Review Article

Obere Extremität 2021 · 16:237–246
https://doi.org/10.1007/s11678-021-00658-5
Received: 6 May 2021
Accepted: 13 July 2021
Published online: 3 September 2021

Pseudoparalysis and pseudoparesis of the shoulder

Clinical presentation, biomechanics, and implications for treatment

Roland Stefan Camenzind[1] · Laurent Lafosse[2] · Thibault Lafosse[2]
[1] Department of Orthopedics, Balgrist University Hospital, University of Zurich, Zurich, Switzerland
[2] Alps Surgery Institute, Clinique Générale Annecy, Annecy, France

Abstract

Background: Clinical presentation of massive rotator cuff tears range from pain to loss of active range of motion. Pseudoparalysis and pseudoparesis are defined inconsistently in the literature, but both include limited active with maintained passive range of motion.
Objective: This article aims to provide a consistent definition of pseudoparalysis and pseudoparesis of the shoulder and show structural and biomechanical differences between these two types of rotator cuff tear with their implications for treatment.
Methods: A literature review including key and basic papers discussing clinical symptoms, biomechanical differences, and their impact on therapeutic options for pseudoparalysis and pseudoparesis was performed.
Results: Biomechanically, structural differences between pseudoparalysis (active scapular plane abduction <45°) and pseudoparesis (active scapular plane abduction 45–90°) exist. For massive posterosuperior rotator cuff tears, the integrity of the inferior subscapularis tendon is the most predictive factor for active humeral elevation. Patients with pseudoparalysis have a higher grade of subscapularis tendon involvement (>50%) and fatty infiltration of the subscapularis muscle. Treatment options depend on the acuteness and repairability of the tear. Rotator cuff repair can reliably reverse the active loss of active range of motion in acute and reparable rotator cuff tears. In chronic and irreparable cases reverse total shoulder arthroplasty is the most reliable treatment option in elderly patients.
Conclusion: The most concise definition of pseudoparalysis is a massive rotator cuff tear that leads to limited active (<45° shoulder elevation) with free passive range of motion in the absence of neurologic deficits as the reason for loss of active elevation. The integrity of the subscapularis tendon is the most important difference between a pseudoparalytic and pseudoparetic (active shoulder elevation 45–90°) shoulder. Decision-making for surgical options depends more on reparability of the tendon tear and patient age than on differentiation between pseudoparalysis and pseudoparesis.

Keywords
Rotator cuff injuries · Arthroscopy · Tendon transfer · Arthroplasty, replacement, shoulder · Clinical decision-making

Scan QR code & read article online

Massive rotator cuff tears (mRCT) comprise approximately 10 to 40% of all treated rotator cuff tears (RCT) [1, 13]. In 1985, Cofield [6] introduced a definition of mRCT as a tear greater than 5 cm in diameter. A more reliable and generally accepted definition was reported by Gerber et al. [22], as complete disinsertion of two or more tendons of the rotator cuff (RC). More recently, Lädermann et al. [31] introduced a classification of mRCT considering the group of tendons involved. The pattern of the tear influences the biomechanics of the shoulder, particularly regarding the balance between anterior and posterior forces on the humeral head, resulting in a modification

Table 1 Definition of pseudoparalysis or pseudoparesis

Study	Year	Study design	LoE	Rotator cuff tear	Definition	Included patients	Imaging criteria
Ernstbrunner et al. AJSM [16]	2020	Case–control study	3	Massive RCTs: >2 tendons	Pseudoparalysis: active scapular plane abduction <45° Pseudoparesis: active scapular plane abduction >45° and <90°	$n = 50$ pseudoparalysis group $n = 24$ pseudoparesis group $n = 26$	Plain radiographs: no difference MRI: fatty infiltration SSC (2.9 vs. 1.6; $p < 0.001$) and ISP (3.6 vs. 3.0; $p < 0.001$) muscles; anterior (–23° vs. 4°, $p < 0.001$), posterior (–23° vs. –14°, $p = 0.034$) and global RCT extensions (225° vs. 190°, $p < 0.001$)
Ernstbrunner et al. AJSM [17]	2020	Case–control study	3	Massive RCTs: >2 tendons	Pseudoparalysis: active scapular plane abduction <90°	$n = 100$ pseudoparalysis group $n = 50$ age- and sex-matched control group $n = 50$	Plain radiographs: CSA (38.2° vs. 35.2°, $p = 0.001$), ACHD (4.7 vs. 7.3, $p < 0.001$), posterior acromial height (22 vs. 17, $p = 0.005$), anterior (–9° vs. 25°, $p < 0.001$) and posterior RCT extension (–18° vs. 2°, $p < 0.001$) MRI: fatty infiltration SSC (2.2 vs. 1.4, $p < 0.001$)
Tokish et al. JSES [44]	2017	Systematic Review	4	Massive RCT (not exactly defined)	Pseudoparalysis: maintained passive elevation, 0° of active elevation, no neurologic deficit Pseudoparesis: maintained passive elevation, <90° of active elevation, no neurologic deficit	16 studies 4 studies: no differentiation, <90° active elevation 5 studies: no definition 7 studies: heterogenous definitions	N. A.

ACHD acromiohumeral distance, *CSA* critical shoulder angle, *ISP* infraspinatus, *LoE* level of evidence, *MRI* magnetic resonance imaging, *RCT* rotator cuff tear, *SSC* subscapularis

of the active centralization of the humeral head [16]. If a mRCT leads to loss of active range of motion, the definition of "pseudoparalysis" or "pseudoparesis" is inconsistent. Werner et al. [46] originally defined pseudoparesis as active shoulder anterior elevation of less than 90° in the presence of free passive anterior elevation caused by an mRCT. Despite paresis being defined as weakness with some motion and paralysis as no motion, most authors use the term pseudoparalysis inconsistently to describe a lack of active anterior shoulder elevation greater than 90° with free passive elevation after an mRCT. Tokish et al. [44] suggested clarifying the terms and recommended reserving pseudoparalysis for patients with 0° active range of motion, while pseudoparesis should be referred to in patients who are able to actively elevate their arm up to 90°. Unfortunately, this systematic review does not specify exact values for active motion to differentiate between the two conditions. Therefore, the definition of pseudoparalysis and pseudoparesis of Tokish et al. was combined with recent structural and biomechanical findings [16]: pseudoparalysis is defined as mRCT with maintained passive range of motion and limited active scapular plane abduction <45° without neurologic deficits; pseudoparesis is defined as mRCT with maintained passive range of motion and limited active scapular plane abduction >45° and <90° without neurologic deficits (**Table 1**).

This article focuses on clinical presentation, biomechanical behavior, and implications for therapy of pseudoparalysis and pseudoparesis of the shoulder based on current literature and the authors' opinions and experience.

Clinical presentation

Clinical presentation of patients suffering from mRCT differs substantially and can range from free active range of motion without pain to painful or pain-free inability to actively elevate the affected arm. The diagnosis of an mRCT is based on clinical and imaging findings. Patients with pseudoparalysis or pseudoparesis suffer from loss of active range of motion with almost free passive range of motion. Differentiation of pseudoparalysis and pseudoparesis can be assessed clinically by active scapular plane abduction. Patients with pseudoparalysis cannot forward elevate their arm higher than 45° (**Fig. 1**), while patients with pseudoparesis can forward elevate their arm higher than 45° but not higher than 90° (**Figs. 2 and 3**). These values are based on a recent structural and biomechanical analysis performed by Ernstbrunner et al. [16], who showed that patients with chronic pseudoparalysis and pseudoparesis have different structural lesions. Patients with chronic pseudoparalysis have a significantly higher grade of fatty infiltration of the subscapularis (SSC) and infraspinatus muscles and a greater extension of RCT. Furthermore, these patients showed an anterior extension of the posterosuperior RC tear involving more than 50% of the SSC tendon, which correlated to an inability to actively abduct more than 45°.

Biomechanics

Stability of the glenohumeral joint in all possible positions of the humerus is achieved by the interaction of all scapulohumeral muscles, thus equilibrating

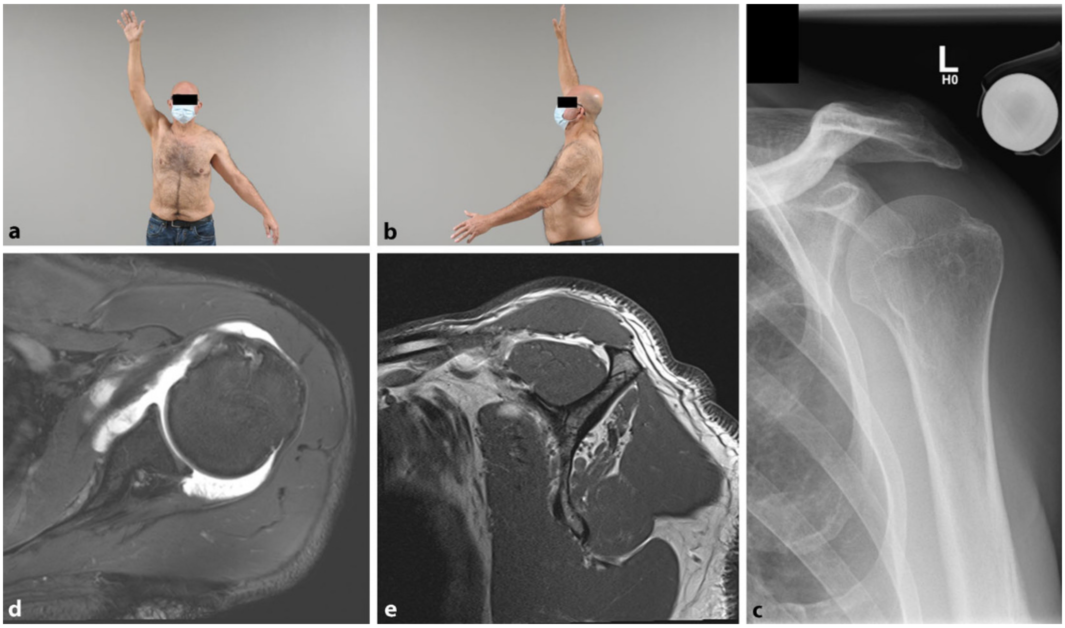

Fig. 1 ▲ Acute pseudoparalysis in a 67-year-old patient after a fall on his left shoulder with an acute subscapularis tendon tear and chronic infraspinatus tear. Limited active range of motion with **a** 30° of abduction and **b** 30° of anterior flexion. **c** Anteroposterior radiographs show no cranialization of the humeral head with an acromiohumeral distance of 10 mm. **d** Axial MRI slides show full-thickness subscapularis tendon tear with **e** no fatty infiltration of the subscapularis muscle and a chronic grade 4 infiltration of the infraspinatus muscle. This patient was treated with arthroscopic subscapularis tendon repair

Fig. 2 ▲ Acute pseudoparesis in a 56-year-old manual worker after a fall on his right shoulder with an acute subscapularis, supra-, and infraspinatus tendon tear. Limited active range of motion with **a** 45° of abduction and **b** 60° of anterior flexion. **c** Anteroposterior radiographs show slight cranialization of the humeral head with an acromiohumeral distance of 7 mm. **e** Coronal MRI shows full-thickness supraspinatus tendon tear with **f** fatty infiltration grade 2 of the supra- and infraspinatus muscle. This patient was treated with arthroscopic rotator cuff repair

external forces and at the same time counteracting redundant actions of similar muscle groups [18]. Pseudoparalysis is caused by a loss of active centralization of the humeral head by the RC followed by cranial subluxation of the humeral head due to excessive pull force of the deltoid during elevation [30].

Loss of forward elevation

Pseudoparalysis of the shoulder is associated with a complete tear of the SSC and supraspinatus tendon or the involvement of at least three tendons of the RC [7].

Fig. 3 ◀ Chronic pseudoparesis of the left shoulder in an 84-year-old female. Limited active range of motion with **a** 60° of abduction and **b** 60° of anterior flexion. **c** Cranial migration of the humeral head (Hamada stage 4B) with **d** complete tear of the supraspinatus tendon and **e** fatty infiltration of the supra- and infraspinatus muscle grade 4. This patient was treated with **f** reverse total shoulder arthroplasty

Wieser et al. [47] performed a fluoroscopic, magnetic resonance imaging, and electrophysiologic assessment of shoulders with massive posterosuperior RCT and showed that involvement of the inferior SSC tendon appeared to be the most predictive factor to lift the humerus above 90°. This finding was confirmed by a recent study [16] that showed that involvement of more than 50% of the SSC tendon with fatty infiltration of stage 3 is associated with active scapular plane abduction of less than 45°. Furthermore, this study showed a difference in structural lesions between pseudoparalysis and pseudoparesis. In a biomechanical computer model, the key function of the SSC in developing pseudoparalysis with inability of active abduction >45° was confirmed [16].

The SSC acts against the posterior deltoid and cuff to initiate the movement of forward flexion when starting with the arm at the side of the body. When SSC is completely torn, the humeral head subluxates anteriorly and superiorly (anterosuperior escape), making any forward flexion impossible (◘ **Fig. 1**). In pseudoparesis, the remaining SSC (more than 50%) may be active enough to maintain active centralization of the humeral head during the initial phase of the forward flexion movement, to enable the anterior deltoid to take over (◘ **Figs. 2 and 3**).

Bony anatomy

The etiology of non-traumatic mRCT is not yet fully understood. Some authors suggest including the bony anatomy and the vector forces of the RC and the deltoid muscle to explain tear pattern and their functional consequences. Clinical observation and biomechanical observation of the pseudoparalytic shoulder by Bouaicha et al. [3] led to introduction of the Shoulder Abduction Moment (SAM) index. The SAM index is the ratio of the radii of two concentric spheres based on the center of rotation (COR) of the glenohumeral joint. One sphere captures the humeral head (so-called "numerator" to capture the stabilizing forces of the rotator cuff), while the other sphere includes the origin of the deltoid muscle around the acromion ("denominator" to capture the destabilizing forces of the deltoid muscles). In the clinical analysis, a total of 36 patients with pseudoparalysis were compared to an age- and gender-matched cohort of 36 patients without pseudoparalysis. All patients showed MRI-confirmed mRCT. A SAM <0.77 corresponded to 11-fold-elevated risk of pseudoparalysis. These findings suggest a strong correlation of anatomical features (small humeral head and lateral acromion and subsequent high critical shoulder angle [CSA] [39]). The initial hypothesis that acromial morphologic characteristics influence the development of pseudoparalysis was confirmed by showing that patients with pseudoparalysis have a larger CSA, smaller acromiohumeral distance (ACHD), and a higher-positioned acromion in the sagittal plane [17].

Implications for treatment

Deciding on the treatment for pseudoparetic or pseudoparalytic shoulders remains challenging. The most important differentiation is between acute and chronic mRCT, since this significantly influences the possible surgical treatment. In acute cases, the loss of active range might be influenced by pain and can in general be reliably reversed with early arthroscopic repair of the mRCT [9, 43]. In chronic cases with a decentered humeral head and advanced myotendinous degeneration, RC repair is, however, prone to failure. Therefore, treatment options for chronic pseudoparalysis or pseudoparesis

Table 2 Treatment options for pseudoparalysis or pseudoparesis

Study	Year	Study design	LoE	Definition	Included patients	Treatment	Imaging criteria	Follow-up	Mean age	Clinical results: forward elevation	Pseudo-paralysis reversal
Levy et al. JSES [32]	2008	Case series	4	Pseudoparalysis not defined, free passive motion	$n = 17$	Subacromial injection of local anesthetic and long-acting steroid, deltoid re-education	ACHD less than 7 mm, Hamada grade 2 ($n = 5$), 3 ($n = 7$), 4 ($n = 5$) Grade 4 fatty infiltration (SSP & ISP: 100%, SSC: 82%), grade 3 (SSC: 18%)	Minimum: 9 months	60 years	Preintervention: 40° Postintervention: 160°	82%
Oh et al. AJSM [40]	2011	Cohort study	3	Pseudoparalysis/-paresis: <90° active elevation with free passive motion	$n = 29$ (Non-pseudoparalytic control group, $n = 29$)	Arthroscopically assisted mini-open repair, $n = 11$ All-arthroscopic repair, $n = 18$	N. A.	33 months (control group: 29 months)	65 years (control group: 65 years)	Preoperative: 64° postoperative: 135° (control group: preoperative: 152° postoperative: 159)	76%
Denard et al. Arthroscopy [8]	2012	Case series	4	Pseudoparalysis: <90° active flexion with free passive motion	$n = 53$ (group 1: primary, $n = 39$; group 2: revision, $n = 14$)	Arthroscopic rotator cuff repair	N. A.	75 months	62 years (group 1: 62 years, group 2: 63 years)	Group 1: preoperative: 49° postoperative: 155° group 2: preoperative: 43° postoperative: 109°	Group 1: 90% group 2: 43%
Denard et al. AJSM [9]	2015	Case series	4	Pseudoparalysis: <90° active elevation with free passive motion	$n = 56$ Traumatic: 80%	Arthroscopic rotator cuff repair	Hamada grade 1 (76%), 2 (20%), 3 (2%), 4 (2%) positive tangent sign: 57% fatty infiltration grade ≥3: 16%	14 months	63 years	Preoperative: 47° postoperative: 159°	95%
Spross et al. Arthroscopy [43]	2019	Case series	4	Pseudoparesis: <90° active elevation with free passive motion	$n = 21$ Traumatic: 100%	Arthroscopic rotator cuff repair	Complete 2 tendon tear, <grade 3 fatty infiltration	39 months	61 years	Preoperative: 36° postoperative: 165°	100%
Birmingham and Nevasier JSES [2]	2008	Case series	4	Pseudoparalysis not defined, active motion <80°, passive motion >110°	$n = 18$	Diagnostic arthroscopy, open latissimus transfer	N. A.	25 months	60 years	Preoperative: 56° postoperative: 137°	100%
Kanatli et al. Arthroscopy [29]	2016	Case series	4	Pseudoparalysis: <90° active elevation and abduction	$n = 15$	Arthroscopically assisted latissimus dorsi transfer	N. A.	26 months	62 years	Preoperative: 58° postoperative: 130°	N. A.
Elhassan et al. JSES [11]	2020	Case series	4	Pseudoparalysis: <60° active flexion, <60° active abduction	$n = 19$	Arthroscopically assisted lower trapezius transfer	Not specified for pseudoparalytic shoulders	14 months	52 years	Not specified for pseudoparalytic shoulders	95%
Burkhart and Hartzler Arthroscopy [4]	2019	Case series	4	Pseudoparalysis: <45° active flexion with free passive motion	$n = 10$	Arthroscopically assisted superior capsular reconstruction	Complete 2-tendon tear, Hamada ≤3	13 months	69 years	Preoperative: 27° postoperative: 159°	90%

Table 2 (Continued)

Study	Year	Study design	LoE	Definition	Included patients	Treatment	Imaging criteria	Follow-up	Mean age	Clinical results: forward elevation	Pseudo-paralysis reversal
Mihata et al. AJSM [36]	2018	Case series	4	Moderate pseudoparalysis: <90° active elevation, maintained >90° elevation after passive elevation Severe elevation: <90° active elevation, positive drop-arm sign	Moderate $n = 28$ Severe $n = 15$ (no pseudoparalysis $n = 45$)	Arthroscopically assisted superior capsular reconstruction	Moderate: Hamada grade 1 (25%), 2 (61%), 3 (11%); fatty infiltration grade 1 (0), 2 (4%), 3 (39%), 4 (57%) Severe: Hamada grade 1 (20%), 2 (67%), 3 (13%); fatty infiltration grade 1 (0), 2 (7%), 3 (27%), 4 (67%)	60 months	Moderate: 68 years severe: 62 years	Moderate: preoperative: 54° postoperative: 147° Severe: preoperative: 37° postoperative: 150°	Moderate: 96% Severe: 93%
Valenti et al. CORR [45]	2011	Case series	4	Pseudoparalysis: <60° active elevation	$n = 76$	Reversed total shoulder arthroplasty	SSC: 30% superior third, 2.2 fatty infiltration SSP: 100% rupture, Patte grade 3 retraction, 2.96 fatty infiltration ISP: 2.9 fatty infiltration	44 months	73 years	Preoperative: 65° Postoperative: 126°	100%
Ernstbrunner et al. JBJS [14]	2017	Case series	4	Pseudoparalysis: <90° active elevation and abduction	$n = 21$	Reversed total shoulder arthroplasty	ACHD <7 mm, fatty infiltration grade >2	11.7 years	57 years	Preoperative: 64° postoperative: 117°	N.A.
Gerber et al. JSES [25]	2018	Case series	4	Pseudoparalysis: <90° active elevation and abduction	$n = 16$	Reversed total shoulder arthroplasty	ACHD <7 mm, fatty infiltration grade >2	16 years	68 years	Preoperative: 53° postoperative: 101°	N.A.

ACHD acromiohumeral distance, *ISP* infraspinatus, *LoE* level of evidence, *MRI* magnetic resonance imaging, *SSC* subscapularis, *SSP* supraspinatus,

of the shoulder vary from nonoperative partial RC repair, superior capsular reconstruction, tendon transfers, or reverse total shoulder arthroplasty (RTSA) without or with muscle transfer.

The most challenging aspect in the management of pseudoparalysis and pseudoparesis remains the repair or compensation of SSC tears. As detailed above, the manifestation of pseudoparalysis or pseudoparesis increases with the involvement of the SSC tear. Many chronic tears are well compensated until an acute SSC tear occurs ("acute on chronic RC tear"). This event often leads to emergence of a pseudoparalytic shoulder which can be efficiently treated by addressing the acute component of the tear even if some of the tears remain irreparable. The challenge becomes greater in cases of a pseudoparalytic shoulder with chronic anterior and superior cuff tears and a non-repairable SSC tear in young patients.

Conservative treatment

Nonoperative management in chronic pseudoparalysis or pseudoparesis involves corticosteroid injections and exercises for strengthening the deltoid and periscapular muscles. In addition, rehabilitation focuses on the work of scapulohumeral and thoracohumeral muscles, e.g., the latissimus dorsi, and on their ability to actively center the humeral head and counterbalance the deltoid forces to maintain a moment arm responsible for the scapular abduction. This treatment is an excellent first option in most patients with painful limitation of shoulder movement [44]. Some other authors add a specific anterior deltoid training to steroid injection and nonsteroidal drugs [32].

Surgical treatment

When conservative treatment fails, surgical options have to be evaluated. Therefore, the reparability of the RCT has to be assessed. Different instruments exist to decide whether an RCT is still reparable. Most important is to evaluate the fatty infiltration of the musculature according to the Goutallier classification initially described in CT scans [26] and adapted by

Fuchs et al. [19] to MRI. Fatty infiltration of a muscle higher than Goutallier grade II (>50% fatty muscle atrophy) is considered to be irreparable. Retraction of the supraspinatus tendon is another important risk factor. Tendon retraction is classified according to Patte [41] in stage 1 (stump near bony insertion), stage 2 (stump at the level of humeral head), and stage 3 (stump at the level of the glenoid). A combination of Goutallier grading and tendon retraction and tendon length appears to be a powerful tool to predict RC reparability [35]; however, evaluation of the quality of the tendon is also an important aspect that cannot always be achieved by the preoperative analysis. So far, no study exists that consequently distinguishes between pseudoparalysis and pseudoparesis and the impact on treatment depending on the consistent definition. Therefore, all cited studies are summarized in **Table 2** to give an overview of diagnostic criteria and treatment options.

Debridement, biceps tenotomy, and balloon

In elderly patients with irreparable RCT where the main goal is pain relief and a more prolonged surgical time is not applicable, arthroscopic debridement with biceps tenotomy is a valuable option [20]. However, it may fail; therefore, patients must be aware that a second surgery may be required with the implantation of an RTSA. Even though decreased pain level and improved functional outcome scores are reported for patients with massive irreparable RCT with debridement only, reversal of pseudoparalysis or pseudoparesis has, however, not been reported in the literature and cannot be expected. Satisfactory clinical mid-term outcome is also achieved with arthroscopic subacromial balloon spacer implantation, but only in patients without preexisting pseudoparalysis [33].

Arthroscopic rotator cuff repair

If ever an RCT is reparable, arthroscopic reconstruction is preferred by the authors (**Figs. 1 and 2**). In patients with absence of preoperative glenohumeral osteoarthritis, no fatty infiltration of the RC muscle grade 3 or higher, and acromiohumeral distance higher than 7 mm, arthroscopic RC repair can be successful and might lead to a reversal of preoperative pseudoparalysis [9, 40]. In revision cases, the outcome was much worse [9]. Where a complete repair cannot be achieved, even a partial repair is a considerable alternative. In patients with irreparable posterosuperior RCT, arthroscopic partial repair was an effective treatment, with an improvement of pain values and clinical scores despite a high failure rate of the repair (41.6%) [5]. So far, no evidence exists that a partial repair can successfully reverse chronic pseudoparesis or even pseudoparalysis. Therefore, the authors do not see an indication for arthroscopic partial repair alone without any additional procedure, e.g., tendon transfer, in chronic pseudoparetic or pseudoparalytic shoulders.

Tendon transfer

In younger patients in whom RTSA is not yet an option, tendon transfer should be considered. Tendon transfer not only offers the potential for pain relief but also improves the function of the affected shoulder. For irreparable posterosuperior RCT, Gerber et al. [21] introduced the latissimus dorsi transfer (LDT) in 1988, with benefits for the patients concerning pain and function [23]. Birmingham and Neviaser [2] reported on patients with failed RC repair and limited active elevation (mean 56°, range 20–80) but free passive motion (mean 126°, range 110–150) preoperatively treated with LDT and 100% pseudoparesis reversal. Unfortunately, the term pseudoparalysis was not defined nor mentioned. Nowadays, different techniques from initially reported open to arthroscopically assisted or full arthroscopic LDT exist, eliciting marked improvement in shoulder pain, strength, and function, with a low risk of complications as reported in a recent systematic review [34]. Preoperative assessment of the remaining RC is crucial, since fatty infiltration of the teres minor, as well as insufficiency of the subscapularis muscle, are negative predictors for a good outcome of LDT [24].

There is increasing interest in using lower trapezius transfer for posterosuperior irreparable RCT, since a biomechanical study showed effectiveness in restoring external rotation [27]. Recently, Elhassan et al. [11] reported good short-term clinical outcomes of an arthroscopically assisted lower trapezius transfer, even in patients with pseudoparalysis. Of note, true shoulder pseudoparalysis (defined as active shoulder flexion and abduction <60°) was a factor that significantly predicted a negative result.

In the authors' experience, a tendon transfer cannot by itself restore the function of a chronic pseudoparalytic shoulder, even though it may in a pseudoparetic shoulder, unless anteroposterior stabilization of the humeral head is achieved. Indeed, the misbalance of the anterior and posterior forces must be restored to prevent anterior and superior migration of the humeral head induced by contraction of the posterior and middle deltoid and cuff during the attempt of a forward flexion movement.

The aim of this article was not to provide a description of the tendon transfers, as this has been done previously; however, alongside the historical gold standard for irreparable SSC tears—pectoralis major transfer [28, 42]—anterior LDT has gained popularity and is a reasonable option, providing a better force vector with a line of pull which is very similar to that of the SSC [12]. So far, no subgroup analysis of patients with a pseudoparalysis or pseudoparesis exists for irreparable SSC tendon tear.

Superior capsular reconstruction

In 2012, Mihata et al. [38] introduced superior capsular reconstruction (SCR) in a biomechanical cadaveric study where the superior humeral head translation was restored by SCR after cutting the supraspinatus tendon. Early follow-up (mean 34 months) showed promising radiological and clinical results in patients with irreparable RCT [37]. Reversal of pseudoparalysis was achieved in 90–96% of the patients treated with an arthroscopic SCR, even after a mean follow-up of 60 months [4, 36]. Surgeons who are familiar with this procedure propagate using a 6–8 mm thick and stiff autologous fascia lata graft to achieve good functional outcome. At the authors' institution, this procedure is rarely performed and profound expertise is therefore lacking.

Reverse total shoulder arthroplasty

The most valuable option for older patients with chronic irreparable mRCT and pseudoparalysis or pseudoparesis, showing improved outcomes for up to even 20 years after surgery, is RTSA [15]. This is also the authors' preferred option in elderly patients in whom conservative treatment has failed (**Fig. 3**). A systematic review showed an increased average active elevation of 56° and reversal of pseudoparalysis in 96% of patients treated with RTSA [10]. It should be mentioned that the term "pseudoparalysis" was inconsistently or incorrectly defined as "ROM less than 90°." Nevertheless, implantation of RSTA remains the best option for older patients with pseudoparalysis and pseudoparesis and is even a justifiable treatment for patients under the age of 60 years [14]. Despite the improvement of functional outcome scores at a mean follow-up of 12 years after RTSA, the complication rate was 39%, revision rate 17%, and failure rate 9%, so that the indication in patients younger than 60 years has to be considered carefully.

Conclusion

Massive rotator cuff tear is a disabling condition for patients and can lead to pseudoparalytic or pseudoparetic shoulders with loss of active range of motion. Structural differences exist between pseudoparalysis and pseudoparesis: patients with pseudoparalysis have a higher grade of involvement of subscapularis tendon tears and a higher grade of fatty infiltration of the subscapularis muscle compared to patients with pseudoparesis. Decision-making regarding therapeutic options is mainly based on acuteness, repairability of the RCT, and patient age. RC repair can reliably reverse the loss of active range of motion in acute and reparable RCT. In chronic and irreparable cases, options vary from nonoperative, partial RC repair, tendon transfer, and SCR, to RTSA. Skillful preoperative patient selection is the key to success. RTSA shows good results in predominantly older patients with painful pseudoparalysis or pseudoparesis. In young and active patients with an intact or repairable SSC lesion for whom shoulder arthroplasty is not yet an option, SCR and tendon transfer can lead to reliable clinical outcomes with improvement regarding the range of motion and function.

Corresponding address

Roland Stefan Camenzind
Department of Orthopedics, Balgrist University Hospital, University of Zurich
Forchstrasse 340, 8008 Zurich, Switzerland
roland.camenzind@balgrist.ch

Funding. Open access funding provided by University of Zurich

Declarations

Conflict of interest. R.S. Camenzind, L. Lafosse, and T. Lafosse declare that they have no competing interests.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975 (in its most recently amended version). Informed consent was obtained from all patients included in the study.

References

1. Bedi A, Dines J, Warren RF, Dines DM (2010) Massive tears of the rotator cuff. J Bone Joint Surg Am 92:1894–1908
2. Birmingham PM, Neviaser RJ (2008) Outcome of latissimus dorsi transfer as a salvage procedure for failed rotator cuff repair with loss of elevation. J Shoulder Elbow Surg 17:871–874
3. Bouaicha S, Ernstbrunner L, Jud L, Meyer DC, Snedeker JG, Bachmann E (2018) The lever arm ratio of the rotator cuff to deltoid muscle explains and predicts pseudoparalysis of the shoulder: the shoulder abduction moment index. Bone Joint J 100B:1600–1608
4. Burkhart SS, Hartzler RU (2019) Superior capsular reconstruction reverses profound pseudoparalysis in patients with irreparable rotator cuff tears and minimal or no glenohumeral arthritis. Arthroscopy 35:22–28
5. Chen KH, Chiang ER, Wang HY, Ma HL (2017) Arthroscopic partial repair of irreparable rotator cuff tears: factors related to greater degree of clinical improvement at 2 years of follow-up. Arthroscopy 33:1949–1955
6. Cofield RH (1985) Rotator cuff disease of the shoulder. J Bone Joint Surg Am 67(6):974–979
7. Collin P, Matsumura N, Lädermann A, Denard PJ, Walch G (2014) Relationship between massive chronic rotator cuff tear pattern and loss of active shoulder range of motion. J Shoulder Elbow Surg 23:1195–1202
8. Denard PJ, Lädermann A, Jiwani AZ, Burkhart SS (2012) Functional outcome after arthroscopic repair of massive rotator cuff tears in individuals with pseudoparalysis. J Arthrosc Relat Surg 28(9):1214–1219
9. Denard PJ, Lädermann A, Brady PC et al (2015) Pseudoparalysis from a massive rotator cuff tear is reliably reversed with an arthroscopic rotator cuff repair in patients without preoperative glenohumeral arthritis. Am J Sports Med 43:2373–2378
10. Dickerson P, Pill SG, Longstaffe R, Shanley E, Thigpen CA, Kissenberth MJ (2020) Systematic review of reversing pseudoparalysis of the shoulder due to massive, irreparable rotator cuff tears. J Shoulder Elbow Surg 29:S87–S91
11. Elhassan BT, Sanchez-Sotelo J, Wagner ER (2020) Outcome of arthroscopically assisted lower trapezius transfer to reconstruct massive irreparable posterior-superior rotator cuff tears. J Shoulder Elbow Surg 29:2135–2142
12. Elhassan BT, Wagner ER, Kany J (2020) Latissimus dorsi transfer for irreparable subscapularis tear. J Shoulder Elbow Surg 29:2128–2134
13. Ellman H, Kay SP, Wirth M (1993) Arthroscopic treatment of full-thickness rotator cuff tears: 2- to 7-year follow-up study. Arthroscopy 9:195–200
14. Ernstbrunner L, Suter A, Catanzaro S, Rahm S, Gerber C (2017) Reverse total shoulder arthroplasty for massive, irreparable rotator cuff tears before the Age of 60 years: long-term results. J Bone Joint Surg Am 99:1721–1729
15. Ernstbrunner L, Andronic O, Grubhofer F, Camenzind RS, Wieser K, Gerber C (2019) Long-term results of reverse total shoulder arthroplasty for rotator cuff dysfunction: a systematic review of longitudinal outcomes. J Shoulder Elbow Surg 28(4):774–781. https://doi.org/10.1016/j.jse.2018.10.005
16. Ernstbrunner L, El Nashar R, Favre P, Bouaicha S, Wieser K, Gerber C (2020) Chronic pseudoparalysis needs to be distinguished from pseudoparesis:

a structural and biomechanical analysis. Am J Sports Med 49(2):1–7. https://doi.org/10.1177/0363546520969858
17. Ernstbrunner L, El Nashar R, Bouaicha S, Wieser K, Gerber C (2020) Scapular morphologic characteristics and rotator cuff tear pattern are independently associated with chronic pseudoparalyis: a matched-pair analysis of patients with massive rotator cuff tears. Am J Sports Med 48:2137–2143
18. Favre P, Jacob HAC, Gerber C (2009) Changes in shoulder muscle function with humeral position: a graphical description. J Shoulder Elbow Surg 18:114–121
19. Fuchs B, Weishaupt D, Zanetti M, Hodler J, Gerber C (1999) Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging. J Shoulder Elbow Surg 8:599–605
20. Gartsman GM (1997) Massive, irreparable tears of the rotator cuff: results of operative debridement and subacromial decompression. J Bone Joint Surg Am 79:715–721
21. Gerber C, Vinh TS, Hertel RHC (1988) Latissimus dorsi transfer for the treatment of massive tears of the rotator cuff: a preliminary report. Clin Orthop 232:51–61
22. Gerber C, Fuchs B, Hodler J (2000) The results of repair of massive tears of the rotator cuff. J Bone Joint Surg Am 82:505–515
23. Gerber C, Maquieira G, Espinosa N (2006) Latissimus dorsi transfer for the treatment of irreparable rotator cuff tears. J Bone Joint Surg Am 88:113–120
24. Gerber C, Rahm SA, Catanzaro S, Farshad M, Moor BK (2013) Latissimus dorsi tendon transfer for treatment of irreparable posterosuperior rotator cuff tears: long-term results at a minimum follow-up of ten years. J Bone Joint Surg Am 95:1920–1926
25. Gerber C, Canonica S, Catanzaro S, Ernstbrunner L (2018) Longitudinal observational study of reverse total shoulder arthroplasty for irreparable rotator cuff dysfunction: results after 15 years. J Shoulder Elb Surg 27(5):831–838
26. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC (1994) Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. (304):78–83
27. Hartzler RU, Barlow JD, An KN, Elhassan BT (2012) Biomechanical effectiveness of different types of tendon transfers to the shoulder for external rotation. J Shoulder Elbow Surg 21:1370–1376
28. Jost B, Puskas GJ, Lustenberger A, Gerber C (2003) Outcome of pectoralis major transfer for the treatment of irreparable subscapularis tears. J Bone Joint Surg Am 85:1944–1951
29. Kanatlı U, Özer M, Ataoğlu MB et al (2017) Arthroscopic-assisted latissimus dorsi tendon transfer for massive, irreparable rotator cuff tears: technique and short-term follow-up of patients with pseudoparalysis. J Arthrosc Relat Surg 33(5):929–937
30. Keener JD, Wei AS, Kim HM, Steger-May K, Yamaguchi K (2009) Proximal humeral migration in shoulders with symptomatic and asymptomatic rotator cuff tears. J Bone Joint Surg Am 91:1405–1413
31. Lädermann A, Denard PJ, Collin P (2015) Massive rotator cuff tears: definition and treatment. Int Orthop 39:2403–2414
32. Levy O, Mullett H, Roberts S, Copeland S (2008) The role of anterior deltoid reeducation in patients with massive irreparable degenerative rotator cuff tears. J Shoulder Elbow Surg 17:863–870

Zusammenfassung

Pseudoparalyse und Pseudoparese der Schulter. Klinische Präsentation, Biomechanik und Auswirkungen auf die Behandlung

Hintergrund: Rotatorenmanschettenmassenrupturen machen fast die Hälfte der behandelten Rotatorenmanschettenrupturen aus. Die klinische Symptomatik erstreckt sich von Schmerzen bis zum Verlust der aktiven Schultergelenkbeweglichkeit. Die Begriffe „Pseudoparalyse und Pseudoparese" werden in der Literatur inkonsistent verwendet. Beiden Begriffen gemeinsam ist eine limitierte aktive bei simultan vorliegender freier passiver Schulterbeweglichkeit.
Fragestellung: Es soll eine konsistente Definition für Pseudoparalyse und Pseudoparese der Schulter erstellt werden. Die strukturellen und biomechanischen Unterschiede zwischen diesen beiden Typen von Rotatorenmanschettenrupturen werden aufgezeigt, sowie deren Einfluss auf die Behandlung analysiert.
Methoden: Eine Übersichtsarbeit über die Schlüssel- und Grundlagenstudien bezüglich klinischer Symptome, biomechanischer Unterschiede sowie deren Einfluss auf die Therapieoptionen für Pseudoparalyse und Pseudoparese wurde durchgeführt.
Ergebnisse: Biomechanisch bestehen strukturelle Unterschiede zwischen Pseudoparalyse (aktive Abduktion in der Skapulaebene unter 45°) und Pseudoparese (aktive Abduktion in der Skapulaebene zwischen 45 und 90°). Im Fall einer posterosuperioren Rotatorenmanschettenmassenruptur ist die Integrität des unteren Subskapularissehnenanteils der stärkste prädiktive Faktor für die aktive Elevation des Humerus. Patienten mit einer Pseudoparalyse haben häufig eine Rupturausdehnung in die untere Hälfte der Subskapularissehne sowie einen höheren Grad der fettigen Infiltration der Subskapularismuskulatur. Die therapeutischen Optionen sind abhängig vom Zeitpunkt und der Reparierbarkeit der Ruptur. Die Rekonstruktion einer akuten und rekonstruierbaren Rotatorenmanschettenruptur kann zuverlässig die aktive Beweglichkeit wiederherstellen. In chronischen und irreparablen Fällen variieren die therapeutischen Optionen von konservativ, partieller Rotatorenmanschettenrekonstruktion, superiorer Kapselrekonstruktion, zu Sehnentransfer und schließlich inverser Schulterprothese, wobei Letztere die zuverlässigste Behandlungsoption insbesondere bei älteren Menschen darstellt.
Schlussfolgerung: Die konsistenteste Definition für eine Pseudoparalyse der Schulter beinhaltet eine massive Rotatorenmanschettenruptur, die zu einer eingeschränkten aktiven (<45° Schulterelevation) bei freier passiver Schultergelenkbeweglichkeit – ohne neurologische Ursache für eine Paralyse – führt. Die Integrität der Subskapularissehne ist der wichtigste strukturelle Unterscheidungspunkt zwischen einer pseudoparalytischen und pseudoparetischen (aktive Schulterelevation zwischen 45 und 90°) Schulter. Die Entscheidungsfindung für die chirurgischen Therapieoptionen richtet sich mehr nach der Rekonstruktionsmöglichkeit einer Sehnenruptur und dem Alter des Patienten als nach der Differenzierung zwischen Pseudoparalyse und -parese.

Schlüsselwörter
Rotatorenmanschettenverletzungen · Arthroskopie · Sehnentransfer · Schulterprothese · Klinische Entscheidungsfindung

33. Malahias MA, Brilakis E, Avramidis G, Antonogiannakis E (2019) Satisfactory mid-term outcome of subacromial balloon spacer for the treatment of irreparable rotator cuff tears. Knee Surg Sports Traumatol Arthrosc 27:3890–3896
34. Memon M, Kay J, Quick E, Simunovic N, Duong A, Henry P, Ayeni OR (2018) Arthroscopic-assisted latissimus dorsi tendon transfer for massive rotator cuff tears: a systematic review. Orthop J Sports Med 6(6):2325967118777735. https://doi.org/10.1177/2325967118777735
35. Meyer DC, Wieser K, Farshad M, Gerber C (2012) Retraction of supraspinatus muscle and tendon as predictors of success of rotator cuff repair. Am J Sports Med 40:2242–2247
36. Mihata T, Lee TQ, Hasegawa A, Kawakami T, Fukunishi K, Fujisawa Y, Itami Y, Ohue M, Neo M (2018) Arthroscopic superior capsule reconstruction can eliminate pseudoparalysis in patients with irreparable rotator cuff tears. Am J Sports Med 46:2707–2716
37. Mihata T, Lee TQ, Watanabe C, Fukunishi K, Ohue M, Tsujimura T, Kinoshita M (2013) Clinical results of arthroscopic superior capsule reconstruction for irreparable rotator cuff tears. Arthroscopy 29:459–470
38. Mihata T, McGarry MH, Pirolo JM, Kinoshita M, Lee TQ (2012) Superior capsule reconstruction to restore superior stability in irreparable rotator cuff tears: a biomechanical cadaveric study. Am J Sports Med 40:2248–2255

39. Moor BK, Bouaicha S, Rothenfluh DA, Sukthankar A, Gerber C (2013) Is there an association between the individual anatomy of the scapula and the development of rotator cuff tears or osteoarthritis of the glenohumeral joint? A radiological study of the critical shoulder angle. Bone Joint J 95 B:935–941
40. Oh JH, Kim SH, Shin SH, Chung SW, Kim JY, Kim SH, Kim SJ (2011) Outcome of rotator cuff repair in large-to-massive tear with pseudoparalysis: a comparative study with propensity score matching. Am J Sports Med 39:1413–1420
41. Patte D (1990) Classification of rotator cuff lesions. Clin Orthop Relat Res (254):81–86
42. Resch H, Povacz P, Ritter E, Matschi W (2000) Transfer of the pectoralis major muscle for the treatment of irreparable rupture of the subscapularis tendon. J Bone Joint Surg Am 82:372–382
43. Spross C, Behrens G, Dietrich TJ, Kim OCH, Puskás GJ, Zdravkovic V, Jost B (2019) Early arthroscopic repair of acute traumatic massive rotator cuff tears leads to reliable reversal of pseudoparesis: clinical and radiographic outcome. Arthroscopy 35:343–350
44. Tokish JM, Alexander TC, Kissenberth MJ, Hawkins RJ (2017) Pseudoparalysis: a systematic review of term definitions, treatment approaches, and outcomes of management techniques. J Shoulder Elbow Surg 26:e177–e187
45. Valenti P, Sauzières P, Katz D, Kalouche I, Kilinc AS (2011) Do less medialized reverse shoulder prostheses increase motion and reduce notching? Clinical Orthopaedics and Related Research. 2011:2550–2557
46. Werner CML, Steinmann PA, Gilbart M, Gerber C (2005) Treatment of painful pseudoparesis due to irreparable rotator cuff dysfunction with the delta iii reverse-ball-and-socket total shoulder prosthesis. J Bone Joint Surg Am 87(7):1476–1486
47. Wieser K, Rahm S, Schubert M, Fischer MA, Farshad M, Gerber C, Meyer DC (2015) Fluoroscopic, magnetic resonance imaging, and electrophysiologic assessment of shoulders with massive tears of the rotator cuff. J Shoulder Elbow Surg 24:288–294