuff Tear in the Coronal and Sagittal Planes

Tear Size	No. of Shoulders	No. (%) of Shoulders with a Healed Tendon
Coronal plane		
Stage I (minor retraction)	32	25 (78)
Stage II (medium retraction)	31	18 (58)
Stage III (large retraction)	2	2
Sagittal plane		
Stage D (supraspinatus)	32	29 (91)
Stage CD (supraspinatus and infraspinatus cleavage)	3	3
Stage DE (supraspinatus and rotator interval tear or subscapularis cleavage)	24	11 (46)
Stage CDE (supraspinatus with infraspinatus and subscapularis cleavages)	6	3



Conclusions

- Arthroscopic repair of a supraspinatus tear restores the structural integrity of the tendon in 70% of shoulders.
  - Strength is better in shoulders with repaired, intact tendon
- Anatomical failure rate of 29% compares favorably with rates of 20% to 54% reported for open rotator cuff repair
- Factors affecting tendon healing are age and extension of tear in the sagittal plane
- Results could be affected by diagnostic modality as 22% patients declined arthrogram injection/CT and had MRI scan

Comparative Study > J Bone Joint Surg Am. 2006 Aug;88(8):1699-704.

doi: 10.2106/JBJS.E.00835.

The demographic and morphological features of rotator cuff disease. A comparison of asymptomatic and symptomatic shoulders

Ken Yamaguchi [1], Konstantinos Ditsios, William D Middleton, Charles F Hildebolt, Leesa M Galatz, Sharlene A Teefey

Background

- At the time of the study there was very little comparative research on the demographic and morphological characteristics of asymptomatic and symptomatic rotator cuff tears
- Previous studies demonstrated increased prevalence of tears in older individuals (DePalma et al.) but had limitations
  - Mostly used cadaveric models
  - ***No correlations with gender, cuff thickness, cuff tear size***
  - ***No direct comparison*** between painful and non painful shoulders
- Asymptomatic tears represent a very large at risk population for whom secondary prevention may be helpful
- **Purpose:** compare and analyze the morphological and demographic findings associated with asymptomatic and symptomatic rotator cuff disease in patients who presented with unilateral shoulder pain.
  - This will provide insight into the history of RCT and the development of pain

Study Design

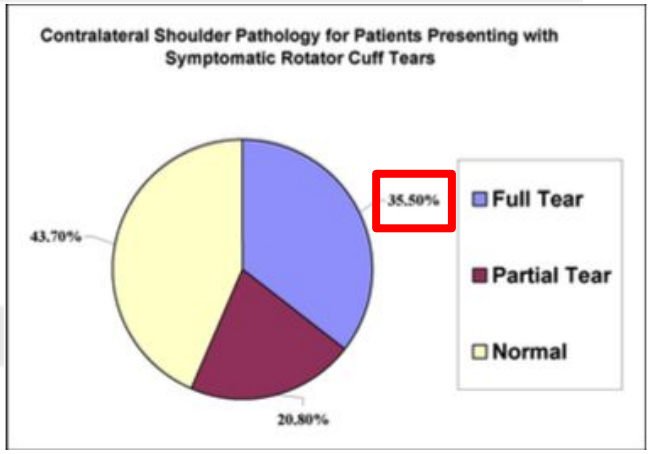
- Retrospective study design from 1996-2001
- 588 patient records with b/l shoulder ultrasonographic evaluations
- Inclusion criteria:
  - undergone b/l shoulder U/S exam for unilateral shoulder pain
  - complete data for both shoulders regarding presence, size, & location of RCT abnormality
- Exclusion criteria:
  - presence of b/l symptoms
  - previous surgical procedure on either shoulder
  - inflammatory arthropathy
  - preceding trauma
- Protocol
  - Patients asked Y/N for pain on either shoulder and if had previous surgery
  - If RCT present was recorded at the level of anatomic neck in the transverse dimension
    - Tears </= 15 mm were considered to involve only the supraspinatus
    - Tears > 15 but </= 30 mm were considered to involve both the supraspinatus and infraspinatus
    - Tears > 30 mm were considered to involve the supraspinatus, infraspinatus, and teres minor and considered massive
- Analysis using T-test, Fisher's exact test, regression analysis and multivariate analysis
  - Age, presence or absence of RCT, width of RCT, partial vs. full thickness RCT, and presence of pain

Population

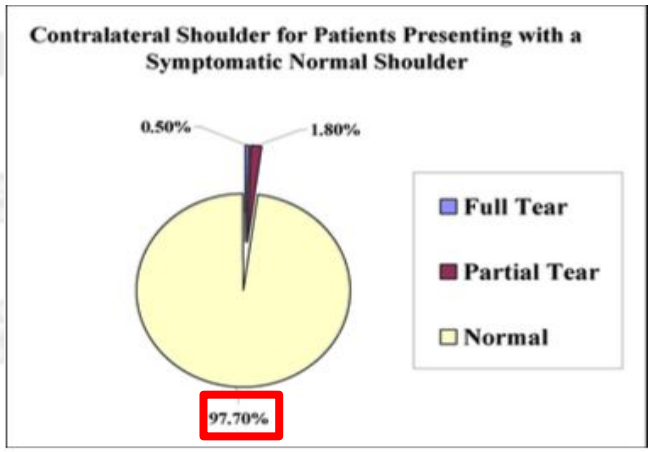
- 588 patients who reported unilateral shoulder pain w/ avg. age of 62.8
  - 212 had b/l intact rotator cuff
  - 199 had unilateral RCT
    - 102 full thickness, 97 partial thickness RCT
  - 177 had b/l RCT
    - 82 b/l full thickness, 54 unilateral full and unilateral partial thickness, 41 b/l partial thickness RCT
- An additional 52 patients were excluded due to incomplete records
- An additional 66 patients were excluded due to b/l shoulder pain

Results

- 376 patients had RCTs (63 y/o)
- Unilateral tears
  - 93/97 partial RCT were painful
  - 101/102 full RCT were painful
- B/l tears
  - 82/177 had b/l full RCT
  - 95 patients with at least one partial PCT
    - 41 b/l partial RCT
    - 6 partial RCT in the painful shoulder, full RCT in nonpainful
    - 48 full RCT in painful, partial RCT in non painful shoulder



Pts with full RCT on painful side had 35.5% chance of having full thickness on contralateral side, 20.8% of partial RCT on contralateral side, 43.7% of being normal



Pts with painful shoulder with no RCT. 1.8% had chance of having contralateral partial RCT, 0.5% of full RCT, and 97.90% normal

Results

- Avg age for prevalence of RCT
  - No RCT: 49
  - Unilateral tear: 59
  - B/l tears: 68
- Tear size
  - median tear width for asymptomatic shoulders was 15.0 mm
    - involved supraspinatus
  - median tear width for symptomatic shoulders was 22.7 mm
    - involved supraspinatus and infraspinatus
  - means size difference between painful and non painful shoulders with b/l tears was 5.4
- Age, gender, and cuff thickness was not significantly related to size of RCT with or without pain

Conclusions

- Development of symptoms was associated with a significant ($p < 0.05$) increase in pain and a decrease in the ability to perform activities of daily living
- Being aged 60 or older was an intrinsic etiology associated with a strong (50%) likelihood of a b/l RCT
- The painful shoulder in b/l RCT was a 30% larger RCT than the non painful shoulders
- **<u>Takeaway</u>**
  - Full RCT should be monitored for size progression and development of contralateral symptoms
- Limitations
  - retrospective study
  - subjective not quantitated pain scales
  - Length of time with symptoms
  - Cannot be generalized to patients with b/l non painful or painful shoulders

Comparative Study > J Bone Joint Surg Am. 2010 Nov 17;92(16):2623-33.
doi: 10.2106/JBJS.I.00506.

Symptomatic progression of asymptomatic rotator cuff tears: a prospective study of clinical and sonographic variables

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Affiliations + expand

PMID: 21084574 PMCID: PMC2970889 DOI: 10.2106/JBJS.I.00506

Background

- At the time of publishment little information was known as to why some RCT were painful while others where asymptomatic.
- Natural history of RCT unknown, many questions unanswered…
  - Such as there is a high prev. of asymp. RCT in elderly populations and some developed pain while others did not.
- Evaluation of risk of pain development and ID of factor that are related to development of pain.
- Understanding risk factors could help ID at risk individuals and guide preventive and therapeutic strategies.
- Aim: Identify changes in tear dimensions, shoulder function, and glenohumeral kinematics when an asymptomatic RCT becomes painful and to identify characteristics of individuals who develop pain compared to those who remain asymptomatic.

Study Design

- Prospective longitudinal study, over a period of 5 years
- Looked at a cohort of 195 pts. with asymptomatic RCT
  - Subgroup of ongoing prospective cohort study at the time
- Evaluation of both shoulder w/ unilateral shoulder pain
- Pts. were annually monitored for…
  - "New" pain development
  - Tear size, fatty degeneration of the RC, glenohumeral kinematics and shoulder function
- Strict inclusion and exclusion criteria
- "Substantial pain"
  - >/= 3/10 that lasted >6 wks., pain greater than expected on a normal day of living, pain that requires meds, pain that prompted physician evaluation.
- "New pain"
  - pain w/o an injury, pain score >/= 3/10 that lasted longer than 6 wks, pain that required formal consultation, pain that required use of meds, pain that was present at night and had affected sleep for longer than 6 wks.
- <u>Three study time points</u>
  - Time of enrollment
  - 1st visit - subjects w/ asym. grp. returned for first annual shoulder exam or those in the symptomatic group were last evaluated before the onset of new pain
  - 2nd visit - subjects in asymp. grp. returned for their sec. annual shoulder exam or when subjects in the symptomatic group first developed pain.
- <u>Metrics studied</u>
  - Shoulder ultrasonography
  - Shoulder function assessment - ASES score, SF-36, physical exam w/ act. & pas. ROM and strength.
  - Radiographic analysis of glenohumeral kinematics - Stand. radiographs
- For those pts who develop new pain, parameters of the pts. were compared before and after development of pain.

Population

- 195 subjects
  - 44 pts. w/ new pain in asymptomatic shoulder (symptomatic grp.)
    - Mean age 63.3 +/- 11, 66% M., 34% F.
  - 55 pts. who remained asymptomatic (asymptomatic grp. for 2 yrs)
    - Mean age 63.1 +/- 9, 55% M. 45% F.
  - 96 pts. who were excluded
    - 62 pts. who remained asymptomatic but had been in the study for less than 2 yrs, 32 pts. who withdrew, 2 pts. with inadequate data.
- When did pain develop?
  - Mean of 1.93 +/- 1.2 yrs after enrollment
- Which shoulder?
  - 24 (56%) of the 43 subjects of the symp. group had the asymp. tear in the dom. side, while 14(26%) of the 54 subjects of the asymp. group had the asymp. tear in the dominant side ($p < 0.01$)
- Few subjects reported their work demands as sedentary as opposed to most who described their work as manual labor or in between sedentary and manual labor.
- Most described some level of participation in sports.

Results

- RCT progression
  - 23% of the symp. group had tear progression compared to only 4% of the asymp. group.
  - Showed enlargement of full thickness tears & conversion of partial to full thickness.
  - Size of full thickness RCT increased significantly w/ 18% of the full thickness tears showing an increase in > 5mm.
  - 40% of partial thickness tears had progressed to full thickness tear
- Fatty degeneration of RC muscles
  - Pain development in asymptomatic RCT is not associated with progression of fatty degeneration

TABLE I Changes in Tear Size and Fatty Infiltration Between Visits in Shoulders with a Full-Thickness Tear

	Asymptomatic Group (N = 35)		Symptomatic Group (N = 34)	
Variable	Median* (Interquartile Range)	P Value†	Median* (Interquartile Range)	P Value†
Tear length *(mm)*		0.62		0.008
Visit 1	11.0 (8.0-15.0)		12.7 (8.0-28.0)	
Visit 2	11.0 (9.0-18.0)		13.2 (9.0-32.0)	
Change	0 (–1.0-1.0)		1.0 (–1.0-3.0)	
Tear width *(mm)*		0.70		0.01
Visit 1	10.0 (7.0-14.0)		13.2 (9.0-22.0)	
Visit 2	10.0 (8.0-16.0)		14.0 (10.0-24.0)	
Change	0 (–1.0-1.0)		1.0 (–1.0-4.0)	
Tear area *(mm^2)*		0.86		0.006
Visit 1	117 (63.0-210)		158 (84.0-493)	
Visit 2	126 (73.0-224)		189 (96.0-504)	
Change	0 (–15.6-18.7)		25.0 (–14.0-86.0)	

*The 25th and 75th percentiles are in parentheses. †P value compares data between visits within the group (Wilcoxon signed-rank test).

Results - Cont.

- Shoulder function
  - ASES score dec. by 28 pts in those who became sympt. whereas no sig. change was observed in those who remained asymptomatic.
  - All measures of shoulder ROM were decreased except for external rotation at 90 deg. of abduction in those symptomatic.
- SF-35 scores did not sig. decrease after pain development

TABLE III Changes in Shoulder Function Between Visits

Variable	Asymptomatic Group (N = 55) Result	Asymptomatic Group (N = 55) P Value*	Symptomatic Group (N = 44) Result	Symptomatic Group (N = 44) P Value*
Pain score on visual analog scale† *(points)*		0.48‡		<0.0001‡
Visit 1	1.0 (1.0 to 2.0)		1.0 (1.0 to 1.5)	
Visit 2	1.0 (1.0 to 2.0)		4.0 (3.0 to 6.0)	
Change	0 (0 to 0)		3.0 (2.0 to 5.0)	
ASES score† *(points)*		0.83‡		<0.0001
Visit 1	95.0 (83.3 to 100)		93.3 (85.0 to 100)	
Visit 2	95.0 (84.4 to 100)		65.8 (49.0 to 77.5)	
Change	0 (–5.0 to 5.0)		–27.5 (–35.8 to –18.0)	
External rotation strength§ *(N)*		0.41		0.37
Visit 1	64.6 ± 28.0 (56.9 to 72.3)		61.8 ± 30.3 (52.3 to 71.2)	
Visit 2	62.7 ± 27.4 (55.2 to 70.3)		58.0 ± 32.5 (47.9 to 68.2)	
Change	–1.9 ± 16.4 (–6.4 to 2.6)		–3.8 ± 26.9 (–12.1 to 4.6)	
Forward elevation§ *(deg)*		0.004		<0.0001‡
Visit 1	153 ± 12.6 (150 to 156)		160 (145 to 160)	
Visit 2	146 ± 13.6 (142 to 150)		150 (140 to 150)	
Change	–6.9 ± 16.7 (–11.4 to –2.3)		–10.0 (–20.0 to 0)	
External rotation at 90° of abduction§ *(deg)*		0.15		0.11
Visit 1	90.1 ± 11.7 (86.9 to 93.2)		86.6 ± 14.1 (82.2 to 90.9)	
Visit 2	86.8 ± 12.9 (83.3 to 90.3)		81.4 ± 14.5 (76.9 to 85.9)	
Change	–3.3 ± 16.5 (–7.7 to 1.2)		–5.1 ± 20.1 (–11.4 to 1.1)	
Internal rotation at 90° of abduction§ *(deg)*		0.20		0.02
Visit 1	66.6 ± 19.3 (61.3 to 71.8)		66.6 ± 17.7 (61.2 to 72.1)	
Visit 2	69.6 ± 11.9 (66.3 to 72.8)		58.4 ± 16.8 (53.2 to 63.5)	
Change	3.0 ± 17.1 (–1.6 to 7.6)		–8.3 ± 22.8 (–15.3 to –1.2)	
External rotation at side§ *(deg)*		0.07		0.03
Visit 1	70.3 ± 15.9 (66.0 to 74.6)		68.7 ± 21.1 (62.2 to 75.2)	
Visit 2	64.7 ± 14.7 (60.8 to 68.7)		60.6 ± 14.4 (56.1 to 65.0)	
Change	–5.6 ± 22.2 (–11.5 to 0.4)		–8.1 ± 24.3 (–15.6 to –0.7)	
Internal rotation in extension†		0.001‡		0.002‡
Visit 1	3.0 (2.0 to 3.0)		3.0 (2.0 to 3.0)	
Visit 2	3.0 (2.0 to 3.0)		3.0 (3.0 to 4.0)	
Change	0 (0 to 1.0)		1.0 (0 to 1.0)	
SF-36 physical health summary score§ *(points)*		0.05		0.41
Visit 1	45.6 ± 9.7 (43.0 to 48.3)		43.7 ± 10.3 (40.6 to 46.9)	
Visit 2	47.6 ± 8.9 (45.1 to 50.0)		42.5 ± 8.3 (40.0 to 45.1)	
Change	2.0 ± 7.1 (0 to 3.9)		–1.2 ± 9.7 (–4.1 to 1.7)	
SF-36 mental health summary score§ *(points)*		0.08		0.56
Visit 1	53.0 ± 3.8 (52.0 to 54.0)		50.9 ± 4.9 (49.4 to 52.4)	
Visit 2	52.1 ± 4.3 (50.9 to 53.3)		50.5 ± 4.9 (49.1 to 52.0)	
Change	–0.9 ± 3.7 (–1.9 to 0.1)		–0.3 ± 3.8 (–1.5 to 0.8)	

*P value, derived with the paired t test, for the comparison of data between visits within the group. †The values are shown as the median with the interquartile range in parentheses. ‡Wilcoxon signed-rank test. §Data are shown as the mean and the standard deviation, with the 95% confidence interval in parentheses.

Results - Cont.

- Glenohumeral kinematics
  - Increased compensatory scapulothoracic motion in relation to the glenohumeral motion during early shoulder abduction with pain development, but no other sig. changes.
- Pain development
  - Those who developed pain had sig. larger tears at time of enrollment.
  - Dominant hands > nondominant

TABLE IV Ratio of Glenohumeral to Scapulothoracic Motion During Abduction in the Symptomatic Group

	Visit 1		Visit 2		
Abduction Angle	Median* (Interquartile Range)	P Value†	Median* (Interquartile Range)	P Value†	P Value‡
0° to 30°	4.2 (1.8-6.8)	0.008§	2.5 (1.5-6.4)	0.20	0.13
30° to 60°	2.2 (1.2-3.8)		1.4 (0.6-4.7)		0.38
60° to 90°	2.0 (1.4-2.8)		2.1 (1.1-3.2)		0.23
0° to 90°	2.6 (1.7-4.0)		2.4 (1.9-3.8)		0.94

*The 25th and 75th percentiles are given in parentheses. †P value for comparison of the values between different abduction segments within a visit is derived by mixed-model repeated-measures analysis of variance using rank-transformed data. ‡P value, derived with the Wilcoxon signed-rank test, for the comparison of certain abduction segments between visits. §Post hoc analysis of this comparison by statistical contrasts showed $p = 0.02$ for 0° to 30° versus 30° to 60°, $p = 0.001$ for 0° to 30° versus 60° to 90°, $p = 0.09$ for 0° to 30° versus 0° to 90°, $p = 0.41$ for 30° to 60° versus 30° to 90°, and $p = 0.38$ for 30° to 60° versus 0° to 90°.

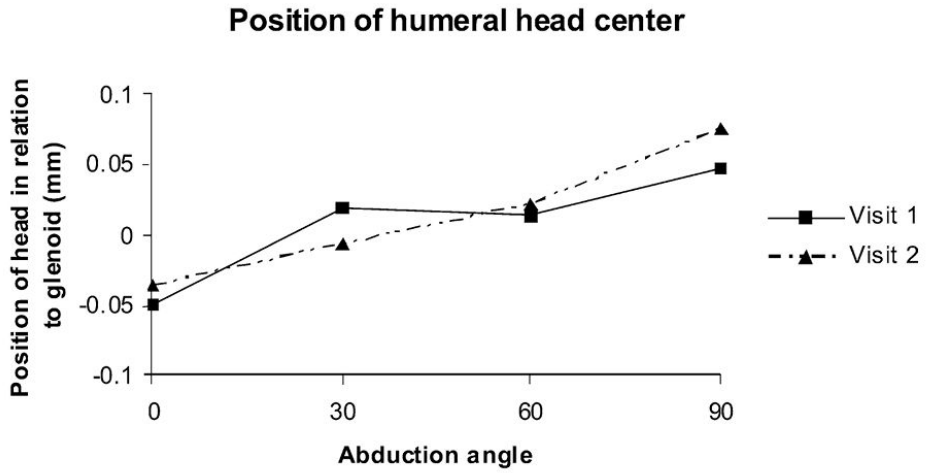

Fig. 2
The position of the humeral head in relation to the glenoid showed a gradual superior translation with shoulder abduction at both Visit 1 and Visit 2. However, there were no significant differences between visits at any of the abduction angles.

Conclusions

- Limitations
  - Early report of ongoing longitudinal cohort study, only subset of those who developed pain were included, questions of duration of follow up.
  - Pts. all had bilateral disease, what about unilateral disease?
  - How long was the disease present since they were asymptomatic at enrollment?
- Strengths
  - Validated objective measures studied, strict def. of pain, strict exclusion and inclusion criteria
- Serves great importance for two parties…
  - Patient - greater understanding of their own disease and possible course
  - Surgeon - better understanding of management and setting patient expectations
- Individuals with shoulder pain exhibited larger tears at baseline and experienced a greater rate of tear progression compared to those who remained asymptomatic.
- While shoulder function and active range of motion declined with the onset of symptoms, no significant changes were observed in external rotation strength or fatty degeneration of the rotator cuff muscle after the development of pain.
- Additionally, an increase in compensatory scapulothoracic motion during early shoulder abduction was noted after pain development, but there was no associated increase in proximal humeral migration.

> Am J Sports Med. 2007 May;35(5):719-28. doi: 10.1177/0363546506297539. Epub 2007 Mar 2.

Fatty infiltration and atrophy of the rotator cuff do not improve after rotator cuff repair and correlate with poor functional outcome

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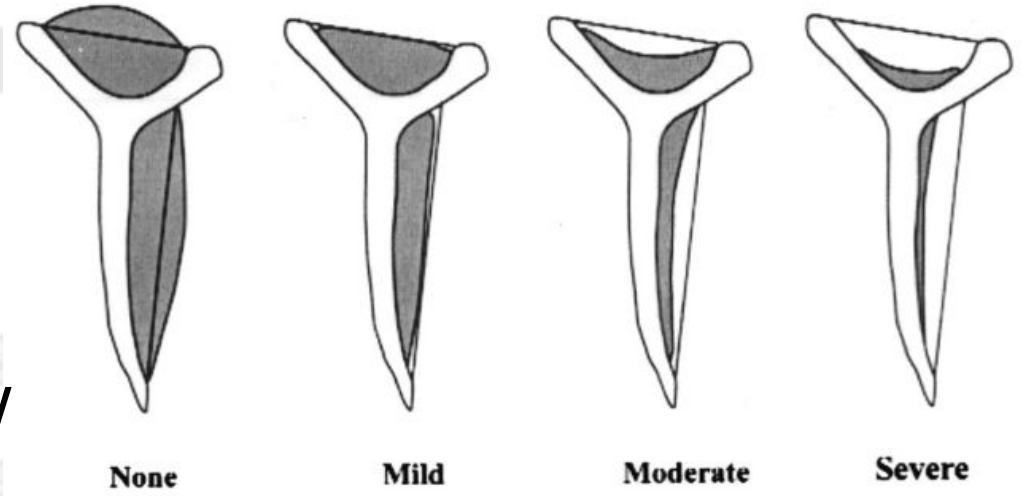
Background

- Goutallier et al demonstrate a highly negative correlation between fatty infiltration of the infraspinatus muscle and outcome
- Thomazeau et al and Gerber et al showed a direct correlation between increasing muscle atrophy and retearing of repair
- Atrophy had a chance to improve if the repair remained healed
- Fatty infiltration never regressed even with a successful repair
- Aim: to determine if poorer preoperative muscle quality negatively affects outcome, and if a healed repair might demonstrate improvements in fatty infiltration and muscle atrophy

Study Design

- Prospective study design with single surgeon
- MRI pre-op and 1 year post-op to evaluate for muscle atrophy and fatty infiltration in patients with full thickness rotator cuff tears
  - Assessed using Goutallier criteria
    - 0: no fat
    - 1: thin streaks of fat
    - 2: less fat than muscle
    - 3: equal amounts of fat and muscle
    - 4: more fat than muscle
- Variables: American Shoulder and Elbow Society (ASES), Constant, and pain scores, strength, retear rate, and progression of muscle degeneration



Warner et al, 2001

Population

- 38 patients
- Average age 62
- 15 patients underwent open repair
- 23 patients underwent arthroscopic repair
- 1 year follow-up
- Exclusion criteria: concomitant disorders such as glenohumeral arthritis, fracture, or osteonecrosis

Results

TABLE 1
Functional Outcome Results[a]

Measurement	Preoperative	Postoperative	*P* value
ASES score	47.3	88.2	.0001
Constant score	58	82	.0001
Pain score	5.6	0.9	.0001
Forward elevation strength (lb)	7.7	13.5	.0006
External rotation strength (lb)	12.1	15	.01

[a]ASES = American Shoulder and Elbow Society.

- Strong negative correlation between muscle quality and outcome results in most cases
- Muscle atrophy and fatty infiltration of the infraspinatus muscle were the only independent predictors of ASES and Constant scores
- Preoperative muscle atrophy of the supraspinatus and infraspinatus and fatty infiltration of the supraspinatus correlated to postoperative cuff integrity
- Tear size and rotator cuff healing did not play an independent role
- Both atrophy and fatty infiltration progressed significantly over the course of the study

Conclusions

- Muscle atrophy and fatty infiltration of the rotator cuff muscles, particularly of the infraspinatus, play a significant role in determining functional outcome after cuff repair
- Tear size appears to have the most influential effect on repair integrity
- A successful repair did not lead to improvement or reversal of muscle degeneration and a failed repair resulted in significantly more progression of muscle degeneration
- Repairs should be performed before more significant deterioration in the cuff musculature if possible

Citations Classics Shoulder & Elbow

Rotator Cuff Tears

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