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Acute Cuff Tear Repair Trial (ACCURATE): protocol for a multicenter, randomized, placebo-controlled trial on the efficacy of arthroscopic rotator cuff repair

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ABSTRACT

Introduction: Rotator cuff tear is a very common and disabling condition that can be related to acute trauma. Rotator cuff tear surgery is a well-established form of treatment in acute rotator cuff tears. Despite its widespread use and almost position as a gold standard, the efficacy of an arthroscopic rotator cuff repair is still unknown. The objective of this trial is to investigate the difference in

outcome between arthroscopic rotator cuff repair and inspection of the shoulder joint defined as placebo surgery in patients 45 to 70 years of age with an acute rotator tear related to trauma.

Methods and analysis:

Acute Cuff Tear Repair Trial (ACCURATE) is a randomized, placebo controlled, multicenter efficacy trial with sample size of 180 patients. Concealed allocation is done in 1:1 ratio. The randomization is stratified according to participating hospital, gender, and baseline WORC index. Both groups receive the same standardized postoperative treatment and physiotherapy. The primary outcome measure is the change in WORC score from baseline until two years follow-up. Secondary outcome measures include Constant-Murley score, the Numerical Rating Scale for pain, subjective patient satisfaction and the health-related quality of life instrument 15D. Patients and outcome assessors are blinded from the allocated intervention. The primary analysis of results will be conducted according to intention-to-treat analysis.

Discussion: The design of the Acute Cuff Tear Repair Trial allows the evaluation of clinical benefit of arthroscopic rotator cuff repair. If cuff repair is effective and superior to placebo surgery doctors have a strong scientific support to recommend surgery when counseling with the patient. If on the other hand placebo surgery is superior to cuff repair or cuff repair has no benefit over placebo surgery, there is no indication to perform arthroscopic rotator cuff repair in patients with trauma related full-thickness supraspinatus tear with acute symptoms.

Ethics and Dissemination: The study protocol for this clinical trial has been approved by the Ethics Committee of the Hospital District of Southwest Finland and Regional Ethics Committee in Linköping Sweden and REK sør-øst in Norway. Every recruiting center will apply local research approvals. The results of this study will be submitted for publication in peer-reviewed journals.

Trial registration number: ClinicalTrials.gov NCT02885714

Strengths and limitation of this study

· This study will eventually demonstrate the true efficacy of an arthroscopic rotator cuff repair by using a placebo-controlled study design.

· Multicenter setup and three participating countries advance generalizability and external validity of this trial.

· The results of this trial are limited to patients with trauma related full-thickness supraspinatus tendon tears with acute symptoms.

INTRODUCTION

Background and rationale

The prevalence of full-thickness rotator cuff tears is reported to be between 23-32% in previously symptom-free middle-aged patients after having a shoulder trauma. [1-5]. An acute cuff tear is associated with impaired quality of life, and symptoms such as pain in abduction, abduction weakness, and night pain [6]. In clinical practice these patients are often referred to an arthroscopic rotator cuff repair (ACR) for curative treatment [7]. In such an operation the glenohumeral joint is visualized through arthroscopy, the torn tendon is re-attached to its bony footprint, and postoperatively the arm is immobilized in a sling followed by a rehabilitation program. Good clinical results have been reported on surgical treatment [4, 8-11], and subsequently the number of operations and cost of treatment have substantially increased during the past years [12-15]. However, these reports cannot be held as a safeguard that the surgery itself is effective, because of the study designs without a proper control group.

The reported outcome of surgical treatment is thought to be a cumulative effect of three main elements: the critical surgical element, the true placebo effect and non-specific effects [16, 17]. The critical surgical element (in this case repairing the torn tendon) is the component of the surgical procedure that is believed to provide the therapeutic effect and is distinct from aspects of the procedures that are diagnostic or required to access the disease being treated (in this case shoulder arthroscopy) [18]. The true placebo effect is the clinical improvement related specifically to placebo manipulation [16]. It is not a result of placebo itself, but of the context in which placebo is administered, as well as patient's anticipation of benefit, their previous experience with treatment and their interactions with the health professionals [19]. The non-specific effects are caused by the natural history of the disease, regression to the mean, fluctuations in symptom severity, non-specific effects of taking part in a trial such as patients' reaction to being observed and assessed or to additional contact with clinicians [20].

A placebo procedure's function is to simulate the active procedure. It has no real therapeutic effect, and is by definition inert. Therefore, it is the ultimate comparator for the active treatment in clinical randomized controlled trials. With a placebo as comparator in a controlled setup both the placebo and non-specific effects are comparable, and the bias is minimized in investigating the true efficacy of an active treatment. There is some evidence that surgery may not be more effective than conservative treatment alone in treating symptomatic degenerative cuff tears [21]. However, this may not be the case with trauma related tears with acute symptoms. Hitherto there is a lack of evidence, as there are no randomized, placebo controlled trials on the efficacy of surgical treatment of acute cuff tears.

Objectives

The objective of the Acute Cuff Tear Repair Trial (ACCURATE) is to investigate the difference in outcome between placebo surgery (PS) and arthroscopic rotator cuff repair (ACR) in patients aged 45-70 years with an acute full-thickness supraspinatus tear related to trauma. Our hypothesis is that ACR yields superior results compared to PS in the treatment of an acute tear.

Trial design

ACCURATE is an ongoing randomized, placebo controlled, multicenter efficacy trial, with two parallel (1:1) treatment arms.

METHODS

Study setting

The study protocol is designed according to Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) statement [22] and will be reported using the recommendations in the Consolidated Standards of Reporting Trials (CONSORT) statement [23].

Recruitment

Altogether 14 centers in three countries are signed to recruit patients: eight centers in Finland (Turku University Hospital, Satakunta Central Hospital, Oulu University Hospital, Kuopio University Hospital, Tampere University Hospital, Central Finland Central Hospital, Helsinki University Hospital, Vaasa Central Hospital) three in both Sweden (Linköping University Hospital, Kalmar County Hospital, Helsingborg Hospital) and Norway (Martina Hansens Hospital, Oslo University Hospital, Sorlandet Hospital HF Kristiansand). All three countries have a country manager who belongs to the ACCURATE study chair. Country managers organize the center's participating doctors locally.

All eligible patients are asked to participate in the trial, and a written informed consent is obtained. The patients are openly and thoroughly explained the two different treatment modalities at recruitment. Thereafter, the patients are blinded from the treatment modality. The treatment must be commenced within four months after the initial traumatic event. All screened patients fulfilling the inclusion criteria are recorded.

Eligibility criteria

The ACCURATE trial is set out to investigate the performance of ACR under an ideal and controlled circumstance. Therefore, the eligibility criteria are designed in accordance.

Patients with a previously healthy shoulder and acute shoulder pain and dysfunction, following a traumatic event, are referred to trial centers. Involved shoulder surgeons examine and assess the patients for eligibility (age 45 to 70 years, acute symptoms after trauma for less than 4 months, and magnetic resonance imaging (MRI) documented full thickness supraspinatus tear). A traumatic event is defined as any kind of sudden stretch, pull, fall, or impact, on the upper extremity that is associated with the onset of symptoms. Symptoms have to be typical to cuff tear (pain laterally on the shoulder and/or painful motion arc during abduction or flexion). The patients who fulfil the inclusion criteria are recorded and screened for exclusion criteria.

After a thorough clinical examination standard shoulder radiographs and MRI are carried out for all potential study patients. Patients with a large rotator cuff tear (sagittal tear size at the level of footprint > 3cm on the MRI), clinical signs of a major tear in infraspinatus or subscapularis (positive clinical rotatory lag sign, External Rotation Lag Sign (ER1 lag) >10 degrees, or lift off lag, involuntary drop against the back) are excluded. Also patients with concomitant injuries (nerve injuries, fractures, bony avulsion of the tendons, dislocated long head of the biceps tendon, humeral head or acromioclavicular joint dislocation) in the shoulder region, which can ultimately interfere with the treatment and interpretation of symptoms, are excluded. The condition of glenohumeral joint, tendons and musculature may also affect the treatment outcome. Therefore, patients with incongruent or osteoarthritic joint, previous symptoms or treatment of the ipsilateral shoulder, as well as patients with severe fatty degeneration of the muscles of the rotator cuff, are excluded [24-27] .

All inclusion and exclusion criteria are listed in the Table 1.

Baseline

All baseline demographics are listed in Table 2. High preoperative expectations is described to correlate with better results after rotator cuff surgery [28, 29] and low expectations with failure [30]. To address the validity of the trial in the light of expectancies [31, 32] we measure the preoperative expectations with Stanford Expectations of Treatment Scale (SETS) [33]. Depression and anxiety may have a negative impact on self-assessed outcome measurements in patients scheduled for rotator cuff repair [34]. Therefore we assess the preoperative psychological distress with the Hospital Anxiety and Depression Scale (HADS) [35].

Enrolled patients must be scheduled for intervention within four months from the initial trauma. Preoperative scoring is arranged within 2 weeks before surgery.

Interventions

All patients receive regional nerve block and/or general anesthesia. Also prophylactic antibiotic is administered for all patients. These are not standardized, but delivered as a routine practice of each hospital. The arthroscope is introduced in the glenohumeral joint, and thereafter a thorough diagnostic arthroscopy is performed. The presence of a full-thickness cuff tear is verified by introducing a probe/switching stick through the subacromial space into the joint. If the diagnostic arthroscopy reveals a partial thickness cuff tear only, a total width of infraspinatus or subscapularis tear or a fully dislocated long head of the biceps tendon with concomitant subscapularis tear the patient is excluded from the trial and treated according to local routine. After the diagnostic arthroscopy and confirmation of the eligibility criteria the patient is randomly assigned to ACR or PS, and treated accordingly. A detailed list of findings to be documented during the diagnostic arthroscopy is given in Table 3.

Study interventions

Rotator cuff repair

A biceps tenotomy or tenodesis may be performed according to surgeon preference if the biceps tendon is noted to be frayed, unstable or inflamed. An additional acromioplasty may be performed according to surgeon preference if there are signs of mechanical tightness (fraying on the undersurface and close contact to the cuff structures). The rotator cuff insertion is prepared and the cuff tear is repaired to its anatomic location using suture anchors according to surgeon preference. No additional procedures are performed with regard to possible concomitant pathologies of articular cartilage, or labrum. The wounds are closed and the arm is placed in a sling. A detailed list of procedures to be documented in the rotator cuff repair group is given in Table 4.

Placebo surgery

Only the joint space is evaluated, no subacromial scoping is performed. Nothing is to be removed or excised and the use of any electrocautery or shaver device is not allowed. Altogether 3 to 5 small skin stab incisions are made in typical locations resembling locations of typical rotator cuff repair. After the

evaluation the wounds are closed and the arm is placed in a sling. The time spent in the operating theatre with patients in the placebo group should resemble the time spent with patients in the active treatment group and hence give an impression of a rotator cuff repair.

Postoperative physiotherapy

The postoperative care and rehabilitation is identical in both the ACR and PS groups. The rehabilitation program is based on the current literature [36-41] as well as clinical experience. The program consists of one initial phase (0-4 weeks) were the patients are immobilized in a sling and during this time the exercise program is standardized. After the sling has been phased out the rehabilitation program consists of three phases. Phase one consist of active assisted range of motion exercises, phase 2 of active unloaded exercises and phase 3 of dynamic strengthening exercises. There are several exercises to choose from in each phase in purpose to fit each patients shoulder disability. The physiotherapist decides when the patient is ready to move on to the next phase, considering aspects of quality of motion and pain, in accordance with restrictions. The patients will have approximately 15 visits of physiotherapist guided exercises sessions during a 5- month period. Each visit will take approximately 30-45 minutes. In between these guided exercise sessions patients will perform home-exercises acoording to the different phases. An exercise diary is used to encourage adherence and is handed out at the first visit.

A detailed exercise program is presented in Appendix 1. All patients receive a prescription for analgetics according to local routine to be used if needed. The patients receive a sick leave up to 12 weeks, which can be extended if needed.

Outcomes

Primary outcome

Western Ontario Rotator Cuff index (WORC)

The primary outcome measure is the change in WORC [42] at 2 year follow-up compared to baseline. WORC is a disease specific self-reported instrument for rotator cuff disease. It consists 21 visual analog scale (VAS) items in five domains: physical symptoms (six items), sports/recreation (four items), work (four items), lifestyle (four items) and emotions (three items). All items respect quality of life (QoL) aspects that can particularly be influenced by rotator cuff injury. Each item has a possible score from 0 to 100 (100 mm VAS), and these scores are added to give a total score from 0 to 2100. A score of 0 implies no reduction in QoL, and a score of 2100 is the worst score possible. The data can be

converted to a percent score by inverting the raw score and then converting it to a score out of 100 (2100 – ''patient WORC raw score''/21). The domains are based on the World Health Organization definition of health. WORC is determined to have the highest ratings among all shoulder instruments [43]. The minimally clinically important change (MCIC) for WORC is reported to be 275 points, or 12.8 % [44].

Secondary outcomes

Constant-Murley Score

The Constant-Murley score [45] is the most widely used shoulder evaluating instrument in Europe despite its limitations [46-48]. The 100-point scoring scale takes into account both subjective and objective measurements and is divided into four domains (pain: 15 points; activities of daily living: 20 points; range of motion: 40 points; strength: 25 points). Minimal clinically important difference (MCID) for Constant-Murley score is reported to be between 10.4-17 points [49, 50].

Numerical Rating Scale for pain (Pain NRS)

Pain NRS is a unidimensional measure of pain intensity [51]. The 11-point numeric scale ranges from '0' representing no pain to '10' representing pain as bad as you can imagine or worst pain imaginable. We use pain NRS to measure patient's perceived pain intensity during activity, at rest and at sleep during the last week preceding the assessment. MCIC for pain NRS is reported to be 2 points or 30 % [52, 53].

15D

The 15D is a generic, comprehensive (15-dimensional), self-administered instrument for measuring health-related quality of life (HRQoL) [54]. It combines the advantages of a profile and a preference-based, single index measure. A set of utility or preference weights is used to generate the 15D score (single index number) on a 0-1 scale. The estimated MCIC in the 15D scores is reported to be 0.015 [55].

Subjective patient satisfaction

To assess the patient's global satisfaction with the treatment outcome we use a 5 point Likert scale for evaluation.

Imaging studies

Preoperative imaging studies include standard shoulder radiographs and MRI. Radiographs and MRI studies will be done for both groups at 2, 5 and 10 years follow-ups to assess any signs of osteoarthritis (according to Samilson et Prieto) or cuff tear arthropathy (according to Hamada classification) in the radiographs and muscle fatty degeneration (according to Fuchs/Goutallier) and tear progression or re-tears (according to Sugaya [56]) in the MRI. Detailed list of parameters to be reported from the imaging studies are in Table 5.

Participant timeline

Detailed schedule for the assessments are presented in the table 6 and the flow chart of the trial in figure 1.

Assignment of intervention

Allocation

We use computerized internet-based online randomization software application (https://www.randomize.net/) to allocate patients to the intervention (rotator cuff repair) or control (placebo surgery) group. Randomization is done in the operation theatre after the diagnostic arthroscopy when the final confirmation of the eligibility criteria is ascertained. The randomization is stratified, according to participating hospital (X), gender (2), and baseline WORC index (3 separate lists: <20%, 20%-40%, >40%), into (Xx2x3) 6X randomization lists respectively (with variable block size known only by the trial statistician).

Blinding

The patients are openly explained the different treatment modalities at recruitment. Thereafter, the patients, the hospital staff and outcome assessors are unaware of treatment allocation. Only the operating doctor and involved operating theatre personnel know the treatment group of the patient and are not allowed to share this information further. The operating doctor will not see the patient after the operation at any point. There will be no information on the treatment group in the patient files or hospital charts. The content of patient operative file includes information on the date, doctor, randomization number and text (arthroscopy of the right/left shoulder, treatment according to ACCURATE protocol). Registered code of the intervention in the official hospital charts will be the code for arthroscopic rotator cuff repair. Patient follow-ups are performed by a blinded physiotherapist.

Whenever needed a blinded doctor is consulted. There is a blinded who will see the patient at the outpatient clinic at 3 months postoperative, which is the normal routine in our hospitals.

The blinding may only be unrevealed in case of serious adverse event, treatment failure (serious persisting symptoms six months after the treatment) or discontinuation. The need of unblinding is evaluated by the blinded doctor, who then contacts the trial country manager who decides on the unblinding. In no case must the local operating doctor and the blinded doctor discuss directly with regard to issues within this trial.

Failure to maintain blinding can lead to differences in perceived treatment and can contribute to differences between the active treatment and placebo groups. This can limit the internal validity of the trial [31]. We use a 5-point Likert scale Blinding index to evaluate the success and maintaining of blinding at discharge, 3 months, 6 months, 1 year and 2 years after the intervention [57].

Declined cohort

The patients who are otherwise eligible but do not want any operation and/or do not want to participate, are asked for a permission for a later patient file follow-up and to participate in a follow-up study. An informed consent is obtained from these patients. The patient receives the treatment he/she desires after counseling with the involved doctor. The baseline demographics together with treatment modality, WORC outcome measure at baseline, 1 and 2 year follow-up are collected (Table 2).

Patient and public involvement

Patients were not involved in the design, recruitment or conduct of this study. Patients will be informed by the results of the study after completion.

DATA MANAGEMENT AND ANALYSIS

Data management

All data for this study is collected from trial specific patient report forms. The patient information is also stored electronically. The original paper forms with regard to patient evaluation are stored

securely by the local operating doctor, blinded doctor and the physiotherapist in a locked folder. The original paper forms of screened, recruited, and treated patients are stored securely by the local operating doctor. All imaging data is stored in individual CD-R discs and sent by mail to the study nurse after completion of the recruitment and at 2, 5 and 10 year follow-up.

All data is stored and secured in a specific paper form and electronic study subject register held at the coordinating center; Turku University Hospital, TULES Division, Upper Extremity Department. Informed consent is collected, regarding transformation of data to Finland, from Sweden and Norway. The trial patient data is stored for 10 years after the final follow-up.

Sample size

The power calculation is based on assumed behavior of the WORC score. The mean score value at baseline is assumed to be 40% [45, 57]. The mean score of the best treatment group after the follow-up is assumed to be 85% [58]. The standard deviation is assumed to be 18% [57]. The trial is set out to reliably detect the reported minimally clinically important change of WORC, i.e. 273 points (13 % of the total 2100 points) [45]. Therefore the score of the most inefficient treatment group is assumed to be less than 73%. The correlation between measurements during the follow-up is estimated to be about 0.40 to 0.50. In an analysis of variance (ANOVA) test with alpha of 0.05 and power of 95%, we can expect the findings to be statistically significant if the number of subjects in each group is 72. Because of possible drop-outs, the minimum number of subjects per group is decided to be 90.

Missing items

Items of WORC score subdomains are summed to form a score for each subdomain and subsequently total WORC score is a sum of all subdomain scores. Due the nature of WORC score and summing of items, missing items would affect the score interpreting ”worst case scenario”. Therefore, actions for missing items are applied.

Substituting average value. Missing individual items in WORC score subdomains are considered as missing at random (MAR) if only one item is missing per subdomain and thus substituted with average value of available item in each subdomain. Substitution is justified due to reasonably high correlation between items within subdomains [58].
Last observation carried forward (LOCF). If WORC score is missing for any subdomain on adjacent follow-up measures, the last available measurement is substituted.

Hot Deck imputation. Missing WORC scores on any follow-up measurement are substituted using ”Hot Deck” method by matching patients to each other using demographic information such as age, center, gender and WORC score at baseline and substitute missing value with matched patients WORC score on at the follow-up.

Loss to follow-up

Because of possible drop-outs, the minimum number of subjects per group is decided to be 90. This allows to retain statistical power with loss to follow-up, and therefore no imputation or simulation is performed for incomplete records.

Retention

The study nurse stores and holds the paper and electronic patient registry for this trial and checks the data for uncompleted items. In case of non-adherence the investigating doctor is contacted and the reason for non-adherence is collected.

Statistical methods

After completion of 1, 2, 5, and 10 year follow up the cohort data is collected by the principle investigator and will be analysed by an independent statistician (blinded from the treatment arms). Methods suitable for clinical trial regarding comparison of parallel treatment groups with repeated measurements.

A detailed statistical analysis plan (SAP) will be prepared prior to database lock. Any deviations to the planned analyses specified within the SAP will be justified in writing and presented within the final study report.

The intention-to-treat (ITT) dataset will include all enrolled patients who received study treatment and have at least one post baseline primary outcome measurement available. The per protocol (PP) dataset is a subset of the ITT dataset excluding patients or measurements for a given patient with major protocol violation(s) expected to alter the outcome to treatment. The primary outcome measures will be analysed using both the ITT (primary analysis) and the PP dataset.

All background, outcome and safety variables will be summarized by visits. In addition to absolute values, changes relative to baseline values will be summarized, if feasible. Correlations among the study variables may be investigated. The results of outcome variables over the course of the study will be summarized descriptively. Disposition and reasons for discontinuation will be summarized for all patients together with treatment exposure and study duration by treatment group.

The analysis of the primary outcome measure will be done using the generalized linear mixed models. Generalized auto-regressive covariance structure will be used to take into account spatial differences between measuring timepoints. Definition and usage of factors and covariates and the full model is

described in more detail in SAP. All results will be presented with 95% CI's. A two-sided significance level of 0.05 will be used. Multiple correction is applied to all pairwise comparisons including timepoint comparisons and is presented with unadjusted P-values and confidence intervals.

The analysis of secondary outcome measures (change in Constant-Murley score compared to baseline at two years; change in patients' shoulder pain during the last week at rest, during activity and at night (continuous); change in subjective pain intensity measure (continuous pain NRS); change in generic health-related quality of life instrument 15D (continuous); subjective patient satisfaction (classifying); and, radiographic findings) will be done using standard statistical methods for paired data (e.g. McNemar's test for binary data, Wilcoxon signed rank test for ordinal data, and paired t-test for continuous data). Subjects attaining change in WORC and Constant-Murley score greater than MCID are considered as *responders* to the treatment. Evaluation of reaching MCID is done in each timepoint individually and responder status is carried over to all adjacent timepoints once attained. Responder analysis will be carried out with generalized logistic regression model with responder/non-responder as an outcome. In addition, generalized linear mixed models may be used to further characterize the results. All secondary analyses are designed to be supportive of the analysis of the primary endpoint and each analysis will be undertaken at the two-sided 5% level of significance.

If feasible, subgroup analyses will be conducted, for example, by (pooled) center, age, gender, handedness, tear size and appearance, mechanism of injury, and smoking habits.

Statistical analysis, tables and patient data listings will be performed with SAS® version 9.3 for Windows (SAS Institute Inc., Cary, NC, USA).

Blinded data interpretation

To minimize the chance of misleading interpretation of the final data we use the recommended approach of blinded data interpretation [59]. At this stage of the analysis the authors and the statistician are blinded from the two treatment arms when analysing the results. The approach involves developing two interpretations of the results on the basis of a blinded review of the primary outcome data (treatment A compared with treatment B). One interpretation assumes that A is the rotator cuff repair group and another assumes that A is the placebo surgery group. After agreeing that there will be no further changes, the investigators record their decisions and sign the resulting document. The randomization code is then broken, the correct interpretation chosen, and the manuscript finalized.

Monitoring

Data monitoring

The patient data is monitored weekly by the research nurse. In case of delay / interruption in patient data the study nurse informs the local doctor, physiotherapist and the principle investigator in Finland.

The trial leader performs an interim analysis of the available outcome data when 90 (50 %) patients have been recruited and treated to confirm safety and ethical considerations of the study. In case of significantly more adverse events or re-operations within any of the treatment modalities, a premature discontinuation of the study is considered.

Harms

Adverse events (AEs) are documented at the scheduled and unscheduled clinical visits. The patients are urged to report any adverse events or health-related issues immediately after appearance to the blinded doctor. In case of any adverse event the blinded doctor informs the study nurse and the principle investigator in Finland. All adverse events regardless of suspected relationship to the study will be recorded. The blinded doctor assesses the likelihood of the adverse event to be caused by the study treatment on a six-grade causality scale (none, unlikely, possible, probable, definite, cannot be classified). The severity of all adverse events is assessed on a three-grade scale (mild, moderate, severe). All adverse events are dealt with in a symptomatically adequate manner and the patients are hospitalized if needed.

ETHICS AND DISSEMINATION

Ethical approval

The study protocol for this clinical trial has been approved by the Ethics Committee of the Hospital District of Southwest Finland (17.5.2016) and Regional Ethics Committee in Linköping Sweden (2016/263-31) and REK sør-øst in Norway (2016/1446 REK sør-øst B). Every recruiting center will apply local research approvals. ACCURATE trial will be conducted according to the World Medical Association (WMA) Declaration of Helsinki. The template informed consent (in Finnish, Swedish, Norwegian and English) is contained in Appendix 2.

Protocol amendments

Any modifications to the protocol which may affect the conduct of the study, the potential benefit of the patient or patient safety, including changes of study objectives, study design, patient population, sample sizes, study procedures, or significant administrative aspects will require a formal amendment to the protocol. Such amendment will be agreed upon by ACCURATE study chair (main authors of this protocol), and will need approval by the Ethics Committees prior to implementation.

Administrative changes of the protocol are minor corrections and/or clarifications that have no effect on the way the study is to be conducted. These administrative changes will be agreed upon by ACCURATE study chair, and will be documented and updated in the trial registry at ClinicalTrials.gov (NCT02885714).

Consent or assent

Informed consent will be obtained by the local recruiting doctor in each participating center. The consent form is either in Finnish, Swedish or Norwegian. Consent is also obtained from the eligible patient who do not want to participate in the study.

Confidentiality

All patient data (paper forms and electronic database) is handled with confidentiality and will be stored securely. During analyses the patient's personal identification numbers are blinded.

Access to data

The study nurse holds the register of treatment groups and patients within the trial. Only the study nurse may access the patient data during the data collection. During the interim analyses the trial leader has access to the data set. At follow-ups the gathered patient data is analysed by the statistician and authors of the manuscript. The treatment arms will be uncoded after the blinded data interpretation and the study nurse is the only one who knows the codes.

Ancillary and post-trial care

All patients enrolled in the trial have the possibility to contact the local blinded doctor with regard to their treated shoulder at any stage during the trial. A patient may also withdraw consent and discontinue the study prematurely at any time if he or she so wishes. The patients are informed of the trial results by letter after the analyses of two years follow-up is completed.

Dissemination policy

The results of this study will be submitted for publication in peer-reviewed journals.

DISCUSSION

In this ACCURATE protocol we describe the design of a placebo controlled randomized trial on the efficacy of ACR versus PS in patients with full-thickness supraspinatus tear related to trauma with acute symptoms. This enables evaluation of clinical benefit of ACR for the patient, using a validated patient-reported outcome measure. To our knowledge this is the first placebo controlled trial on the subject. The rationale for the ACCURATE trial includes: 1. Rising incidence of ACRs worldwide; 2. Almost a gold standard position of rotator cuff repair on trauma related cuff tears with acute symptoms; 3. The lack of evidence on the efficacy of ACR.

There are several patient related factors, which may influence the outcome of cuff tear in light of cuff integrity, shoulder function and patient satisfaction, such as tear size, number of involved tendons and fatty infiltration of the rotator cuff musculature [60]. In the ACCURATE trial these factors are controlled by precise exclusion criteria. The internal validity of the trial is further ensured by: minimizing bias by use off an online computer-based randomizing system, blinding of patients and outcome accessors, use of appropriate statistical testing, blinded data interpretation, and an adequate sample size based on a power calculation. A cuff tear most often involves the supraspinatus tendon [2] and therefore an eligible patient (without concomitant pathologies) in the ACCURATE trial is an ideal candidate for ACR according to current clinical practice. The results of this trial are generalizable to patients with trauma related tears of the superior part of the rotator cuff with acute symptoms and applicable in evaluating the treatment paradigm. The multicenter setup and three participating countries further advance generalizability and external validity of the trial.

A major challenge in the ACCURATE trial, like in many placebo-controlled surgical trials, is to recruit a required number of patients in a reasonable period of time [17]. ACCURATE trial tries to tackle this obstacle by a large number of participating centers and by regular bulletins. Some problems can certainly arise from a large number of recruiting doctors. Potential lack of equipoise, which might reflect on the doctors' presentation when counseling and recruiting the potential study patient. From the patient side for example previous positive experiences from surgery, or a strong preference for either operative or conservative treatment by the patient, family member or some other doctor. These barriers are dealt with in regular meetings and correspondence with guidance to thorough explanation and wording when recruiting potential participants.

The use of placebo may be criticized for leaving half of the patients not repaired. The ethical considerations regarding the trial setup are presented in Table 7. The main clinical concern is the potential tear progression and further fatty degeneration of the rotator cuff muscles, as reported in a purely degenerative setting [61-63]. On the other hand a re-tear or persistent defect in the rotator cuff,

after repair of small to medium sized tears, is a common finding in up to 10.6-50 % of the patients [64-66].

Interestingly the results of a meta-analysis by Russel et al. [67] suggest that the clinical outcome is similar after the rotator cuff repair regardless of the structural integrity of the repair. A cuff tear may also be associated with global degeneration of the glenohumeral joint. By following these patients ten years after injury the effect of ACR on the eventual development of ostearthritis and/or cuff tear arthropathy may be detected. There are only a few studies available on the evolution of a non-operatively treated traumatic tendon tears and there is up to date no randomized trial with published results [1, 62, 68]. Accordingly, significant short term tear size progression is unlikely. The potential progression is evaluated with a control MRI follow-up. Moreover, the clinical presentation of trial participants is regularly monitored for any complaint/adverse event, and the patients may be unblinded if necessary.

It can be estimated that in average 20 % of people in their 40s to 70s have an asymptomatic full-thickness cuff tear, and the prevalence increases with age [69]. Due to high number of asymptomatic degenerative tears the definition of a traumatic or acute cuff tear is controversial. It is thought that a significant trauma can rupture a healthy rotator cuff tendon. However, the tendons are usually weakened by increasing age-related degeneration [70]. Attempts have been made to distinguish between acute and chronic degenerative tears, through MRI or ultrasound imaging [71-73], without any accepted consensus. We argue that the criteria for an acute cuff tear, introduced in the ACCURATE protocol, reflect the general practice. There is a possibility that a MRI documented cuff tear after a trauma, is actually an acute-on-chronic tear with acute symptoms. However, these tears cannot be distinguished from each other. Furthermore, we exclude all patients with severe degenerative imaging findings as well as patients with preceding symptoms, to ensure inclusion of previously subjectively "healthy" shoulders only.

The aim and ultimate value of the ACCURATE trial is to demonstrate the true efficacy of an arthroscopic rotator cuff repair in patients with trauma related full-thickness supraspinatus tendon tear with acute symptoms. If the repair is effective and superior to placebo surgery doctors have a strong scientific support to recommend surgery when counseling these patients.

REFERENCES

1. Sorensen, A.K., et al., *Acute rotator cuff tear: do we miss the early diagnosis? A prospective study showing a high incidence of rotator cuff tears after shoulder trauma.* J Shoulder Elbow Surg, 2007. **16**(2): p. 174-80.
2. Kukkonen, J., et al., *Operatively treated traumatic versus non-traumatic rotator cuff ruptures: a registry study.* Ups J Med Sci, 2013. **118**(1): p. 29-34.
3. Braune, C., et al., *Mid-term results and quantitative comparison of postoperative shoulder function in traumatic and non-traumatic rotator cuff tears.* Arch Orthop Trauma Surg, 2003. **123**(8): p. 419-24.
4. Bjornsson, H.C., et al., *The influence of age, delay of repair, and tendon involvement in acute rotator cuff tears: structural and clinical outcomes after repair of 42 shoulders.* Acta Orthop, 2011. **82**(2): p. 187-92.
5. Aagaard, K.E., F. Abu-Zidan, and K. Lunsjo, *High incidence of acute full-thickness rotator cuff tears.* Acta Orthop, 2015. **86**(5): p. 558-62.
6. Mall, N.A., et al., *An evidenced-based examination of the epidemiology and outcomes of traumatic rotator cuff tears.* Arthroscopy, 2013. **29**(2): p. 366-76.
7. Tashjian, R.Z., *Epidemiology, natural history, and indications for treatment of rotator cuff tears.* Clin Sports Med, 2012. **31**(4): p. 589-604.
8. Lahteenmaki, H.E., et al., *Results of early operative treatment of rotator cuff tears with acute symptoms.* J Shoulder Elbow Surg, 2006. **15**(2): p. 148-53.
9. Petersen, S.A. and T.P. Murphy, *The timing of rotator cuff repair for the restoration of function.* J Shoulder Elbow Surg, 2011. **20**(1): p. 62-8.
10. Butler, B.R., et al., *Results of the repair of acute rotator cuff tears is not influenced by tear retraction.* Int J Shoulder Surg, 2013. **7**(3): p. 91-9.
11. Duncan, N.S., et al., *Surgery within 6 months of an acute rotator cuff tear significantly improves outcome.* J Shoulder Elbow Surg, 2015. **24**(12): p. 1876-80.
12. Colvin, A.C., et al., *National trends in rotator cuff repair.* J Bone Joint Surg Am, 2012. **94**(3): p. 227-33.
13. Judge, A., et al., *Temporal trends and geographical variation in the use of subacromial decompression and rotator cuff repair of the shoulder in England.* Bone Joint J, 2014. **96-B**(1): p. 70-4.
14. Ensor, K.L., et al., *The rising incidence of rotator cuff repairs.* J Shoulder Elbow Surg, 2013. **22**(12): p. 1628-32.
15. Paloneva, J., et al., *Increasing incidence of rotator cuff repairs--A nationwide registry study in Finland.* BMC Musculoskelet Disord, 2015. **16**: p. 189.
16. Ernst, E. and K.L. Resch, *Concept of true and perceived placebo effects.* BMJ, 1995. **311**(7004): p. 551-3.
17. Wartolowska, K., et al., *Use of placebo controls in the evaluation of surgery: systematic review.* BMJ, 2014. **348**: p. g3253.
18. Tenery, R., et al., *Surgical "placebo" controls.* Ann Surg, 2002. **235**(2): p. 303-7.
19. Colagiuri, B., et al., *The placebo effect: From concepts to genes.* Neuroscience, 2015. **307**: p. 171-90.
20. Savulescu, J., K. Wartolowska, and A. Carr, *Randomised placebo-controlled trials of surgery: ethical analysis and guidelines.* J Med Ethics, 2016. **42**(12): p. 776-783.
21. Ryosa, A., et al., *Surgery or conservative treatment for rotator cuff tear: a meta-analysis.* Disabil Rehabil, 2016: p. 1-7.
22. Chan, A.W., et al., *SPIRIT 2013 statement: defining standard protocol items for clinical trials.* Ann Intern Med, 2013. **158**(3): p. 200-7.
23. Schulz, K.F., et al., *CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials.* BMJ, 2010. **340**: p. c332.
24. Hamada, K., et al., *A radiographic classification of massive rotator cuff tear arthritis.* Clin Orthop Relat Res, 2011. **469**(9): p. 2452-60.
25. Samilson, R.L. and V. Prieto, *Dislocation arthropathy of the shoulder.* J Bone Joint Surg Am, 1983. **65**(4): p. 456-60.

26. Hamada, K., et al., *Roentgenographic findings in massive rotator cuff tears. A long-term observation.* Clin Orthop Relat Res, 1990(254): p. 92-6.
27. Fuchs, B., et al., *Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging.* J Shoulder Elbow Surg, 1999. **8**(6): p. 599-605.
28. Henn, R.F., 3rd, et al., *Patients' preoperative expectations predict the outcome of rotator cuff repair.* J Bone Joint Surg Am, 2007. **89**(9): p. 1913-9.
29. Oh, J.H., et al., *Effect of expectations and concerns in rotator cuff disorders and correlations with preoperative patient characteristics.* J Shoulder Elbow Surg, 2012. **21**(6): p. 715-21.
30. Dunn, W.R., et al., *2013 Neer Award: predictors of failure of nonoperative treatment of chronic, symptomatic, full-thickness rotator cuff tears.* J Shoulder Elbow Surg, 2016. **25**(8): p. 1303-11.
31. Colagiuri, B., *Participant expectancies in double-blind randomized placebo-controlled trials: potential limitations to trial validity.* Clin Trials, 2010. **7**(3): p. 246-55.
32. Frisaldi, E., A. Shaibani, and F. Benedetti, *Why We should Assess Patients' Expectations in Clinical Trials.* Pain Ther, 2017. **6**(1): p. 107-110.
33. Younger, J., et al., *Development of the Stanford Expectations of Treatment Scale (SETS): a tool for measuring patient outcome expectancy in clinical trials.* Clin Trials, 2012. **9**(6): p. 767-76.
34. Cho, C.H., et al., *The impact of depression and anxiety on self-assessed pain, disability, and quality of life in patients scheduled for rotator cuff repair.* J Shoulder Elbow Surg, 2013. **22**(9): p. 1160-6.
35. Zigmond, A.S. and R.P. Snaith, *The hospital anxiety and depression scale.* Acta Psychiatr Scand, 1983. **67**(6): p. 361-70.
36. Holmgren, T., et al., *Effect of specific exercise strategy on need for surgery in patients with subacromial impingement syndrome: randomised controlled study.* BMJ, 2012. **344**: p. e787.
37. Harris, J.D., et al., *Predictors of pain and function in patients with symptomatic, atraumatic full-thickness rotator cuff tears: a time-zero analysis of a prospective patient cohort enrolled in a structured physical therapy program.* Am J Sports Med, 2012. **40**(2): p. 359-66.
38. Kluczynski, M.A., et al., *Early Versus Delayed Passive Range of Motion After Rotator Cuff Repair: A Systematic Review and Meta-analysis.* Am J Sports Med, 2015. **43**(8): p. 2057-63.
39. Thigpen, C.A., et al., *The American Society of Shoulder and Elbow Therapists' consensus statement on rehabilitation following arthroscopic rotator cuff repair.* J Shoulder Elbow Surg, 2016. **25**(4): p. 521-35.
40. Klintberg, I.H., et al., *Consensus for physiotherapy for shoulder pain.* Int Orthop, 2015. **39**(4): p. 715-20.
41. Edwards, P., et al., *Exercise Rehabilitation in the Non-Operative Management of Rotator Cuff Tears: A Review of the Literature.* Int J Sports Phys Ther, 2016. **11**(2): p. 279-301.
42. Kirkley, A., C. Alvarez, and S. Griffin, *The development and evaluation of a disease-specific quality-of-life questionnaire for disorders of the rotator cuff: The Western Ontario Rotator Cuff Index.* Clin J Sport Med, 2003. **13**(2): p. 84-92.
43. Huang, H., et al., *A Systematic Review of the Psychometric Properties of Patient-Reported Outcome Instruments for Use in Patients With Rotator Cuff Disease.* Am J Sports Med, 2015. **43**(10): p. 2572-82.
44. Ekeberg, O.M., et al., *A questionnaire found disease-specific WORC index is not more responsive than SPADI and OSS in rotator cuff disease.* J Clin Epidemiol, 2010. **63**(5): p. 575-84.
45. Constant, C.R. and A.H. Murley, *A clinical method of functional assessment of the shoulder.* Clin Orthop Relat Res, 1987(214): p. 160-4.
46. Henseler, J.F., et al., *The minimal detectable change of the Constant score in impingement, full-thickness tears, and massive rotator cuff tears.* J Shoulder Elbow Surg, 2015. **24**(3): p. 376-81.
47. Constant, C.R., et al., *A review of the Constant score: modifications and guidelines for its use.* J Shoulder Elbow Surg, 2008. **17**(2): p. 355-61.
48. Kirkley, A., S. Griffin, and K. Dainty, *Scoring systems for the functional assessment of the shoulder.* Arthroscopy, 2003. **19**(10): p. 1109-20.
49. Kukkonen, J., et al., *Investigating minimal clinically important difference for Constant score in patients undergoing rotator cuff surgery.* J Shoulder Elbow Surg, 2013. **22**(12): p. 1650-5.

50. Holmgren, T., et al., *Minimal important changes in the Constant-Murley score in patients with subacromial pain.* J Shoulder Elbow Surg, 2014. **23**(8): p. 1083-90.
51. Williamson, A. and B. Hoggart, *Pain: a review of three commonly used pain rating scales.* J Clin Nurs, 2005. **14**(7): p. 798-804.
52. Farrar, J.T., et al., *Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale.* Pain, 2001. **94**(2): p. 149-58.
53. Michener, L.A., A.R. Snyder, and B.G. Leggin, *Responsiveness of the numeric pain rating scale in patients with shoulder pain and the effect of surgical status.* J Sport Rehabil, 2011. **20**(1): p. 115-28.
54. Sintonen, H., *The 15D instrument of health-related quality of life: properties and applications.* Ann Med, 2001. **33**(5): p. 328-36.
55. Alanne, S., et al., *Estimating the minimum important change in the 15D scores.* Qual Life Res, 2015. **24**(3): p. 599-606.
56. Sugaya, H., et al., *Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: single-row versus dual-row fixation.* Arthroscopy, 2005. **21**(11): p. 1307-16.
57. Bang, H., L. Ni, and C.E. Davis, *Assessment of blinding in clinical trials.* Control Clin Trials, 2004. **25**(2): p. 143-56.
58. Wessel, J., et al., *The factor validity of the Western Ontario Rotator Cuff Index.* BMC Musculoskelet Disord, 2005. **6**: p. 22.
59. Jarvinen, T.L., et al., *Blinded interpretation of study results can feasibly and effectively diminish interpretation bias.* J Clin Epidemiol, 2014. **67**(7): p. 769-72.
60. Raman, J., et al., *Predictors of outcomes after rotator cuff repair-A meta-analysis.* J Hand Ther, 2017. **30**(3): p. 276-292.
61. Maman, E., et al., *Outcome of nonoperative treatment of symptomatic rotator cuff tears monitored by magnetic resonance imaging.* J Bone Joint Surg Am, 2009. **91**(8): p. 1898-906.
62. Safran, O., et al., *Natural history of nonoperatively treated symptomatic rotator cuff tears in patients 60 years old or younger.* Am J Sports Med, 2011. **39**(4): p. 710-4.
63. Ranebo, M.C., et al., *Clinical and structural outcome 22 years after acromioplasty without tendon repair in patients with subacromial pain and cuff tears.* J Shoulder Elbow Surg, 2017. **26**(7): p. 1262-1270.
64. Choi, S., et al., *Factors associated with clinical and structural outcomes after arthroscopic rotator cuff repair with a suture bridge technique in medium, large, and massive tears.* J Shoulder Elbow Surg, 2014. **23**(11): p. 1675-81.
65. Boileau, P., et al., *Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal?* J Bone Joint Surg Am, 2005. **87**(6): p. 1229-40.
66. Heuberer, P.R., et al., *Longitudinal Long-term Magnetic Resonance Imaging and Clinical Follow-up After Single-Row Arthroscopic Rotator Cuff Repair: Clinical Superiority of Structural Tendon Integrity.* Am J Sports Med, 2017. **45**(6): p. 1283-1288.
67. Russell, R.D., et al., *Structural integrity after rotator cuff repair does not correlate with patient function and pain: a meta-analysis.* J Bone Joint Surg Am, 2014. **96**(4): p. 265-71.
68. Fucentese, S.F., et al., *Evolution of nonoperatively treated symptomatic isolated full-thickness supraspinatus tears.* J Bone Joint Surg Am, 2012. **94**(9): p. 801-8.
69. Yamamoto, A., et al., *Prevalence and risk factors of a rotator cuff tear in the general population.* J Shoulder Elbow Surg, 2010. **19**(1): p. 116-20.
70. Fukuda, H., *Partial-thickness rotator cuff tears: a modern view on Codman's classic.* J Shoulder Elbow Surg, 2000. **9**(2): p. 163-8.
71. Loew, M., et al., *How to discriminate between acute traumatic and chronic degenerative rotator cuff lesions: an analysis of specific criteria on radiography and magnetic resonance imaging.* J Shoulder Elbow Surg, 2015. **24**(11): p. 1685-93.
72. Teefey, S.A., et al., *Sonographic differences in the appearance of acute and chronic full-thickness rotator cuff tears.* J Ultrasound Med, 2000. **19**(6): p. 377-8; quiz 383.
73. Buirski, G., *Magnetic resonance imaging in acute and chronic rotator cuff tears.* Skeletal Radiol, 1990. **19**(2): p. 109-11.

74. Randelli, P., et al., *Complications associated with arthroscopic rotator cuff repair: a literature review.* Musculoskelet Surg, 2012. **96**(1): p. 9-16.
75. Yeranosian, M.G., et al., *Incidence of acute postoperative infections requiring reoperation after arthroscopic shoulder surgery.* Am J Sports Med, 2014. **42**(2): p. 437-41.
76. Lenza, M., et al., *Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered.* Cochrane Database Syst Rev, 2013(9): p. CD009020.
77. Stock, G., *If the goal is relief, what's wrong with a placebo?* Am J Bioeth, 2003. **3**(4): p. 53-4.
78. Wartolowska, K.A., et al., *A meta-analysis of temporal changes of response in the placebo arm of surgical randomized controlled trials: an update.* Trials, 2017. **18**(1): p. 323.

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Data statement This is a protocol article and we have no data to publish at this point. We will make the research data available when the trial is finalized.

ACCURATE study group

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Table 1. Inclusion and exclusion criteria

Criteria for Inclusion
1. Age of patient is over 45 and below 70 years at the time of injury
2. Acute onset of shoulder symptoms after a traumatic event (any kind of sudden stretch, pull, fall, or impact, on the shoulder that is associated with the onset of symptoms)
3. Shoulder symptoms relating to rotator cuff tear = pain laterally on the shoulder and/or painful motion arc during abduction or flexion
4. MRI documented full thickness supraspinatus (ssp) tear
Criteria for Exclusion

1. Traumatic event of the shoulder due a criminal act of violence with legal consequences
2. A delay of more than 4 months after the onset of symptoms of trauma to the day of intervention
3. Arthroscopically documented partial thickness rotator cuff tear only
4. A large MRI documented full thickness rotator cuff tear, sagittal tear size at the level of footprint larger than 3cm
5. MRI or arthroscopically documented total width of infraspinatus (isp) or subscapularis (ssc) tear
6. MRI or arthroscopically documented fully dislocated biceps tendon (biceps out of the groove) with concomitant subscapularis tear
7. Positive clinical rotatory lag sign (ER1 lag (>10 degrees), lift off lag (involuntary drop against the back), horn blower lag (involuntary internal rotation of the forearm in supported elevated position))
8. Marked fatty degeneration in any of the cuff muscles (more than Fuchs/Goutallier grade 2 [27])
9. Radiographically or MRI documented concomitant fracture line of the involved extremity or bony avulsion of the torn tendon or dislocation of the humeral head or the acromioclavicular joint
10. Concomitant clinically detectable motoric nerve injury affecting the shoulder
11. Radiographically documented severe osteoarthritis of the glenohumeral joint, Samilson-Prieto 2 or above
12. Non-congruency of the glenohumeral joint in radiographs (Hamada stage 2 or above)
13. Clinical stiffness of the glenohumeral joint (severely limited passive range of motion: glenohumeral external rotation < 30 degrees, and abduction with stabilized scapula <60 degrees)
14. Previous surgery of the affected shoulder (affecting clavicle, scapula or upper third of the humerus)
15. Earlier sonographic or MRI finding of a rotator cuff tear

16. Previous symptoms of the ipsilateral shoulder requiring conservative treatment (glucocorticosteroid injections and/or physiotherapy) delivered by health care professionals during the last five years 17. Systemic glucocorticosteroid or antimetabolite medication during the last 5 years
18. Ongoing treatment for malignancy
19. ASA classification 3 or 4
20. Patient's inability to understand written and spoken Finnish, Norwegian or Swedish
21. History of alcoholism, drug abuse, psychological or other emotional problems likely to jeopardise informed consent
22. Patients with a contraindication/noncompliance for MRI examination or use of electrocautery devices
23. Previous randomization of the contralateral shoulder into the ACCURATE trial
24. Patient's denial for operative treatment and/or participation in the trial

Table 2. Baseline demographics

	Rotator cuff repair	Placebo surgery
Age (years), mean (SD)		
Gender (female/male), n (%)		
Dominant side affected, n (%)		

Previous symptoms no pain ever, n (%) pain in shoulder at any point of time, n (%) pain during the past year, n (%)
Smoking habits smoking, n (%) non smoking, n (%)
Occupation
Mechanism of injury stretch, n (%) pull, n (%) fall, n (%) impact, n (%)
Energy of injury < fall from own hight, n (%) > fall from own hight, n (%)
Duration of symptoms (days/weeks from the trauma to the operation), mean (SD)
Working status student, n (%) unemployed, n (%) retired, n (%) on sick leave, n (%) disability pension, n (%) working, n (%)

Treatments after the trauma injections, n (%) physiotherapy, n (%) pain killers, n (%)
Outcome measures Pain NRS (0-10) at night, mean (SD) Pain NRS (0-10) at rest, mean (SD) Pain NRS (0-10) during activity, mean (SD) WORC (WORC %-index 0-100 %) physical symptoms, mean (SD) sports/recreation, mean (SD) work, mean (SD) lifetime, mean (SD) emotions, mean (SD) total %-index, mean (SD) Constant-Murley score pain, mean (SD) activities of daily living, mean (SD) range of motion, mean (SD) shoulder power, mean (SD) total score, mean (SD) 15D, mean (SD)
Stanford expectations of treatment scale (SETS)
Hospital Anxiety and Depression Scale (HADS)

Table 3. Pathology during the diagnostic arthroscopy

	Rotator cuff repair	Placebo surgery
Condition of humerus articular surfaces Outerbridge grade 0, n (%) Outerbridge grade 1, n (%) Outerbridge grade 2, n (%) Outerbridge grade 3, n (%) Condition of glenoid articular surfaces Outerbridge grade 0, n (%) Outerbridge grade 1, n (%) Outerbridge grade 2, n (%) Outerbridge grade 3, n (%)		
Condition of the biceps tendon normal, n (%) tendinosis, n (%) subluxation, n (%)		

Table 4. Procedures in the rotator cuff repair group

Anatomic reconstruction, n (%) Partial reconstruction, n (%)
Brand of suture anchors
Number of suture anchors 1, n (%) 2, n (%) 3, n (%) 4, n (%)

Biceps procedure none, n (%) tenotomy, n (%) tenodesis, n (%)
Acromioplasty yes, n (%) no, n (%)

Table 5. Imaging studie's parameters at baseline and at follow-up

Shoulder radiograph	Rotator cuff repair	Placebo surgery
osteoarthritic changes Samilson et Prieto grade 1, n (%) Samilson et Prieto grade 2, n (%) Samilson et Prieto grade 3, n (%) cuff tear arthropathy Hamada grade 1, n (%) Hamada grade 2, n (%) Hamada grade 3, n (%) Hamada grade 4, n (%) Hamada grade 5, n (%)		
Shoulder MRI arthrography MRI, n (%) native MRI, n (%)		

Supraspinatus

Re-tear if operated
Sugaya type I, n (%)
Sugaya type II, n (%)
Sugaya type III, n (%)
Sugaya type IV, n (%)
Sugaya type V, n (%)

sagittal tear size (mm), mean (SD)
coronal tear size (mm), mean (SD)

fatty degeneration
Fuchs/Goutallier grade 0, n (%)
Fuchs/Goutallier grade 1, n (%)
Fuchs/Goutallier grade 2, n (%)
Fuchs/Goutallier grade 3, n (%)
Fuchs/Goutallier grade 4, n (%)

Warner tangent sign
positive, n (%)
negative, n (%)

muscle edema
yes, n (%)
no, n (%)

Infraspinatus Re-tear if operated Sugaya type I, n (%) Sugaya type II, n (%) Sugaya type III, n (%) Sugaya type IV, n (%) Sugaya type V, n (%) sagittal tear size (mm), mean (SD) coronal tear size (mm), mean (SD) fatty degeneration Fuchs/Goutallier grade 0, n (%) Fuchs/Goutallier grade 1, n (%) Fuchs/Goutallier grade 2, n (%) Fuchs/Goutallier grade 3, n (%) Fuchs/Goutallier grade 4, n (%) muscle edema yes, n (%) no, n (%)
Subscapularis Re-tear if operated Sugaya type I, n (%) Sugaya type II, n (%) Sugaya type III, n (%) Sugaya type IV, n (%) Sugaya type V, n (%) sagittal tear size (mm), mean (SD) coronal tear size (mm), mean (SD) fatty degeneration Fuchs/Goutallier grade 0, n (%) Fuchs/Goutallier grade 1, n (%) Fuchs/Goutallier grade 2, n (%) Fuchs/Goutallier grade 3, n (%) Fuchs/Goutallier grade 4, n (%) muscle edema yes, n (%) no, n (%)

Teres minor fatty degeneration Fuchs/Goutallier grade 0, n (%) Fuchs/Goutallier grade 1, n (%) Fuchs/Goutallier grade 2, n (%) Fuchs/Goutallier grade 3, n (%) Fuchs/Goutallier grade 4, n (%) muscle edema yes, n (%) no, n (%)
Long head of the biceps tendon normal, n (SD) subluxation, n (SD) frayed, n (SD) ruptured, n (SD) tendon missing, n (SD) tenodesis, n (SD)

Table 6. Schedule for the assesments

Assesment	Screening	Baseline	Intervention (within 4 months after trauma)	3 months	6 months	1 year	2 years	5 years	10 years
Screening form	X								
Radiograps and MRI	X						X	X	X
Clinical examination		X		X (BD+PT)	X (PT)	X (PT)	X (PT)	X (PT)	X (PT)
Preoperative data form		X							
Randomization			X						
Intraoperative data form			X						
Blinding index			X*	X	X	X	X		
SETS		X							
HADS		X		X	X	X	X	X	X
Pain NRS		X		X	X	X	X	X	X
15D		X		X	X	X	X	X	X
CM score		X		X	X	X	X	X	X
WORC		X		X	X	X	X	X	X
Working status		X		X	X	X	X	X	X
Analgesic usage		X		X	X	X	X	X	X
Supplementary treatment		X		X	X	X	X	X	X
Subjective satisfaction				X	X	X	X	X	X
Amount of supervised PT visits					X				
Exercise diary					X				
Question on treatment satisfaction†						X	X	X	X
Adverse event form§			(X)	(X)	(X)	(X)	(X)	(X)	(X)
Discontinuation form§				(X)	(X)	(X)	(X)	(X)	(X)
Unblinding form§					(X)	(X)	(X)	(X)	(X)
Reoperation form§				(X)	(X)	(X)	(X)	(X)	(X)

* After the intervention, at the point of discharge

† Looking back at your shoulder trauma and the treatment that you initially received, would you choose to undergo the same treatment if you could turn back time?

§ If required

BD, blinded doctor; PT, physiotherapist; SETS, Stanford Expectations of Treatment Scale; HADS, Hospital Anxiety and Depression Scale; Pain NRS, Numerical Rating Scale for pain; CM score, Constant-Murley score; WORC, Western Ontario Rotator Cuff index

Table 7.

Criteria to make surgical placebo-controlled trial ethical outlined by Savulescu et al. [20]
The presence of equipoise
There are no randomized controlled trials on acute rotator cuff tears, i.e. there is a lack of unbiased evidence for efficacy of the arthroscopic rotator cuff repair. There is a meta-analysis [21] from three randomized controlled trials on the treatment of mainly non-traumatic rotator cuff tears and it showed clinically similar results between operative and conservative treatment.
Preliminary evidence for efficacy of the procedure
There are several open-label studies [4, 8-11] on the operative treatment of rotator cuff tears. The results usually range from good to excellent and in terms of outcome measures the overall improvement has been clinically significant. These studies on the other hand are highly biased because of the study design itself; not controlling the critical surgical element, true placebo effect and non-specific effects [16, 17]. In surgical treatment of rotator cuff tear the outcome is always a subjective change in quality of life because of non-life-threatening nature of the condition. The critical element is the repair/suturing the torn tendon. The aim is to relieve pain and improve function by reinserting tendon with suture anchors back into its footprint where it should biologically heal. However, considerable amount of these sutured tendons do not heal or they re-rupture. Furthermore a re-tear do not seem to affect the outcome [67]; patients with a re-tear are as satisfied as patients with an intact tendon. Taking into account the previously mentioned facts there exists a doubt whether the improvement seen in the open-label studies is caused by the rotator cuff repair, or not.
Minimizing risk for patients in the placebo arm
In the ACCURATE trial the placebo arm includes a diagnostic arthroscopy and supervised physiotherapy. The potential risks for patients are associated with operative treatment and include: preoperative medication (usually pain killers and sedatives/anksiolytes), plexus anesthesia, global/total intravenous anesthesia, prophylactic antibiotic, diagnostic arthroscopy itself and post-operative medications (mainly pain killers). All medications can cause side-effects, but this risk is estimated to be low. Surgery, which is by definition invasive, comes always with a risk of adverse events or complications. A complication is defined as an event or condition that requires additional treatment, either non-operative or operative. Because literature does not consistently report on surgery related complications after shoulder arthroscopy it is impossible to draw valid conclusion on

the incidence of complications. The most common complication is the postoperative shoulder stiffness, which is reported to occur in 2.6 % - 23.3 % of cases [74]. The overall infection rate for all arthroscopic shoulder procedures is 0.27 %, being highest for rotator cuff repair (0.29 %) and lowest for capsulorrhaphy (0.16 %) [75]. Rate for neurovascular complications is 0.4 % - 3.4 % [74]. Taking into account that diagnostic arthroscopy does not include any shaving, burning or additional procedure, it is much less traumatic than the active treatment arm. In addition, there will be no foreign materials left in the shoulder after the procedure.

Considering the aforementioned issues we will assume that incidence of complications in the diagnostic arthroscopy group will be smaller than those reported for arthroscopic procedures. The main concern is if the unrepaired tear becomes larger by time, retracts and induces irreversible fatty degeneration of the scapular musculature. There are no high quality studies on the natural course of an acute cuff tear. There are only a few studies available on the evolution of a non-operatively treated supraspinatus tendon tear [1, 62, 68]. Accordingly, significant short term tear size progression is unlikely. Overall we consider the risk profile to be acceptable.

Avoiding deception

Patients are openly explained the placebo-design of the trial and told what it means. They get oral and written information concerning the trial and a written informed consent is obtained. The operating doctor and staff (who are the only ones who know the allocated intervention group) will not meet with patient after the operation to avoid compromise in blinding. The follow-up visits are carried out by the blinded physiotherapist and doctor.

Potential significant change to clinical practice

The results of this trial will directly affect the decision-making process worldwide. If the results show that repair and physiotherapy is clinically superior to placebo surgery and physiotherapy, it corroborates that the tendon repair has an important effect in the treatment of an acute cuff tear. On the other hand if placebo surgery group is superior or the difference between groups is not clinically significant, there is no justification for a tendon repair in the treatment of an acute supraspinatus tear. Consequently, conservative treatment should be advocated taking into account the higher costs and greater risk for complications in the operative treatment.

Benefits to the patients in the placebo group

All patients in the placebo group do not get only placebo surgery but also supervised specific exercise therapy delivered by a physiotherapist, like the patients in the cuff repair group. To our knowledge there is no published study on conservative treatment of traumatic rotator cuff tears.

According to prospective cohort study and open-label RCTs on atraumatic cuff tears, conservative treatment yields clinically significant improvement. Secondly the patients in the placebo group will probably experience a positive meaning response due to the trial design. Thirdly the patients in the placebo group get a diagnostic arthroscopy prior to randomization. Their glenohumeral joint is evaluated and any encountered pathology is documented and if, for example, a total subscapularis or infraspinatus tear or a partial-thickness tear is verified, patient is excluded from the trial and treated accordingly. Although the MRI has a good diagnostic accuracy on full-thickness rotator cuff tears, the specificity and sensitivity is not 100% [76]. In addition, patients in clinical trials have many potential benefits over standard care with respect to additional monitoring (including imaging, clinic visits, interviews) and ongoing attention and care, all of which would be likely to have value by itself [77]. Further, after a surgical placebo intervention, patients report significant improvement for a prolonged period of time and the effect does not seem to change significantly with time [78]. If at the end of trial the placebo group is equal or superior to tendon repair group, the patients in the placebo group will benefit by getting a smaller operation with a minor risk for complication and no foreign material is left in their body.

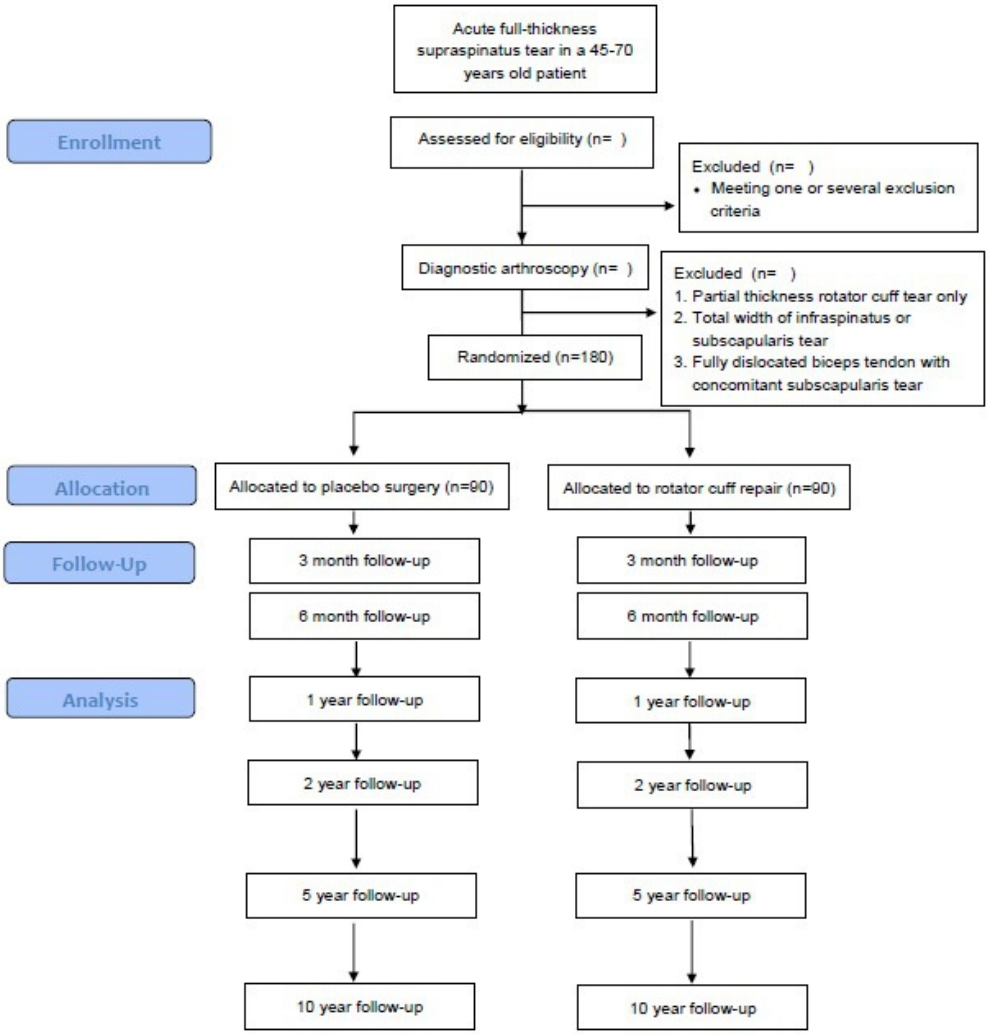

Figure 1. Flow chart of the trial

51x54mm (300 x 300 DPI)

BMJ Open

Acute Cuff Tear Repair Trial (ACCURATE): protocol for a multicenter, randomized, placebo-controlled trial on the efficacy of arthroscopic rotator cuff repair

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Acute Cuff Tear Repair Trial (ACCURATE): protocol for a multicenter, randomized, placebo-controlled trial on the efficacy of arthroscopic rotator cuff repair

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ABSTRACT

Introduction: Rotator cuff tear is a very common and disabling condition that can be related to acute trauma. Rotator cuff tear surgery is a well-established form of treatment in acute rotator cuff tears. Despite its widespread use and almost a gold standard position, the efficacy of an arthroscopic rotator cuff repair is still unknown. The objective of this trial is to investigate the difference in outcome between

arthroscopic rotator cuff repair and inspection of the shoulder joint defined as placebo surgery in patients 45 to 70 years of age with an acute rotator tear related to trauma.

Methods and analysis:

Acute Cuff Tear Repair Trial (ACCURATE) is a randomized, placebo controlled, multicenter efficacy trial with sample size of 180 patients. Concealed allocation is done in 1:1 ratio. The randomization is stratified according to participating hospital, gender, and baseline WORC index. Both groups receive the same standardized postoperative treatment and physiotherapy. The primary outcome measure is the change in WORC score from baseline until two years follow-up. Secondary outcome measures include Constant-Murley score, the Numerical Rating Scale for pain, subjective patient satisfaction and the health-related quality of life instrument 15D. Patients and outcome assessors are blinded from the allocated intervention. The primary analysis of results will be conducted according to intention-to-treat analysis.

Ethics and Dissemination: The study protocol for this clinical trial has been approved by the Ethics Committee of the Hospital District of Southwest Finland and Regional Ethics Committee in Linköping Sweden and Regional Committees for Medical and Health Research Ethics South East in Norway. Every recruiting center will apply local research approvals. The results of this study will be submitted for publication in peer-reviewed journals.

Trial registration number: ClinicalTrials.gov NCT02885714

Strengths and limitation of this study

· This study will eventually demonstrate the true efficacy of an arthroscopic rotator cuff repair by using a placebo-controlled study design.

· Multicenter setup and three participating countries advance generalizability and external validity of this trial.

· The results of this trial are limited to patients with trauma related full-thickness supraspinatus tendon tears with acute symptoms.

INTRODUCTION

Background and rationale

The prevalence of full-thickness rotator cuff tears is reported to be between 23-32% in previously symptom-free middle-aged patients after having a shoulder trauma. [1-5]. An acute cuff tear is

associated with impaired quality of life, and symptoms such as pain in abduction, abduction weakness, and night pain [6]. In clinical practice these patients are often referred to an arthroscopic rotator cuff repair (ACR) for curative treatment [7]. In such an operation the glenohumeral joint is visualized through arthroscopy, the torn tendon is re-attached to its bony footprint, and postoperatively the arm is immobilized in a sling followed by a rehabilitation program. Good clinical results have been reported on surgical treatment [4, 8-11], and subsequently the number of operations and cost of treatment have substantially increased during the past years [12-15]. However, these reports cannot be held as a safeguard that the surgery itself is effective, because of the study designs without a proper control group.

The reported outcome of surgical treatment is thought to be a cumulative effect of three main elements: the critical surgical element, the true placebo effect and non-specific effects [16, 17]. The critical surgical element (in this case repairing the torn tendon) is the component of the surgical procedure that is believed to provide the therapeutic effect and is distinct from aspects of the procedures that are diagnostic or required to access the disease being treated (in this case shoulder arthroscopy) [18]. The true placebo effect is not a result of placebo itself, but of the context in which placebo is administered, including patient's beliefs, expectations and interaction with the health care professionals [16, 19]. The non-specific effects are caused by the natural history of the disease, regression to the mean, fluctuations in symptom severity, non-specific effects of taking part in a trial such as patients' reaction to being observed and assessed or to additional contact with clinicians [20].

A placebo procedure's function is to simulate the active procedure. It has no real therapeutic effect, and is by definition inert. Therefore, it is the ultimate comparator for the active treatment in clinical randomized controlled trials. With a placebo as comparator in a controlled setup both the placebo and non-specific effects are comparable, and the bias is minimized in investigating the true efficacy of an active treatment. There is some evidence that surgery may not be more effective than conservative treatment alone in treating symptomatic degenerative cuff tears [21]. However, this may not be the case with trauma related tears with acute symptoms. Hitherto there is a lack of evidence, as there are no randomized, placebo controlled trials on the efficacy of surgical treatment of acute cuff tears.

Objectives

The objective of the Acute Cuff Tear Repair Trial (ACCURATE) is to investigate the difference in outcome between placebo surgery (PS) and arthroscopic rotator cuff repair (ACR) in patients aged 45-70 years with an acute full-thickness supraspinatus tear related to trauma. Our hypothesis is that ACR yields superior results compared to PS in the treatment of an acute tear.

Trial design

ACCURATE is an ongoing randomized, placebo controlled, multicenter efficacy trial, with two parallel (1:1) treatment arms.

METHODS

Study setting

The study protocol is designed according to Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) statement [22] and will be reported using the recommendations in the Consolidated Standards of Reporting Trials (CONSORT) statement [23].

Recruitment

Altogether 14 centers in three countries are signed to recruit patients: eight centers in Finland (Turku University Hospital, Satakunta Central Hospital, Oulu University Hospital, Kuopio University Hospital, Tampere University Hospital, Central Finland Central Hospital, Helsinki University Hospital, Vaasa Central Hospital) three in both Sweden (Linköping University Hospital, Kalmar County Hospital, Helsingborg Hospital) and Norway (Martina Hansens Hospital, Oslo University Hospital, Sorlandet Hospital HF Kristiansand). All three countries have a country manager who belongs to the ACCURATE study chair. Country managers organize the center's participating doctors locally.

All eligible patients are asked to participate in the trial, and a written informed consent is obtained. The patients are openly and thoroughly explained the two different treatment modalities at recruitment. Thereafter, the patients are blinded from the treatment modality. The treatment must be commenced within four months after the initial traumatic event. All screened patients fulfilling the inclusion criteria are recorded.

Eligibility criteria

The ACCURATE trial is set out to investigate the performance of ACR under an ideal and controlled circumstance. Therefore, the eligibility criteria are designed in accordance.

Patients with a previously healthy shoulder and acute shoulder pain and dysfunction, following a traumatic event, are referred to trial centers. Involved shoulder surgeons examine and assess the patients for eligibility (age 45 to 70 years, acute symptoms after trauma for less than 4 months, and magnetic resonance imaging (MRI) documented full thickness supraspinatus tear). A traumatic event is defined as any kind of sudden stretch, pull, fall, or impact, on the upper extremity that is associated with the onset of symptoms. Any kind of planned or controlled movement like throwing a ball or lifting an object is not defined as a sudden traumatic event. The traumatic event must happen quickly and without

warning, for example falling down on an outstretched arm or straight on the shoulder, hanging on the arm after falling down. Symptoms have to be typical to cuff tear (pain laterally on the shoulder and/or painful motion arc during abduction or flexion). The patients who fulfil the inclusion criteria are recorded and screened for exclusion criteria.

After a thorough clinical examination standard shoulder radiographs and MRI are carried out for all potential study patients. Patients with a large rotator cuff tear (sagittal tear size at the level of footprint > 3cm on the MRI), clinical signs of a major tear in infraspinatus or subscapularis (positive clinical rotatory lag sign, External Rotation Lag Sign (ER1 lag) >10 degrees, or lift off lag, involuntary drop against the back) are excluded. Also patients with concomitant injuries (nerve injuries, fractures, bony avulsion of the tendons, dislocated long head of the biceps tendon, humeral head or acromioclavicular joint dislocation) in the shoulder region, which can ultimately interfere with the treatment and interpretation of symptoms, are excluded. The condition of glenohumeral joint, tendons and musculature may also affect the treatment outcome. Therefore, patients with incongruent or osteoarthritic joint, previous symptoms or treatment of the ipsilateral shoulder, as well as patients with severe fatty degeneration of the muscles of the rotator cuff, are excluded [24-27] .

All inclusion and exclusion criteria are listed in the Table 1.

Baseline

All baseline demographics are listed in Table 2. High preoperative expectations are described to correlate with better results after rotator cuff surgery [28, 29] and low expectations with failure [30]. To address the validity of the trial in the light of expectancies [31, 32] we measure the preoperative expectations with Stanford Expectations of Treatment Scale (SETS) [33]. Depression and anxiety may have a negative impact on self-assessed outcome measurements in patients scheduled for rotator cuff repair [34]. Therefore we assess the preoperative psychological distress with the Hospital Anxiety and Depression Scale (HADS) [35].

Enrolled patients must be scheduled for intervention within four months from the initial trauma. Preoperative scoring is arranged within 2 weeks before surgery.

Interventions

All patients receive regional nerve block and/or general anesthesia. Also prophylactic antibiotic is administered for all patients. These are not standardized, but delivered as a routine practice of each hospital. The arthroscope is introduced in the glenohumeral joint, and thereafter a thorough diagnostic

arthroscopy is performed and a global assessment of the joint surfaces is performed according to the Outerbridge classification [36]. The presence of a full-thickness cuff tear is verified by introducing a probe/switching stick through the subacromial space into the joint. If the diagnostic arthroscopy reveals a partial thickness cuff tear only, a total width of infraspinatus or subscapularis tear or a fully dislocated long head of the biceps tendon with concomitant subscapularis tear the patient is excluded from the trial and treated according to local routine. After the diagnostic arthroscopy and confirmation of the eligibility criteria the patient is randomly assigned to ACR or PS, and treated accordingly. A detailed list of findings to be documented during the diagnostic arthroscopy is given in Table 3.

Study interventions

Rotator cuff repair

A biceps tenotomy or tenodesis may be performed according to surgeon preference if the biceps tendon is noted to be frayed, unstable or inflamed. An additional acromioplasty may be performed according to surgeon preference if there are signs of mechanical tightness (fraying on the undersurface and close contact to the cuff structures). The rotator cuff insertion is prepared and the cuff tear is repaired to its anatomic location using suture anchors according to surgeon preference. Although an eligible patient should have an anatomically repairable tear there is always a chance that in vivo the torn tendon is not completely repairable on its anatomic insertion. In this unlikely circumstance a partial reconstruction is carried out according to surgeon preference. The retraction of the tear will be measured and documented on the MRI images. No additional procedures are performed with regard to possible concomitant pathologies of articular cartilage, or labrum. The wounds are closed and the arm is placed in a sling. A detailed list of procedures to be documented in the rotator cuff repair group is given in Table 4.

Placebo surgery

Only the joint space is evaluated, no subacromial scoping is performed. Nothing is to be removed or excised and the use of any electrocautery or shaver device is not allowed. Altogether 3 to 5 small skin stab incisions are made in typical locations resembling locations of typical rotator cuff repair. After the evaluation the wounds are closed and the arm is placed in a sling. The time spent in the operating theatre with patients in the placebo group should resemble the time spent with patients in the active treatment group and hence give an impression of a rotator cuff repair.

Postoperative physiotherapy

The postoperative care and rehabilitation is identical in both the ACR and PS groups. The rehabilitation program is based on the current literature [37-42] as well as clinical experience. The program consists of one initial phase (0-4 weeks) were the patients are immobilized in a sling and during this time the exercise program is standardized. After the sling has been phased out the rehabilitation program consists of three phases. Phase one consist of active assisted range of motion exercises, phase 2 of active unloaded exercises and phase 3 of dynamic strengthening exercises. There are several exercises to choose from in each phase in purpose to fit each patients shoulder disability. The physiotherapist decides when the patient is ready to move on to the next phase, considering aspects of quality of motion and pain, in accordance with restrictions. The patients will have approximately 15 visits of physiotherapist guided exercises sessions during a 5- month period. Each visit will take approximately 30-45 minutes. In between these guided exercise sessions patients will perform home-exercises according to the different phases. An exercise diary is used to encourage adherence and is handed out at the first visit.

A detailed exercise program is presented in Appendix 1. All patients receive a prescription for analgetics according to local routine to be used if needed. The patients receive a sick leave up to 12 weeks, which can be extended if needed.

Outcomes

Primary outcome

Western Ontario Rotator Cuff index (WORC)

The primary outcome measure is the change in WORC [43] at 2 year follow-up compared to baseline. WORC is a disease specific self-reported instrument for rotator cuff disease. It consists 21 visual analog scale (VAS) items in five domains: physical symptoms (six items), sports/recreation (four items), work (four items), lifestyle (four items) and emotions (three items). All items respect quality of life (QoL) aspects that can particularly be influenced by rotator cuff injury. Each item has a possible score from 0 to 100 (100 mm VAS), and these scores are added to give a total score from 0 to 2100. A score of 0 implies no reduction in QoL, and a score of 2100 is the worst score possible. The data can be converted to a percent score by inverting the raw score and then converting it to a score out of 100 (2100 – ''patient WORC raw score''/21). The domains are based on the World Health Organization definition of health. WORC is determined to have the highest ratings among all shoulder instruments [44]. The minimally clinically important change (MCIC) for WORC is reported to be 275 points, or 12.8 % [45].

Secondary outcomes

Constant-Murley Score

The Constant-Murley score [46] is the most widely used shoulder evaluating instrument in Europe despite its limitations [47-49]. The 100-point scoring scale takes into account both subjective and objective measurements and is divided into four domains (pain: 15 points; activities of daily living: 20 points; range of motion: 40 points; strength: 25 points). Minimal clinically important difference (MCID) for Constant-Murley score is reported to be between 10.4-17 points [50, 51].

Numerical Rating Scale for pain (Pain NRS)

Pain NRS is a unidimensional measure of pain intensity [52]. The 11-point numeric scale ranges from '0' representing no pain to '10' representing pain as bad as you can imagine or worst pain imaginable. We use pain NRS to measure patient's perceived pain intensity during activity, at rest and at sleep during the last week preceding the assessment. MCIC for pain NRS is reported to be 2 points or 30 % [53, 54].

15D

The 15D is a generic, comprehensive (15-dimensional), self-administered instrument for measuring health-related quality of life (HRQoL) [55]. It combines the advantages of a profile and a preference-based, single index measure. A set of utility or preference weights is used to generate the 15D score (single index number) on a 0-1 scale. The estimated MCIC in the 15D scores is reported to be 0.015 [56].

Subjective patient satisfaction

To assess the patient's global satisfaction with the treatment outcome we use a 5 point Likert scale for evaluation.

Imaging studies

Preoperative imaging studies include standard shoulder radiographs and MRI. Radiographs and MRI studies will be done for both groups at 2, 5 and 10 years follow-ups to assess any signs of osteoarthritis (according to Samilson et Prieto) or cuff tear arthropathy (according to Hamada classification) in the radiographs and muscle fatty degeneration (according to Fuchs/Goutallier) and tear progression or re-tears (according to Sugaya [57]) in the MRI. Detailed list of parameters to be reported from the imaging studies are in Table 5.

Participant timeline

Detailed schedule for the assessments are presented in the table 6 and the flow chart of the trial in figure 1.

Assignment of intervention

Allocation

We use computerized internet-based online randomization software application (https://www.randomize.net/) to allocate patients to the intervention (rotator cuff repair) or control (placebo surgery) group. Randomization is done in the operation theatre after the diagnostic arthroscopy when the final confirmation of the eligibility criteria is ascertained. The randomization is stratified, according to participating hospital (X), gender (2), and baseline WORC index (3 separate lists: <20%, 20%-40%, >40%), into (Xx2x3) 6X randomization lists respectively (with variable block size known only by the trial statistician).

Blinding

The patients are openly explained the different treatment modalities at recruitment. Thereafter, the patients, the hospital staff and outcome assessors are unaware of treatment allocation. Only the operating doctor and involved operating theatre personnel know the treatment group of the patient and are not allowed to share this information further. The operating doctor will not see the patient after the operation at any point. There will be no information on the treatment group in the patient files or hospital charts. The content of patient operative file includes information on the date, doctor, randomization number and text (arthroscopy of the right/left shoulder, treatment according to ACCURATE protocol). Registered code of the intervention in the official hospital charts will be the code for arthroscopic rotator cuff repair. Patient follow-ups are performed by a blinded physiotherapist. Whenever needed a blinded doctor is consulted. There is a blinded doctor who will see the patient at the outpatient clinic at 3 months postoperative, which is the normal routine in our hospitals.

The blinding may only be unrevealed in case of serious adverse event, treatment failure (serious persisting symptoms six months after the treatment) or discontinuation. The need of unblinding is evaluated by the blinded doctor, who then contacts the trial country manager who decides on the unblinding. In no case must the local operating doctor and the blinded doctor discuss directly with regard to issues within this trial.

Failure to maintain blinding can lead to differences in perceived treatment and can contribute to differences between the active treatment and placebo groups. This can limit the internal validity of the

trial [31]. We use a 5-point Likert scale Blinding index to evaluate the success and maintaining of blinding at discharge, 3 months, 6 months, 1 year and 2 years after the intervention [58].

Declined cohort

The patients who are otherwise eligible but do not want any operation and/or do not want to participate, are asked for a permission for a later patient file follow-up and to participate in a follow-up study. An informed consent is obtained from these patients. The patient receives the treatment he/she desires after counseling with the involved doctor. The baseline demographics together with treatment modality, WORC outcome measure at baseline, 1 and 2 year follow-up are collected (Table 2).

Patient and public involvement

Patients were not involved in the design, recruitment or conduct of this study. Patients will be informed by the results of the study after completion.

DATA MANAGEMENT AND ANALYSIS

Data management

All data for this study is collected from trial specific patient report forms. The patient information is also stored electronically. The original paper forms with regard to patient evaluation are stored securely by the local operating doctor, blinded doctor and the physiotherapist in a locked folder. The original paper forms of screened, recruited, and treated patients are stored securely by the local operating doctor. All imaging data is stored in individual CD-R discs and sent by mail to the study nurse after completion of the recruitment and at 2, 5 and 10 year follow-up.

All data is stored and secured in a specific paper form and electronic study subject register held at the coordinating center; Turku University Hospital, TULES Division, Upper Extremity Department. Informed consent is collected, regarding transformation of data to Finland, from Sweden and Norway. The trial patient data is stored for 10 years after the final follow-up.

Sample size

The power calculation is based on assumed behavior of the WORC score. The mean score value at baseline is assumed to be 40% [45, 57]. The mean score of the best treatment group after the follow-up is assumed to be 85% [58]. The standard deviation is assumed to be 18% [57]. The trial is set out to reliably detect the reported minimally clinically important change of WORC, i.e. 273 points (13 % of the total 2100 points) [45]. Therefore the score of the most inefficient treatment group is assumed to be less than 73%. The correlation between measurements during the follow-up is estimated to be about 0.40 to 0.50. In an analysis of variance (ANOVA) test with alpha of 0.05 and power of 95%, we can expect the findings to be statistically significant if the number of subjects in each group is 72. Because of possible drop-outs, the minimum number of subjects per group is decided to be 90.

Missing items

Items of WORC score subdomains are summed to form a score for each subdomain and subsequently total WORC score is a sum of all subdomain scores. Due the nature of WORC score and summing of items, missing items would affect the score interpreting "worst case scenario". Therefore, actions for missing items are applied.

Substituting average value. Missing individual items in WORC score subdomains are considered as missing at random (MAR) if only one item is missing per subdomain and thus substituted with average value of available item in each subdomain. Substitution is justified due to reasonably high correlation between items within subdomains [59].

Last observation carried forward (LOCF). If WORC score is missing for any subdomain on adjacent follow-up measures, the last available measurement is substituted.

Hot Deck imputation. Missing WORC scores on any follow-up measurement are substituted using "Hot Deck" method by matching patients to each other using demographic information such as age, center, gender and WORC score at baseline and substitute missing value with matched patients WORC score on at the follow-up.

Loss to follow-up

Because of possible drop-outs, the minimum number of subjects per group is decided to be 90. This allows retaining statistical power with losses to follow-up. Imputations methods will be applied to primary outcome on follow-up measures unless the follow-up record was missing completely, e.g. dropout of a subject.

Retention

The study nurse stores and holds the paper and electronic patient registry for this trial and checks the data for uncompleted items. In case of non-adherence the investigating doctor is contacted and the reason for non-adherence is collected.

Statistical methods

After completion of 1, 2, 5, and 10 year follow up the cohort data is collected by the principle investigator and will be analysed by an independent statistician (blinded from the treatment arms). Methods suitable for clinical trial regarding comparison of parallel treatment groups with repeated measurements.

A detailed statistical analysis plan (SAP) will be prepared prior to database lock. Any deviations to the planned analyses specified within the SAP will be justified in writing and presented within the final study report.

The intention-to-treat (ITT) dataset will include all enrolled patients who received study treatment and have at least one post baseline primary outcome measurement available. The per protocol (PP) dataset is a subset of the ITT dataset excluding patients or measurements for a given patient with major protocol violation(s) expected to alter the outcome to treatment. The primary outcome measures will be analysed using both the ITT (primary analysis) and the PP dataset.

All background, outcome and safety variables will be summarized by visits. In addition to absolute values, changes relative to baseline values will be summarized, if feasible. Correlations among the study variables may be investigated. The results of outcome variables over the course of the study will be summarized descriptively. Disposition and reasons for discontinuation will be summarized for all patients together with treatment exposure and study duration by treatment group.

The analysis of the primary outcome measure will be done using the generalized linear mixed models. Generalized auto-regressive covariance structure will be used to take into account spatial differences between measuring timepoints. Definition and usage of factors and covariates and the full model is described in more detail in SAP. All results will be presented with 95% CIs. A two-sided significance level of 0.05 will be used. Multiple correction is applied to all pairwise comparisons including timepoint comparisons and is presented with unadjusted P-values and confidence intervals.

The analysis of secondary outcome measures (change in Constant-Murley score compared to baseline at two years; change in patients' shoulder pain during the last week at rest, during activity and at night (continuous); change in subjective pain intensity measure (continuous pain NRS); change in generic health-related quality of life instrument 15D (continuous); subjective patient satisfaction (classifying);

and, radiographic findings) will be analysed with the same approach as the primary outcome when appropriate , and otherwise statistical methods for repeated measures or methods for paired data (e.g. McNemar's test for binary data, Wilcoxon signed rank test for ordinal data, and paired t-test for continuous data). Subjects attaining change in WORC and Constant-Murley score greater than MCID are considered as *responders* to the treatment. Evaluation of reaching MCID is done in each timepoint individually and responder status is carried over to all adjacent timepoints once attained. Responder analysis will be carried out with generalized logistic regression model with responder/non-responder as an outcome. In addition, generalized linear mixed models may be used to further characterize the results. All secondary analyses are designed to be supportive of the analysis of the primary endpoint and each analysis will be undertaken at the two-sided 5% level of significance.

If feasible, subgroup analyses will be conducted, for example, by (pooled) center, age, gender, handedness, tear size and appearance, mechanism of injury, and smoking habits.

Statistical analysis, tables and patient data listings will be performed with SAS® version 9.3 for Windows (SAS Institute Inc., Cary, NC, USA).

Blinded data interpretation

To minimize the chance of misleading interpretation of the final data we use the recommended approach of blinded data interpretation [60]. Breaking of treatment code is done on reported statistical results, not on the data itself before analysis. The approach involves developing two interpretations of the results on the basis of a blinded review of the primary outcome data (treatment A compared with treatment B). One interpretation assumes that A is the rotator cuff repair group and another assumes that A is the placebo surgery group. After agreeing on the interpretations, the investigators record their decisions and sign the resulting document. The randomization code is then broken, the correct interpretation chosen, and the manuscript finalized.

Monitoring

Data monitoring

The patient data is monitored weekly by the research nurse. In case of delay / interruption in patient data the study nurse informs the local doctor, physiotherapist and the principle investigator in Finland.

The trial leader performs an interim analysis of the available outcome data when 90 (50 %) patients have been recruited and treated to confirm safety and ethical considerations of the study. In case of significantly more adverse events or re-operations within any of the treatment modalities, a premature discontinuation of the study is considered.

Harms

Adverse events (AEs) are documented at the scheduled and unscheduled clinical visits. The patients are urged to report any adverse events or health-related issues immediately after appearance to the blinded doctor. In case of any adverse event the blinded doctor informs the study nurse and the principle investigator in Finland. All adverse events regardless of suspected relationship to the study will be recorded. The blinded doctor assesses the likelihood of the adverse event to be caused by the study treatment on a six-grade causality scale (none, unlikely, possible, probable, definite, cannot be classified). The severity of all adverse events is assessed on a three-grade scale (mild, moderate, severe). All adverse events are dealt with in a symptomatically adequate manner and the patients are hospitalized if needed.

ETHICS AND DISSEMINATION

Ethical approval

The study protocol for this clinical trial has been approved by the Ethics Committee of the Hospital District of Southwest Finland (17.5.2016) and Regional Ethics Committee in Linköping Sweden (2016/263-31) and Regional Committees for Medical and Health Research Ethics South East in Norway (2016/1446). Every recruiting center will apply local research approvals. ACCURATE trial will be conducted according to the World Medical Association (WMA) Declaration of Helsinki. The template informed consent (in Finnish, Swedish, Norwegian and English) is contained in Appendix 2.

Protocol amendments

Any modifications to the protocol which may affect the conduct of the study, the potential benefit of the patient or patient safety, including changes of study objectives, study design, patient population, sample sizes, study procedures, or significant administrative aspects will require a formal amendment to the protocol. Such amendment will be agreed upon by ACCURATE study chair (main authors of this protocol), and will need approval by the Ethics Committees prior to implementation.

Administrative changes of the protocol are minor corrections and/or clarifications that have no effect on the way the study is to be conducted. These administrative changes will be agreed upon by ACCURATE study chair, and will be documented and updated in the trial registry at ClinicalTrials.gov (NCT02885714).

Consent or assent

Informed consent will be obtained by the local recruiting doctor in each participating center. The consent form is either in Finnish, Swedish or Norwegian. Consent is also obtained from the eligible patient who do not want to participate in the study.

Confidentiality

All patient data (paper forms and electronic database) is handled with confidentiality and will be stored securely. During analyses the patient's personal identification numbers are blinded.

Access to data

The study nurse holds the register of treatment groups and patients within the trial. Only the study nurse may access the patient data during the data collection. During the interim analyses the trial leader has access to the data set. At follow-ups the gathered patient data is analysed by the statistician and authors of the manuscript. The treatment arms will be uncoded after the blinded data interpretation and the study nurse is the only one who knows the codes.

Ancillary and post-trial care

All patients enrolled in the trial have the possibility to contact the local blinded doctor with regard to their treated shoulder at any stage during the trial. A patient may also withdraw consent and discontinue the study prematurely at any time if he or she so wishes. The patients are informed of the trial results by letter after the analyses of two years follow-up is completed.

Dissemination policy

The results of this study will be submitted for publication in peer-reviewed journals.

DISCUSSION

In this ACCURATE protocol we describe the design of a placebo controlled randomized trial on the efficacy of ACR versus PS in patients with full-thickness supraspinatus tear related to trauma with acute symptoms. This enables evaluation of clinical benefit of ACR for the patient, using a validated patient-reported outcome measure. To our knowledge this is the first placebo controlled trial on the subject.

The rationale for the ACCURATE trial includes: 1. Rising incidence of ACRs worldwide; 2. Almost a gold standard position of rotator cuff repair on trauma related cuff tears with acute symptoms; 3. The lack of evidence on the efficacy of ACR.

There are several patient related factors, which may influence the outcome of cuff tear in light of cuff integrity, shoulder function and patient satisfaction, such as tear size, number of involved tendons and fatty infiltration of the rotator cuff musculature [61]. In the ACCURATE trial these factors are controlled by precise exclusion criteria. The internal validity of the trial is further ensured by: minimizing bias by use off an online computer-based randomizing system, blinding of patients and outcome accessors, use of appropriate statistical testing, blinded data interpretation, and an adequate sample size based on a power calculation. In addition to the patient related factors the repair technique of the tear can influence the final outcome and re-tear rates according to reports of patient series [62, 63]. However, the latest meta-analyses showed no sound evidence on the difference in clinical outcome or re-tear rates between single and double row repair in small to medium sized (<3 cm) tears [64-67]. Therefore we left the decision of repair technique to the operating surgeon.

A cuff tear most often involves the supraspinatus tendon [2] and therefore an eligible patient (without concomitant pathologies) in the ACCURATE trial is an ideal candidate for ACR according to current clinical practice. The results of this trial are generalizable to patients with trauma related tears of the superior part of the rotator cuff with acute symptoms and applicable in evaluating the treatment paradigm. The multicenter setup and three participating countries further advance generalizability and external validity of the trial.

A major challenge in the ACCURATE trial, like in many placebo-controlled surgical trials, is to recruit a required number of patients in a reasonable period of time [17]. ACCURATE trial tries to tackle this obstacle by a large number of participating centers and by regular bulletins. Some problems can certainly arise from a large number of recruiting doctors. Potential lack of equipoise, which might reflect on the doctors' presentation when counseling and recruiting the potential study patient. From the patient side for example previous positive experiences from surgery, or a strong preference for either operative or conservative treatment by the patient, family member or some other doctor. These barriers are dealt with in regular meetings and correspondence with guidance to thorough explanation and wording when recruiting potential participants.

The use of placebo may be criticized for leaving half of the patients not repaired. The ethical considerations regarding the trial setup are presented in Table 7 according to Savulescu et al [20]. The main clinical concern is the potential tear progression and further fatty degeneration of the rotator cuff muscles, as reported in a purely degenerative setting [68-70]. On the other hand a re-tear or persistent

defect in the rotator cuff, after repair of small to medium sized tears, is a common finding in up to 10.6-50 % of the patients [71-73].

Interestingly the results of a meta-analysis by Russel et al. [74] suggest that the clinical outcome is similar after the rotator cuff repair regardless of the structural integrity of the repair. A cuff tear may also be associated with global degeneration of the glenohumeral joint. By following these patients ten years after injury the effect of ACR on the eventual development of ostearthritis and/or cuff tear arthropathy may be detected. There are only a few studies available on the evolution of a non-operatively treated traumatic tendon tears and there is up to date no randomized trial with published results [1, 69, 75]. Accordingly, significant short term tear size progression is unlikely. The potential progression is evaluated with a control MRI follow-up. Moreover, the clinical presentation of trial participants is regularly monitored for any complaint/adverse event, and the patients may be unblinded if necessary.

It can be estimated that in average 20 % of people in their 40s to 70s have an asymptomatic full-thickness cuff tear, and the prevalence increases with age [76]. Due to high number of asymptomatic degenerative tears the definition of a traumatic or acute cuff tear is controversial. It is thought that a significant trauma can rupture a healthy rotator cuff tendon. However, the tendons are usually weakened by increasing age-related degeneration [77]. Attempts have been made to distinguish between acute and chronic degenerative tears, through MRI or ultrasound imaging [78-80], without any accepted consensus. We argue that the criteria for an acute cuff tear, introduced in the ACCURATE protocol, reflect the general practice. There is a possibility that a MRI documented cuff tear after a trauma, is actually an acute-on-chronic tear with acute symptoms. However, these tears cannot be distinguished from each other. Furthermore, we exclude all patients with severe degenerative imaging findings as well as patients with preceding symptoms, to ensure inclusion of previously subjectively "healthy" shoulders only.

The aim and ultimate value of the ACCURATE trial is to demonstrate the true efficacy of an arthroscopic rotator cuff repair in patients with trauma related full-thickness supraspinatus tendon tear with acute symptoms. If the repair is effective and superior to placebo surgery doctors have a strong scientific support to recommend surgery when counseling these patients.

REFERENCES

1. Sorensen, A.K., et al., *Acute rotator cuff tear: do we miss the early diagnosis? A prospective study showing a high incidence of rotator cuff tears after shoulder trauma.* J Shoulder Elbow Surg, 2007. **16**(2): p. 174-80.

2. Kukkonen, J., et al., *Operatively treated traumatic versus non-traumatic rotator cuff ruptures: a registry study.* Ups J Med Sci, 2013. **118**(1): p. 29-34.
3. Braune, C., et al., *Mid-term results and quantitative comparison of postoperative shoulder function in traumatic and non-traumatic rotator cuff tears.* Arch Orthop Trauma Surg, 2003. **123**(8): p. 419-24.
4. Bjornsson, H.C., et al., *The influence of age, delay of repair, and tendon involvement in acute rotator cuff tears: structural and clinical outcomes after repair of 42 shoulders.* Acta Orthop, 2011. **82**(2): p. 187-92.
5. Aagaard, K.E., F. Abu-Zidan, and K. Lunsjo, *High incidence of acute full-thickness rotator cuff tears.* Acta Orthop, 2015. **86**(5): p. 558-62.
6. Mall, N.A., et al., *An evidenced-based examination of the epidemiology and outcomes of traumatic rotator cuff tears.* Arthroscopy, 2013. **29**(2): p. 366-76.
7. Tashjian, R.Z., *Epidemiology, natural history, and indications for treatment of rotator cuff tears.* Clin Sports Med, 2012. **31**(4): p. 589-604.
8. Lahteenmaki, H.E., et al., *Results of early operative treatment of rotator cuff tears with acute symptoms.* J Shoulder Elbow Surg, 2006. **15**(2): p. 148-53.
9. Petersen, S.A. and T.P. Murphy, *The timing of rotator cuff repair for the restoration of function.* J Shoulder Elbow Surg, 2011. **20**(1): p. 62-8.
10. Butler, B.R., et al., *Results of the repair of acute rotator cuff tears is not influenced by tear retraction.* Int J Shoulder Surg, 2013. **7**(3): p. 91-9.
11. Duncan, N.S., et al., *Surgery within 6 months of an acute rotator cuff tear significantly improves outcome.* J Shoulder Elbow Surg, 2015. **24**(12): p. 1876-80.
12. Colvin, A.C., et al., *National trends in rotator cuff repair.* J Bone Joint Surg Am, 2012. **94**(3): p. 227-33.
13. Judge, A., et al., *Temporal trends and geographical variation in the use of subacromial decompression and rotator cuff repair of the shoulder in England.* Bone Joint J, 2014. **96-B**(1): p. 70-4.
14. Ensor, K.L., et al., *The rising incidence of rotator cuff repairs.* J Shoulder Elbow Surg, 2013. **22**(12): p. 1628-32.
15. Paloneva, J., et al., *Increasing incidence of rotator cuff repairs--A nationwide registry study in Finland.* BMC Musculoskelet Disord, 2015. **16**: p. 189.
16. Ernst, E. and K.L. Resch, *Concept of true and perceived placebo effects.* BMJ, 1995. **311**(7004): p. 551-3.
17. Wartolowska, K., et al., *Use of placebo controls in the evaluation of surgery: systematic review.* BMJ, 2014. **348**: p. g3253.
18. Tenery, R., et al., *Surgical "placebo" controls.* Ann Surg, 2002. **235**(2): p. 303-7.
19. Colagiuri, B., et al., *The placebo effect: From concepts to genes.* Neuroscience, 2015. **307**: p. 171-90.
20. Savulescu, J., K. Wartolowska, and A. Carr, *Randomised placebo-controlled trials of surgery: ethical analysis and guidelines.* J Med Ethics, 2016. **42**(12): p. 776-783.
21. Ryosa, A., et al., *Surgery or conservative treatment for rotator cuff tear: a meta-analysis.* Disabil Rehabil, 2016: p. 1-7.
22. Chan, A.W., et al., *SPIRIT 2013 statement: defining standard protocol items for clinical trials.* Ann Intern Med, 2013. **158**(3): p. 200-7.
23. Schulz, K.F., et al., *CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials.* BMJ, 2010. **340**: p. c332.
24. Hamada, K., et al., *A radiographic classification of massive rotator cuff tear arthritis.* Clin Orthop Relat Res, 2011. **469**(9): p. 2452-60.
25. Samilson, R.L. and V. Prieto, *Dislocation arthropathy of the shoulder.* J Bone Joint Surg Am, 1983. **65**(4): p. 456-60.
26. Hamada, K., et al., *Roentgenographic findings in massive rotator cuff tears. A long-term observation.* Clin Orthop Relat Res, 1990(254): p. 92-6.
27. Fuchs, B., et al., *Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging.* J Shoulder Elbow Surg, 1999. **8**(6): p. 599-605.

28. Henn, R.F., 3rd, et al., *Patients' preoperative expectations predict the outcome of rotator cuff repair.* J Bone Joint Surg Am, 2007. **89**(9): p. 1913-9.
29. Oh, J.H., et al., *Effect of expectations and concerns in rotator cuff disorders and correlations with preoperative patient characteristics.* J Shoulder Elbow Surg, 2012. **21**(6): p. 715-21.
30. Dunn, W.R., et al., *2013 Neer Award: predictors of failure of nonoperative treatment of chronic, symptomatic, full-thickness rotator cuff tears.* J Shoulder Elbow Surg, 2016. **25**(8): p. 1303-11.
31. Colagiuri, B., *Participant expectancies in double-blind randomized placebo-controlled trials: potential limitations to trial validity.* Clin Trials, 2010. **7**(3): p. 246-55.
32. Frisaldi, E., A. Shaibani, and F. Benedetti, *Why We should Assess Patients' Expectations in Clinical Trials.* Pain Ther, 2017. **6**(1): p. 107-110.
33. Younger, J., et al., *Development of the Stanford Expectations of Treatment Scale (SETS): a tool for measuring patient outcome expectancy in clinical trials.* Clin Trials, 2012. **9**(6): p. 767-76.
34. Cho, C.H., et al., *The impact of depression and anxiety on self-assessed pain, disability, and quality of life in patients scheduled for rotator cuff repair.* J Shoulder Elbow Surg, 2013. **22**(9): p. 1160-6.
35. Zigmond, A.S. and R.P. Snaith, *The hospital anxiety and depression scale.* Acta Psychiatr Scand, 1983. **67**(6): p. 361-70.
36. Outerbridge, R.E. and J.A. Dunlop, *The problem of chondromalacia patellae.* Clin Orthop Relat Res, 1975(110): p. 177-96.
37. Holmgren, T., et al., *Effect of specific exercise strategy on need for surgery in patients with subacromial impingement syndrome: randomised controlled study.* BMJ, 2012. **344**: p. e787.
38. Harris, J.D., et al., *Predictors of pain and function in patients with symptomatic, atraumatic full-thickness rotator cuff tears: a time-zero analysis of a prospective patient cohort enrolled in a structured physical therapy program.* Am J Sports Med, 2012. **40**(2): p. 359-66.
39. Kluczynski, M.A., et al., *Early Versus Delayed Passive Range of Motion After Rotator Cuff Repair: A Systematic Review and Meta-analysis.* Am J Sports Med, 2015. **43**(8): p. 2057-63.
40. Thigpen, C.A., et al., *The American Society of Shoulder and Elbow Therapists' consensus statement on rehabilitation following arthroscopic rotator cuff repair.* J Shoulder Elbow Surg, 2016. **25**(4): p. 521-35.
41. Klintberg, I.H., et al., *Consensus for physiotherapy for shoulder pain.* Int Orthop, 2015. **39**(4): p. 715-20.
42. Edwards, P., et al., *Exercise Rehabilitation in the Non-Operative Management of Rotator Cuff Tears: A Review of the Literature.* Int J Sports Phys Ther, 2016. **11**(2): p. 279-301.
43. Kirkley, A., C. Alvarez, and S. Griffin, *The development and evaluation of a disease-specific quality-of-life questionnaire for disorders of the rotator cuff: The Western Ontario Rotator Cuff Index.* Clin J Sport Med, 2003. **13**(2): p. 84-92.
44. Huang, H., et al., *A Systematic Review of the Psychometric Properties of Patient-Reported Outcome Instruments for Use in Patients With Rotator Cuff Disease.* Am J Sports Med, 2015. **43**(10): p. 2572-82.
45. Ekeberg, O.M., et al., *A questionnaire found disease-specific WORC index is not more responsive than SPADI and OSS in rotator cuff disease.* J Clin Epidemiol, 2010. **63**(5): p. 575-84.
46. Constant, C.R. and A.H. Murley, *A clinical method of functional assessment of the shoulder.* Clin Orthop Relat Res, 1987(214): p. 160-4.
47. Henseler, J.F., et al., *The minimal detectable change of the Constant score in impingement, full-thickness tears, and massive rotator cuff tears.* J Shoulder Elbow Surg, 2015. **24**(3): p. 376-81.
48. Constant, C.R., et al., *A review of the Constant score: modifications and guidelines for its use.* J Shoulder Elbow Surg, 2008. **17**(2): p. 355-61.
49. Kirkley, A., S. Griffin, and K. Dainty, *Scoring systems for the functional assessment of the shoulder.* Arthroscopy, 2003. **19**(10): p. 1109-20.
50. Kukkonen, J., et al., *Investigating minimal clinically important difference for Constant score in patients undergoing rotator cuff surgery.* J Shoulder Elbow Surg, 2013. **22**(12): p. 1650-5.
51. Holmgren, T., et al., *Minimal important changes in the Constant-Murley score in patients with subacromial pain.* J Shoulder Elbow Surg, 2014. **23**(8): p. 1083-90.

52. Williamson, A. and B. Hoggart, *Pain: a review of three commonly used pain rating scales.* J Clin Nurs, 2005. **14**(7): p. 798-804.
53. Farrar, J.T., et al., *Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale.* Pain, 2001. **94**(2): p. 149-58.
54. Michener, L.A., A.R. Snyder, and B.G. Leggin, *Responsiveness of the numeric pain rating scale in patients with shoulder pain and the effect of surgical status.* J Sport Rehabil, 2011. **20**(1): p. 115-28.
55. Sintonen, H., *The 15D instrument of health-related quality of life: properties and applications.* Ann Med, 2001. **33**(5): p. 328-36.
56. Alanne, S., et al., *Estimating the minimum important change in the 15D scores.* Qual Life Res, 2015. **24**(3): p. 599-606.
57. Sugaya, H., et al., *Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: single-row versus dual-row fixation.* Arthroscopy, 2005. **21**(11): p. 1307-16.
58. Bang, H., L. Ni, and C.E. Davis, *Assessment of blinding in clinical trials.* Control Clin Trials, 2004. **25**(2): p. 143-56.
59. Wessel, J., et al., *The factor validity of the Western Ontario Rotator Cuff Index.* BMC Musculoskelet Disord, 2005. **6**: p. 22.
60. Jarvinen, T.L., et al., *Blinded interpretation of study results can feasibly and effectively diminish interpretation bias.* J Clin Epidemiol, 2014. **67**(7): p. 769-72.
61. Raman, J., et al., *Predictors of outcomes after rotator cuff repair-A meta-analysis.* J Hand Ther, 2017. **30**(3): p. 276-292.
62. Wade, R. and S. Salgar, *Clinico-radiological evaluation of retear rate in arthroscopic double row versus single row repair technique in full thickness rotator cuff tear.* J Orthop, 2017. **14**(2): p. 313-318.
63. Pennington, W.T., et al., *Comparative analysis of single-row versus double-row repair of rotator cuff tears.* Arthroscopy, 2010. **26**(11): p. 1419-26.
64. Sobhy, M.H., et al., *Do functional outcomes and cuff integrity correlate after single- versus double-row rotator cuff repair? A systematic review and meta-analysis study.* Eur J Orthop Surg Traumatol, 2018. **28**(4): p. 593-605.
65. Spiegl, U.J., et al., *Summary of Meta-Analyses Dealing with Single-Row versus Double-Row Repair Techniques for Rotator Cuff Tears.* Open Orthop J, 2016. **10**: p. 330-338.
66. Mascarenhas, R., et al., *Is double-row rotator cuff repair clinically superior to single-row rotator cuff repair: a systematic review of overlapping meta-analyses.* Arthroscopy, 2014. **30**(9): p. 1156-65.
67. Millett, P.J., et al., *Clinical and structural outcomes after arthroscopic single-row versus double-row rotator cuff repair: a systematic review and meta-analysis of level I randomized clinical trials.* J Shoulder Elbow Surg, 2014. **23**(4): p. 586-97.
68. Maman, E., et al., *Outcome of nonoperative treatment of symptomatic rotator cuff tears monitored by magnetic resonance imaging.* J Bone Joint Surg Am, 2009. **91**(8): p. 1898-906.
69. Safran, O., et al., *Natural history of nonoperatively treated symptomatic rotator cuff tears in patients 60 years old or younger.* Am J Sports Med, 2011. **39**(4): p. 710-4.
70. Ranebo, M.C., et al., *Clinical and structural outcome 22 years after acromioplasty without tendon repair in patients with subacromial pain and cuff tears.* J Shoulder Elbow Surg, 2017. **26**(7): p. 1262-1270.
71. Choi, S., et al., *Factors associated with clinical and structural outcomes after arthroscopic rotator cuff repair with a suture bridge technique in medium, large, and massive tears.* J Shoulder Elbow Surg, 2014. **23**(11): p. 1675-81.
72. Boileau, P., et al., *Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal?* J Bone Joint Surg Am, 2005. **87**(6): p. 1229-40.
73. Heuberer, P.R., et al., *Longitudinal Long-term Magnetic Resonance Imaging and Clinical Follow-up After Single-Row Arthroscopic Rotator Cuff Repair: Clinical Superiority of Structural Tendon Integrity.* Am J Sports Med, 2017. **45**(6): p. 1283-1288.
74. Russell, R.D., et al., *Structural integrity after rotator cuff repair does not correlate with patient function and pain: a meta-analysis.* J Bone Joint Surg Am, 2014. **96**(4): p. 265-71.

75. Fucentese, S.F., et al., *Evolution of nonoperatively treated symptomatic isolated full-thickness supraspinatus tears.* J Bone Joint Surg Am, 2012. **94**(9): p. 801-8.
76. Yamamoto, A., et al., *Prevalence and risk factors of a rotator cuff tear in the general population.* J Shoulder Elbow Surg, 2010. **19**(1): p. 116-20.
77. Fukuda, H., *Partial-thickness rotator cuff tears: a modern view on Codman's classic.* J Shoulder Elbow Surg, 2000. **9**(2): p. 163-8.
78. Loew, M., et al., *How to discriminate between acute traumatic and chronic degenerative rotator cuff lesions: an analysis of specific criteria on radiography and magnetic resonance imaging.* J Shoulder Elbow Surg, 2015. **24**(11): p. 1685-93.
79. Teefey, S.A., et al., *Sonographic differences in the appearance of acute and chronic full-thickness rotator cuff tears.* J Ultrasound Med, 2000. **19**(6): p. 377-8; quiz 383.
80. Buirski, G., *Magnetic resonance imaging in acute and chronic rotator cuff tears.* Skeletal Radiol, 1990. **19**(2): p. 109-11.
81. Randelli, P., et al., *Complications associated with arthroscopic rotator cuff repair: a literature review.* Musculoskelet Surg, 2012. **96**(1): p. 9-16.
82. Yeranosian, M.G., et al., *Incidence of acute postoperative infections requiring reoperation after arthroscopic shoulder surgery.* Am J Sports Med, 2014. **42**(2): p. 437-41.
83. Lenza, M., et al., *Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered.* Cochrane Database Syst Rev, 2013(9): p. CD009020.
84. Stock, G., *If the goal is relief, what's wrong with a placebo?* Am J Bioeth, 2003. **3**(4): p. 53-4.
85. Wartolowska, K.A., et al., *A meta-analysis of temporal changes of response in the placebo arm of surgical randomized controlled trials: an update.* Trials, 2017. **18**(1): p. 323.

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Conflicts of interests None declared.

Patient consent Obtained.

Ethics approval The study protocol for this clinical trial has been approved by the Ethics Committee of the Hospital District of Southwest Finland (17.5.2016) and Regional Ethics Committee in Linköping Sweden (2016/263-31) and Regional Committees for Medical and Health Research Ethics South East in Norway (2016/1446).

Data statement This is a protocol article and we have no data to publish at this point. We will make the research data available when the trial is finalized.

ACCURATE study group

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Table 1. Inclusion and exclusion criteria

Criteria for Inclusion
1. Age of patient is over 45 and below 70 years at the time of injury

2. Acute onset of shoulder symptoms after a traumatic event (any kind of sudden stretch, pull, fall, or impact, on the shoulder that is associated with the onset of symptoms)
3. Shoulder symptoms relating to rotator cuff tear = pain laterally on the shoulder and/or painful motion arc during abduction or flexion
4. MRI documented full thickness supraspinatus (ssp) tear
Criteria for Exclusion
1. Traumatic event of the shoulder due a criminal act of violence with legal consequences
2. A delay of more than 4 months after the onset of symptoms of trauma to the day of intervention
3. Arthroscopically documented partial thickness rotator cuff tear only
4. A large MRI documented full thickness rotator cuff tear, sagittal tear size at the level of footprint larger than 3cm
5. MRI or arthroscopically documented total width of infraspinatus (isp) or subscapularis (ssc) tear
6. MRI or arthroscopically documented fully dislocated biceps tendon (biceps out of the groove) with concomitant subscapularis tear
7. Positive clinical rotatory lag sign (ER1 lag (>10 degrees), lift off lag (involuntary drop against the back), horn blower lag (involuntary internal rotation of the forearm in supported elevated position))
8. Marked fatty degeneration in any of the cuff muscles (more than Fuchs/Goutallier grade 2 [27])
9. Radiographically or MRI documented concomitant fracture line of the involved extremity or bony avulsion of the torn tendon or dislocation of the humeral head or the acromioclavicular joint
10. Concomitant clinically detectable motor nerve injury affecting the shoulder

11. Radiographically documented severe osteoarthritis of the glenohumeral joint, Samilson-Prieto 2 or above
12. Non-congruency of the glenohumeral joint in radiographs (Hamada stage 2 or above)
13. Clinical stiffness of the glenohumeral joint (severely limited passive range of motion: glenohumeral external rotation < 30 degrees, and abduction with stabilized scapula <60 degrees)
14. Previous surgery of the affected shoulder (affecting clavicle, scapula or upper third of the humerus)
15. Earlier sonographic or MRI finding of a rotator cuff tear
16. Previous symptoms of the ipsilateral shoulder requiring conservative treatment (glucocorticosteroid injections and/or physiotherapy) delivered by health care professionals during the last five years 17. Systemic glucocorticosteroid or antimetabolite medication during the last 5 years
18. Ongoing treatment for malignancy
19. ASA classification 3 or 4
20. Patient's inability to understand written and spoken Finnish, Norwegian or Swedish
21. History of alcoholism, drug abuse, psychological or other emotional problems likely to jeopardise informed consent
22. Patients with a contraindication/noncompliance for MRI examination or use of electrocautery devices
23. Previous randomization of the contralateral shoulder into the ACCURATE trial
24. Patient's denial for operative treatment and/or participation in the trial

Table 2. Baseline demographics

	Rotator cuff repair	Placebo surgery
Age (years), mean (SD)		
Gender (female/male), n (%)		
Dominant side affected, n (%)		
Previous symptoms no pain ever, n (%) pain in shoulder at any point of time, n (%) pain during the past year, n (%)		
Smoking habits smoking, n (%) non smoking, n (%)		
Occupation		
Mechanism of injury stretch, n (%) pull, n (%) fall, n (%) impact, n (%)		
Energy of injury < fall from own height, n (%) > fall from own height, n (%)		
Duration of symptoms (days/weeks from the trauma to the operation), mean (SD)		

Working status
student, n (%)
unemployed, n (%)
retired, n (%)
on sick leave, n (%)
disability pension, n (%)
working, n (%)
Treatments after the trauma
injections, n (%)
physiotherapy, n (%)
pain killers, n (%)

Outcome measures
Pain NRS (0-10) at night, mean (SD)
Pain NRS (0-10) at rest, mean (SD)
Pain NRS (0-10) during activity, mean (SD)
WORC (WORC %-index 0-100 %)
physical symptoms, mean (SD)
sports/recreation, mean (SD)
work, mean (SD)
lifetime, mean (SD)
emotions, mean (SD)
total %-index, mean (SD)
Constant-Murley score
pain, mean (SD)
activities of daily living, mean (SD)
range of motion, mean (SD)
shoulder power, mean (SD)
total score, mean (SD)
15D, mean (SD)
Stanford expectations of treatment scale (SETS)
Hospital Anxiety and Depression Scale (HADS)

Table 3. Pathology during the diagnostic arthroscopy

	Rotator cuff repair	Placebo surgery
Condition of humerus articular surfaces Outerbridge grade 0, n (%) Outerbridge grade 1, n (%) Outerbridge grade 2, n (%) Outerbridge grade 3, n (%) Condition of glenoid articular surfaces Outerbridge grade 0, n (%) Outerbridge grade 1, n (%) Outerbridge grade 2, n (%) Outerbridge grade 3, n (%)		
Condition of the biceps tendon normal, n (%) tendinosis, n (%) subluxation, n (%)		

Table 4. Procedures in the rotator cuff repair group

Anatomic reconstruction, n (%) Partial reconstruction, n (%)
Brand of suture anchors
Number of suture anchors 1, n (%) 2, n (%) 3, n (%) 4, n (%)
Biceps procedure none, n (%) tenotomy, n (%) tenodesis, n (%)
Acromioplasty yes, n (%) no, n (%)

Table 5. Imaging studies parameters at baseline and at follow-up

Shoulder radiograph	Rotator cuff repair	Placebo surgery
osteoarthritic changes		
Samilson et Prieto grade 1, n (%)		
Samilson et Prieto grade 2, n (%)		
Samilson et Prieto grade 3, n (%)		
cuff tear arthropathy		
Hamada grade 1, n (%)		
Hamada grade 2, n (%)		
Hamada grade 3, n (%)		
Hamada grade 4, n (%)		
Hamada grade 5, n (%)		
Shoulder MRI		
arthrography MRI, n (%)		
native MRI, n (%)		
Supraspinatus		
Re-tear if operated		
Sugaya type I, n (%)		
Sugaya type II, n (%)		
Sugaya type III, n (%)		
Sugaya type IV, n (%)		
Sugaya type V, n (%)		
sagittal tear size (mm), mean (SD)		
coronal tear size (mm), mean (SD)		
fatty degeneration		
Fuchs/Goutallier grade 0, n (%)		
Fuchs/Goutallier grade 1, n (%)		
Fuchs/Goutallier grade 2, n (%)		
Fuchs/Goutallier grade 3, n (%)		
Fuchs/Goutallier grade 4, n (%)		
Warner tangent sign		
positive, n (%)		
negative, n (%)		
muscle edema		
yes, n (%)		
no, n (%)		

Infraspinatus Re-tear if operated Sugaya type I, n (%) Sugaya type II, n (%) Sugaya type III, n (%) Sugaya type IV, n (%) Sugaya type V, n (%) sagittal tear size (mm), mean (SD) coronal tear size (mm), mean (SD) fatty degeneration Fuchs/Goutallier grade 0, n (%) Fuchs/Goutallier grade 1, n (%) Fuchs/Goutallier grade 2, n (%) Fuchs/Goutallier grade 3, n (%) Fuchs/Goutallier grade 4, n (%) muscle edema yes, n (%) no, n (%)
Subscapularis Re-tear if operated Sugaya type I, n (%) Sugaya type II, n (%) Sugaya type III, n (%) Sugaya type IV, n (%) Sugaya type V, n (%) sagittal tear size (mm), mean (SD) coronal tear size (mm), mean (SD) fatty degeneration Fuchs/Goutallier grade 0, n (%) Fuchs/Goutallier grade 1, n (%) Fuchs/Goutallier grade 2, n (%) Fuchs/Goutallier grade 3, n (%) Fuchs/Goutallier grade 4, n (%) muscle edema yes, n (%) no, n (%)

Teres minor fatty degeneration Fuchs/Goutallier grade 0, n (%) Fuchs/Goutallier grade 1, n (%) Fuchs/Goutallier grade 2, n (%) Fuchs/Goutallier grade 3, n (%) Fuchs/Goutallier grade 4, n (%) muscle edema yes, n (%) no, n (%)
Long head of the biceps tendon normal, n (SD) subluxation, n (SD) frayed, n (SD) ruptured, n (SD) tendon missing, n (SD) tenodesis, n (SD)

Table 6. Schedule for the assesments

Assesment	Screening	Baseline	Intervention (within 4 months after trauma)	3 months	6 months	1 year	2 years	5 years	10 years
Screening form	X								
Radiograps and MRI	X						X	X	X
Clinical examination		X		X (BD+PT)	X (PT)	X (PT)	X (PT)	X (PT)	X (PT)
Preoperative data form		X							
Randomization			X						
Intraoperative data form			X						
Blinding index			X*	X	X	X	X		
SETS		X							
HADS		X		X	X	X	X	X	X
Pain NRS		X		X	X	X	X	X	X
15D		X		X	X	X	X	X	X
CM score		X		X	X	X	X	X	X
WORC		X		X	X	X	X	X	X
Working status		X		X	X	X	X	X	X
Analgesic usage		X		X	X	X	X	X	X
Supplementary treatment		X		X	X	X	X	X	X
Subjective satisfaction				X	X	X	X	X	X
Amount of supervised PT visits					X				
Exercise diary					X				
Question on treatment satisfaction†						X	X	X	X
Adverse event form§			(X)	(X)	(X)	(X)	(X)	(X)	(X)
Discontinuation form§				(X)	(X)	(X)	(X)	(X)	(X)
Unblinding form§					(X)	(X)	(X)	(X)	(X)
Reoperation form§				(X)	(X)	(X)	(X)	(X)	(X)

* After the intervention, at the point of discharge

† Looking back at your shoulder trauma and the treatment that you initially received, would you choose to undergo the same treatment if you could turn back time?

§ If required

BD, blinded doctor; PT, physiotherapist; SETS, Stanford Expectations of Treatment Scale; HADS, Hospital Anxiety and Depression Scale; Pain NRS, Numerical Rating Scale for pain; CM score, Constant-Murley score; WORC, Western Ontario Rotator Cuff index

Table 7. Ethical considerations about the trial setup

Criteria to make surgical placebo-controlled trial ethical outlined by Savulescu et al.
The presence of equipoise
There are no randomized controlled trials on acute rotator cuff tears, i.e. there is a lack of unbiased evidence for efficacy of the arthroscopic rotator cuff repair. There is a meta-analysis [21] from three randomized controlled trials on the treatment of mainly non-traumatic rotator cuff tears and it showed clinically similar results between operative and conservative treatment.
Preliminary evidence for efficacy of the procedure
There are several open-label studies [4, 8-11] on the operative treatment of rotator cuff tears. The results usually range from good to excellent and in terms of outcome measures the overall improvement has been clinically significant. These studies on the other hand are highly biased because of the study design itself; not controlling the critical surgical element, true placebo effect and non-specific effects [16, 17]. In surgical treatment of rotator cuff tear the outcome is always a subjective change in quality of life because of non-life-threatening nature of the condition. The critical element is the repair/suturing the torn tendon. The aim is to relieve pain and improve function by reinserting tendon with suture anchors back into its footprint where it should biologically heal. However, considerable amount of these sutured tendons do not heal or they re-rupture. Furthermore a re-tear do not seem to affect the outcome [74]; patients with a re-tear are as satisfied as patients with an intact tendon. Taking into account the previously mentioned facts there exists a doubt whether the improvement seen in the open-label studies is caused by the rotator cuff repair, or not.
Minimizing risk for patients in the placebo arm
In the ACCURATE trial the placebo arm includes a diagnostic arthroscopy and supervised physiotherapy. The potential risks for patients are associated with operative treatment and include: preoperative medication (usually pain killers and sedatives/anksiolytes), plexus anesthesia, global/total intravenous anesthesia, prophylactic antibiotic, diagnostic arthroscopy itself and post-operative medications (mainly pain killers). All medications can cause side-effects, but this risk is estimated to be low. Surgery, which is by definition invasive, comes always with a risk of adverse events or complications. A complication is defined as an event or condition that requires additional treatment, either non-operative or operative. Because literature does not consistently report on surgery related complications after shoulder arthroscopy it is impossible to draw valid conclusion on the incidence of complications. The most common complication is the postoperative shoulder

stiffness, which is reported to occur in 2.6 % - 23.3 % of cases [81]. The overall infection rate for all arthroscopic shoulder procedures is 0.27 %, being highest for rotator cuff repair (0.29 %) and lowest for capsulorrhaphy (0.16 %) [82]. Rate for neurovascular complications is 0.4 % - 3.4 % [81]. Taking into account that diagnostic arthroscopy does not include any shaving, burning or additional procedure, it is much less traumatic than the active treatment arm. In addition, there will be no foreign materials left in the shoulder after the procedure.

Considering the aforementioned issues we will assume that incidence of complications in the diagnostic arthroscopy group will be smaller than those reported for arthroscopic procedures. The main concern is if the unrepaired tear becomes larger by time, retracts and induces irreversible fatty degeneration of the scapular musculature. There are no high quality studies on the natural course of an acute cuff tear. There are only a few studies available on the evolution of a non-operatively treated supraspinatus tendon tear [1, 69, 75]. Accordingly, significant short term tear size progression is unlikely. Overall we consider the risk profile to be acceptable.

Avoiding deception

Patients are openly explained the placebo-design of the trial and told what it means. They get oral and written information concerning the trial and a written informed consent is obtained. The operating doctor and staff (who are the only ones who know the allocated intervention group) will not meet with patient after the operation to avoid compromise in blinding. The follow-up visits are carried out by the blinded physiotherapist and doctor.

Potential significant change to clinical practice

The results of this trial will directly affect the decision-making process worldwide. If the results show that repair and physiotherapy is clinically superior to placebo surgery and physiotherapy, it corroborates that the tendon repair has an important effect in the treatment of an acute cuff tear. On the other hand if placebo surgery group is superior or the difference between groups is not clinically significant, there is no justification for a tendon repair in the treatment of an acute supraspinatus tear. Consequently, conservative treatment should be advocated taking into account the higher costs and greater risk for complications in the operative treatment.

Benefits to the patients in the placebo group

All patients in the placebo group do not get only placebo surgery but also supervised specific exercise therapy delivered by a physiotherapist, like the patients in the cuff repair group. To our knowledge there is no published study on conservative treatment of traumatic rotator cuff tears. According to prospective cohort study and open-label RCTs on atraumatic cuff tears, conservative treatment yields

clinically significant improvement. Secondly the patients in the placebo group will probably experience a positive meaning response due to the trial design. Thirdly the patients in the placebo group get a diagnostic arthroscopy prior to randomization. Their glenohumeral joint is evaluated and any encountered pathology is documented and if, for example, a total subscapularis or infraspinatus tear or a partial-thickness tear is verified, patient is excluded from the trial and treated accordingly. Although the MRI has a good diagnostic accuracy on full-thickness rotator cuff tears, the specificity and sensitivity is not 100% [83]. In addition, patients in clinical trials have many potential benefits over standard care with respect to additional monitoring (including imaging, clinic visits, interviews) and ongoing attention and care, all of which would be likely to have value by itself [84]. Further, after a surgical placebo intervention, patients report significant improvement for a prolonged period of time and the effect does not seem to change significantly with time [85]. If at the end of trial the placebo group is equal or superior to tendon repair group, the patients in the placebo group will benefit by getting a smaller operation with a minor risk for complication and no foreign material is left in their body.

Figure 1 Flow chart of the trial

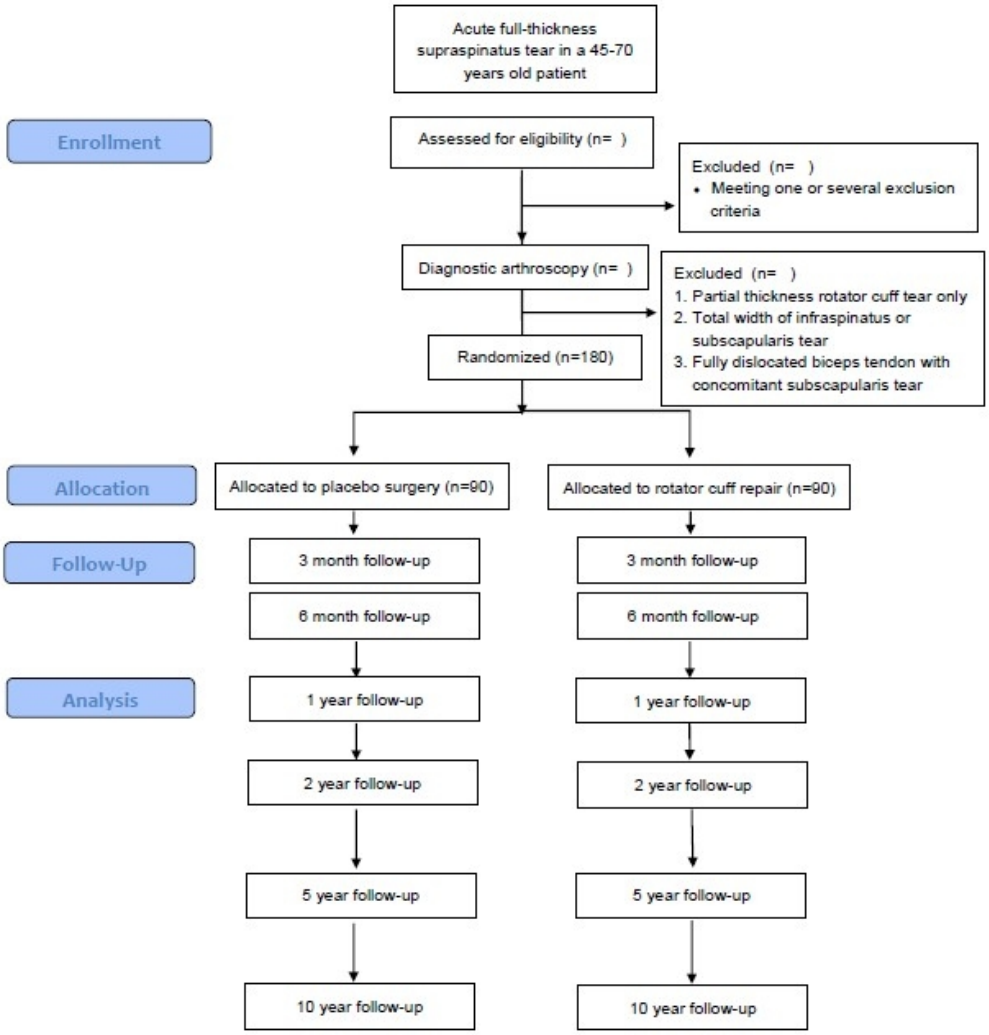


Figure 1 Flow chart of the trial

51x54mm (300 x 300 DPI)

Rehabilitation protocol for the ACCURATE study.

Instructions for the Physiotherapists participating in the ACCURATE study.

The rehabilitation program is based on the current literature (Holmgren et al 2012, Moon shoulder group 2011, Kluczynski et al 2015, Consensus statement, Thigpen et al 2016, Klintberg et al 2015, Edwards et al 2016) as well as clinical experience. All patients in both groups will follow the same rehabilitation program that consists of an initial phase (0-4 weeks) and then three phases (1-3) after taking the sling off. All patients will be fixated in a sling for 4 weeks, 24 hours a day. During the first 4 weeks it is allowed to take the sling off when taking a shower and also for passive range of motion exercises. **The initial phase** contains patient education passive range of motion exercises and resting positions for the shoulder. This exercise program is standardized. **The first phase** consists of active assisted and short level arm active range of motion exercises. **The second phase** consists of active range of motion exercises and isometric muscle activation and the **third phase** of dynamic strengthening exercises and stretching. There are several exercises to choose from in each phase (1-3) in purpose to fit each patients shoulder disability. **Choose a maximum of 3-4 exercises** to work with during a specific time and progress to new exercises when the patient is ready with respect to quality of movement and pain. The physiotherapist (PT) decides when the patient is ready to move on to the next phase, considering aspects of quality of motion and pain, in accordance with restrictions. **None or minimal pain (0-3/10 NRS) during the exercises is one milestone to progress to the next phase.** It is important to respect the timeframes in the phases. Patient may pass slower through the phases but not faster. Exercises from earlier phases could still be used even though the patient has moved on to the next phase.

The first visit will be at the ward after surgery and a PT will give information about restrictions, go through the initial phase as well as introduce the exercise diary. After that the patients will meet the research PT within a week after surgery to be introduced to the rehabilitation program. The patients will have approximately 15 visits of PT guided exercises sessions during a 5- month period. Each visit will take approximately 30-45 minutes. In between these guided exercise sessions patients will perform home-exercises acoording to the different phases. An exercise diary is used to encourage adherence and is handed out at the ward. The PT will write down the number of the exercise used from the exercise bank in the diary. Each phase is decribed with three headings; Patient education, PT assisted passive range of motion exercises, Exercises to perform with PT supervision and as home exercises. See below the short version that describes the content in each phase during the rehabilitation program.

Initial phase (weeks 0-3)

- Patient education. Exercises to promote good circulation in the shoulder and arm as well as a good posture. Passive range of motion exercises for the shoulder.

Phase 1 (weeks 4-6)

- Active assisted/supported range of motion exercises in elevation, abduction, Internal and external rotation that initially unload the rotator cuff.

Phase 2 (weeks 7-11)

- Active unloaded exercises mainly in full can elevation, external and internal rotation. Isometric strengthening exercises for the rotator cuff.

Phase 3 (weeks12-20)

- Dynamic strengthening exercises for the rotator cuff and scapula stabilizers- and rotators as well as stretching exercises according to the specific exercise program.

Each phased described in more detail:

Initial Phase (Weeks 0-3)

In this phase the patients will have approximately 2 PT supervised sessions. The first visit should be within the first week after surgery. The patient has been given the standardized exercise program at the ward after surgery and been informed about the restrictions of having the sling on 24 hours a day for four weeks. At the first session you will educate the patient and go through the exercise program to make sure that the patients perform the exercises correctly. Use a mirror when you instruct the exercises to the patient. For further instructions of treatment at the first visit see below. If you have a second visit during this phase you will do the same as at the first visit.

Goals:

- Maintain integrity of the surgical repair
- Do not overstress healing tissue
- Minimize pain
- Increase passive range of motion gradually
- Prevent muscular inhibition
- Compliance to both restrictions and home-exercise program

- Patient education

Explain to the patient what a rotator cuff tear is and the nature of surgery. Talk about tissue healing and the importance of their immobilization period and the restrictions. Also explain the ability to compensate with the rotator cuff that is intact in case of no surgical repairing. Use models and pictures so that they can understand the biomechanics. Inform the patients about resting positions for the shoulder and how to relax in sitting and standing positions. Practice good posture, thoracic extension and avoid elevated and protracted shoulders. Repeat the restrictions of having the sling on 24 hours a day in four weeks. Show the

patients and let them practice to put on and take off the sling, which is allowed when the patients are doing their exercises and personal hygiene. Instruct the patients that they may lean their upper body to the operated side in order to wash the axilla. Apart from using the sling as described above also inform the patient about following **restrictions during this phase;**

No lifting of objects, no active range of motion, no excessive stretching and no supporting of body weight by hands.

- PT assisted passive range of motion exercises (starts 1 week after surgery)

Performed with the patient in supine position. Forward elevation in the scapular plane, abduction and external rotation with the shoulder in approximately 20 ° of abduction in the shoulder. Repeat approximately 5-7 times in each direction. No pain is allowed during the PT assisted passive range of motion exercises.

- Exercises to perform with the PT and as home exercises (the first four weeks to perform three times per day)

- Flexion/extension of the elbow
- Raising and lowering the shoulder
- Arm hanging loose at sides and then bending the upper body forward to attain flexion in the shoulder.
- Active assisted external rotation with a stick
- Supine elevation self-assisted or assisted by husband/wife, friend or relatives.

  Outside the program, patients were recommended to perform pumping with the hand x 30, 4-5 times per day.

Phase 1 (weeks 4-6)

In this phase the patients will have 3-4 PT supervised sessions. After 4 weeks the sling can be eliminated. If the patient still have much pain or feel unsecure at a particular activity they may keep the sling on while performing the particular activity. It is important that the patients try to get used to not wear the sling and use their hand and arm in easier activities in the dialing living to prevent stiffness. This phase consists of active supported exercises and in the end low level arm active exercises. During this phase you will meet the patient 3-4 times depending on how much support the patient need during the exercises and also if the shoulder is stiff.

Goals

- Maintain integrity of the surgical repair
- Do not overstress healing tissue

- Increase passive range of motion gradually
- Start with active assisted exercises with good quality
- Prevent muscular inhibition
- Compliance to both restrictions and home-exercise program

- Patient education

Go through resting positons of the shoulder in lying and sitting. Explain that they may not use their shoulders in demanding activities yet. Explain the process of healing in relation to progression of exercises. Inform the patient about following **restrictions during this phase;**

No lifting of objects, no excessive stretching or sudden movements, no excessive shoulder extension and no supporting of body weight by hands.

- PT assisted passive range of motion exercises

Performed with the patient in supine position. Forward elevation in the scapular plane, abduction and external rotation in approximately 20 ° of abduction in the shoulder. Repeat 5-7 times in each direction. When the PT assist passive range of motion exercises no pain is allowed.

- Exercises to perform with the PT and as home exercises

Use exercises from the exercise bank. Guide the patients while doing their exercises, in positioning of the shoulder and scapula in the starting position and also throughout the movement. It is preferable to use a mirror. Home-exercises to perform twice daily.

- One exercises of active supported elevation
- One exercises of active supported abduction
- One exercise of active supported external rotation
- Scapula positioning and scapula retraction
- Active flexion and abduction with short level arm (can be added at the earliest week 6)

Phase 2 (weeks 7-11)

In this phase the patients will have 4-5 PT supervised sessions. After 6 weeks patients are allowed to perform active range of motion exercises through the whole range of motion in all directions of the shoulder. It is important to guide the patient so that the exercise is performed correctly and with quality. The quality of the movement is more important than the quantity. Guide your patient in front of a mirror. You will meet the patient 4-5 times during this phase. Agree with the patients in functional goals in between the PT supervised sessions. The home-exercises will be performed twice daily.

Goals

- Maintain integrity of the surgical repair
- Do not overstress healing tissue
- Gradually increase to full passive and active range of motion
- Restore dynamic scapular and humeral kinematic

- Patient education

Remind the patient that it is not allowed to put any heavy load on the shoulder. Patients may use their arm and shoulder in activities of daily living. It is preferable to have functional goals.

- PT assisted passive range of motion exercises (if needed)

Performed with the patient in supine position. Forward elevation in the scapular plane, abduction and external in approximately 20 ° of abduction in the shoulder. Repeat 5-7 times in each direction. When the PT assist passive range of motion exercises no pain is allowed.

- Exercises to perform with the PT and as home exercises

- One or two exercise of active elevation (you may use exercise as the ball against the wall as a start).
- One exercise of active abduction (sometimes you need to start with assistance in the concentric phase and work in the eccentric phase)
- Isometric contractions of the rotator cuff (internal/external rotation)
- Unloaded side lying external rotation
- Scapula positioning and scapula retraction

Phase 3 (weeks 12-20)

In this last phase the patients will have approximately 5-6 PT supervised sessions. Patients may start with exercises loading the rotator cuff muscles and the scapula stabilizers and rotators as well as stretching exercises. Sometimes it is easier for the patients to start in the eccentric phase and have assistance in the concentric phase, if so use those exercises in order to achieve quality in the performance of the exercise. In the beginning of this phase when you have less load patients may do their exercises program once a day. When the load becomes more challenging patients should do the exercise program once every other day. Exercises in purpose to gain in range of motion could be performed daily.

Goals

- Progressive rotator cuff strengthening
- Restore scapular stability
- Restore full shoulder flexibility
- Functional training aiming for patient to return to work

- Patient education

Remind the patients that it is not allowed to aggravate the pain when performing the exercises. The may feel sore and some strain in the muscles but not pain that becomes more intense. If so the load need to be decreased. The patients should be aware of the total load they put on the shoulder every day. Sometimes it is their leisure time activities that aggravate the pain. It is essential to find a good balance.

- PT assisted stretching exercises (if needed)
- Internal rotation
- External rotation
- Pectoralis minor

- Exercises to perform with the PT and as home exercises
- One row exercise
- One or two external rotation exercises. tart in side-lying and then progress with shoulder in 90 degrees of abduction and with bilateral external rotation with elevation)
- One or two elevation exercises in the scapula plane. Start to work in the eccentric phase and then progress to concentric /eccentric work.
- One for the scapula stabilizers
- Stretching exercises (If needed)

After week 14 up until week 20 the exercises could be more individually adjusted according to the patients work and leisure times activities. Chose exercises from the exercise bank. The exercises could be more complex and speed and load can increase.

General principles concerning the performance of exercises in the rehabilitation process.

- **The quality of movement is essential:** If an exercise is performed incorrectly replace the exercise with an exercise that is easier for the patient to perform with a correct movement pattern.
- **The exercises should not aggrevate the pain**: If patients have pain while performing an exercise , the exercise usually is not performed correctly. Guide the patients or chose another exercise. It is ok to have some soreness or strain but no pain.
- **Hands on guidance:** To guide you patient with feedback from your hands is important within the PT supervised sessions (approximately 15 visits). Make sure, by going through the home-exercise program, that the patients perform it correctly.
- **Step wise progression:** The load needs to be increased in steps and with respect to shoulder pain. This aspect is considered in the different phases.
- **Load:** The load will be individually adjusted. If the patient get pain reduce the load.
- **Home- exercise dosage:** Home exercise programs should consist of no more than 3-4 exercises.

- **Dosage and progression:** Recommended repetions for each exercise is in the explantory text attached to each exercise. Loading exercises in purpose to strengthening the muscles in phase III are performed once every other day. Exercises in purpose to restore or increase range of motion or neuromuscular control exercises should be performed daily. If the patient got (has) pain the dosage can be reduced.

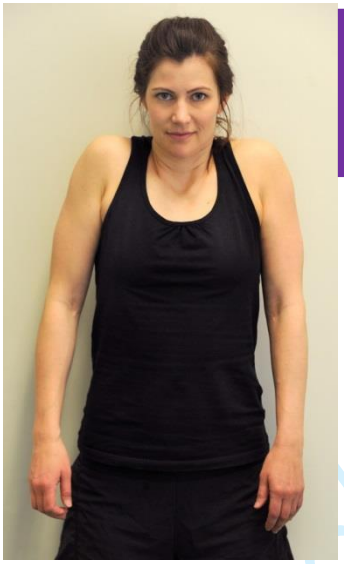
Initial phase, weeks 0-3

All patients will be fixated in a sling for 3 weeks 24 hours a day. During week 4 the sling is used at nights but could be phased out at daytime. During the first 3 weeks it is allowed to take the sling off when taking a shower and also for passive range of motion exercises. It is important to perform all the exercises with a good posture and to avoid compensation movements with elevation of the shoulder. It is recommended to use a mirror when you are performing the exrecises.

Exercises to perform twice daily

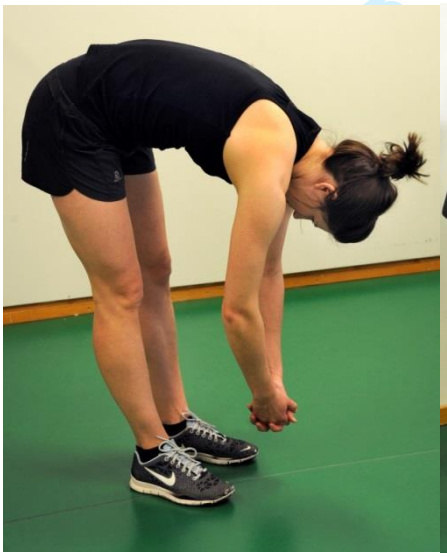
Pump with your hand 30 times at least 4 times per day

Flexion and extension of the elbow 10 repetitions in 2 sets



Shoulder shrug

Shrug the shoulders 20 repetitions



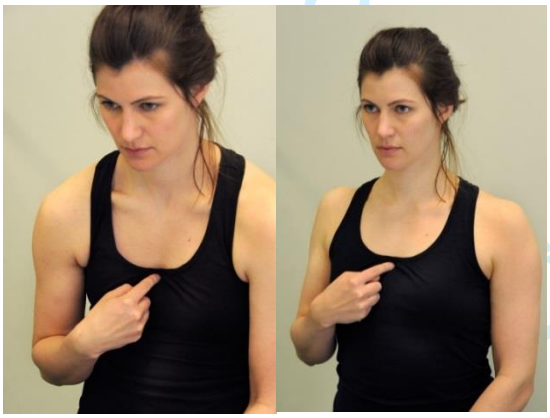
Pendulum exercises

-Arms hanging loose at sides, bending the upper body forward to attain flexion in the shoulder 10 repetitions in 2 sets.

-If you need support use the pendulum exercise instead 10 seconds 5 repetitions.

Internal and external rotation

(0°-20° of external rotation during the first 3 weeks). Push the arm from the body with help from the stick.
10 repetitions.



Posture

Put your finger on sternum and lift it up to attain thoracic extension.

Activity of daily living

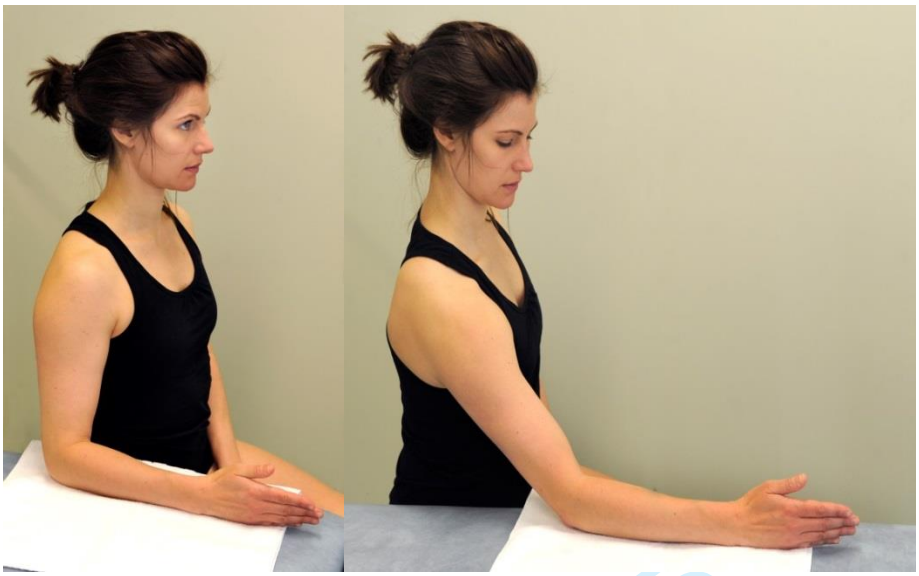
Lean your upper body to the operated side in order to wash under the axilla.

Phase 1, weeks 4-6

During the week 4 the sling should be phased out at daytime but still used during the night.

Exercises in this phase should be performed twice daily. While performing the exercises, it is important to start with and maintain a good posture and also to avoid compensating with elevation of your shoulders and/or trunk movements. Perform your exercises in front of a mirror if it is possible.

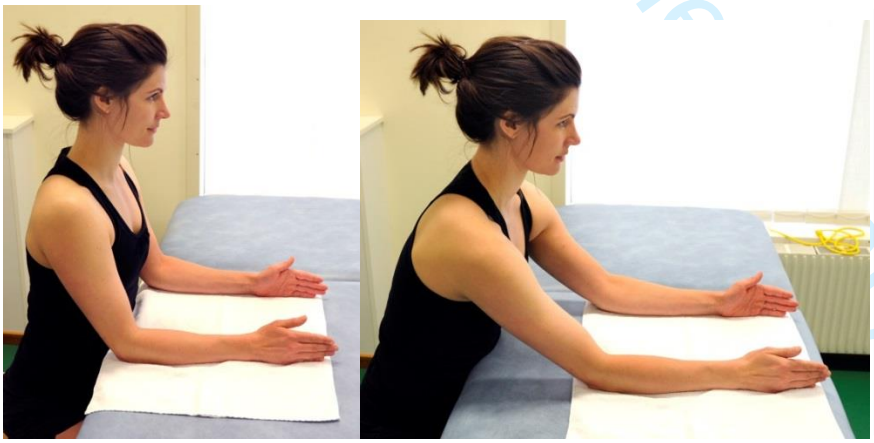
Active assisted/supported flexion



Exercise no: 1

Use a towel to slide forward with your arm as far as you can.

Start with 5 repetitions and increase to 10 within 1 week.



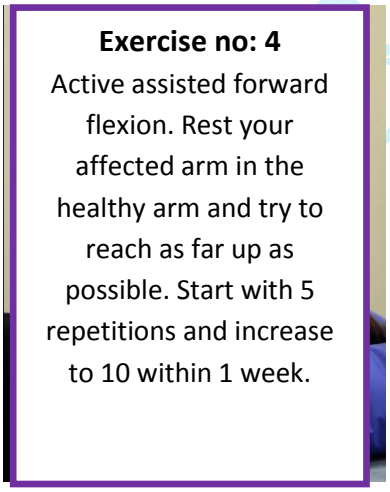
Exercise no: 2

Use a towel to glide forward with your arms.

Start with 5 repetitions and increase to 10 within 1 week.

Exercise no: 3

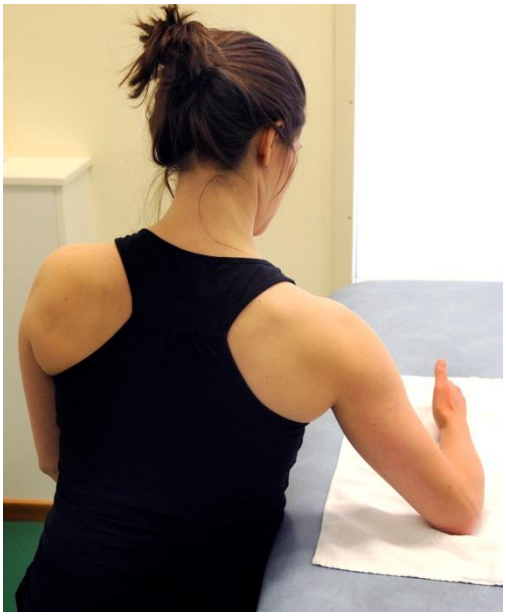
Starting position with hands in your knee. Slide down your legs while bending your back forward, Try to reach your toes. Start with 5 repetitions and increase to 10 within 1 week.



Exercise no: 4

Active assisted forward flexion. Rest your affected arm in the healthy arm and try to reach as far up as possible. Start with 5 repetitions and increase to 10 within 1 week.

Active assisted/ supported abduction



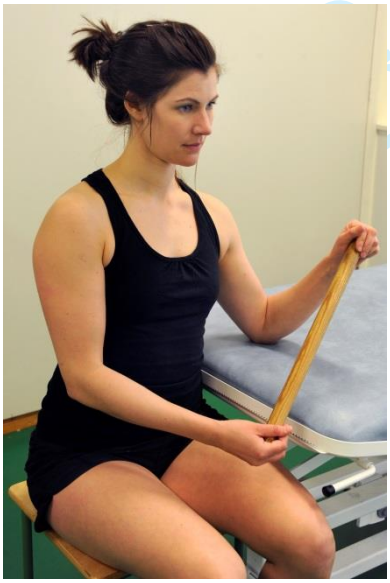
Exercise no: 5

Active supported abduction. Rest your affected arm on the table. Use a towel and slide with the arm away from the body. Start with 5 repetitions and increase to 10 within 1 week.

Active assisted/supported external and internal rotation

Exercise no: 6

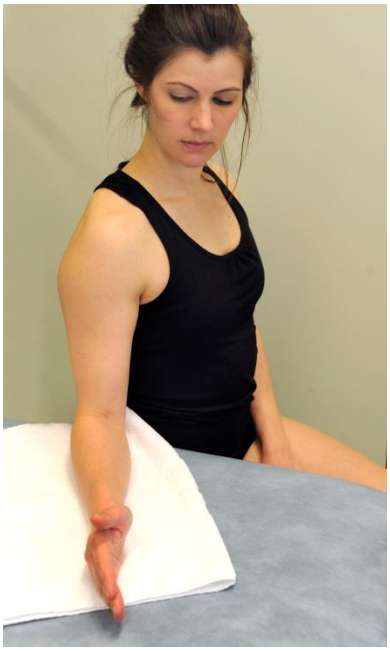
Use a stick to push and move the underarm away from the body as far as possible and then return with the hand against the stomach. Start with 5 repetitions and increase to 10 within 1 week.



Exercise no: 7

Use a stick to push and move the underarm as far back as possible.

Start with 5 repetitions and increase to 10 within 1 week.



Exercise no: 8

Rest the arm against a table. Use a towel to slide on and rotate the arm externally and internally.

Start with 5 repetitions and increase to 10 within 1 week.

Shoulder retraction and scapula positioning

Exercise no: 9

Scapula retraction with a short level arm. Lower your shoulders and do a small external rotation in the shoulders in purpose to retract the scapula

Start with 5 repetitions and increase to 10 within 1 week.

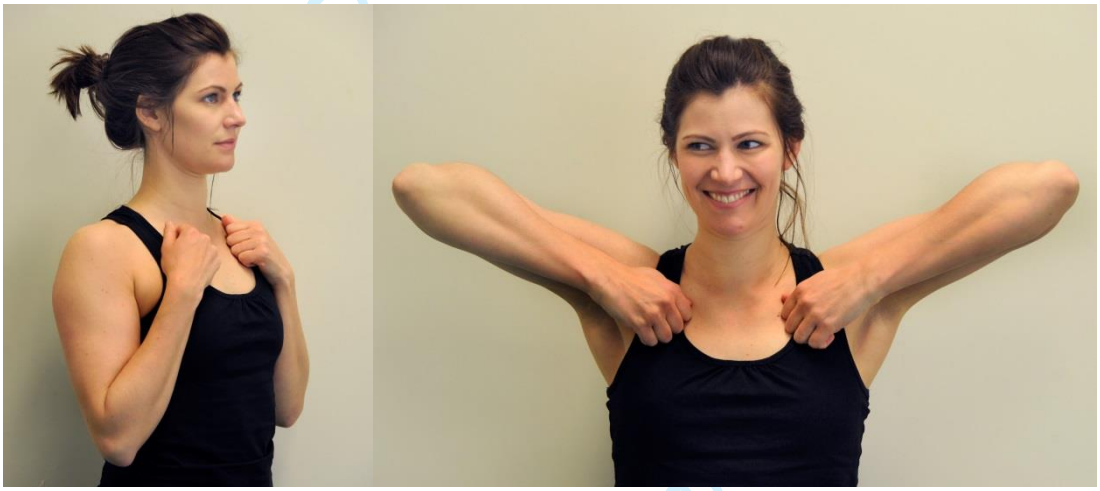
Exercise no: 10

Scapula retraction. Lower your shoulders and do a small external rotation in the shoulders in purpose to retract the scapula

Start with 5 repetitions and increase to 10 within 1 week.

Resting positions

During week 5 active range of motion exercises with a short level arm could be added.



Exercise no: 11 and 12

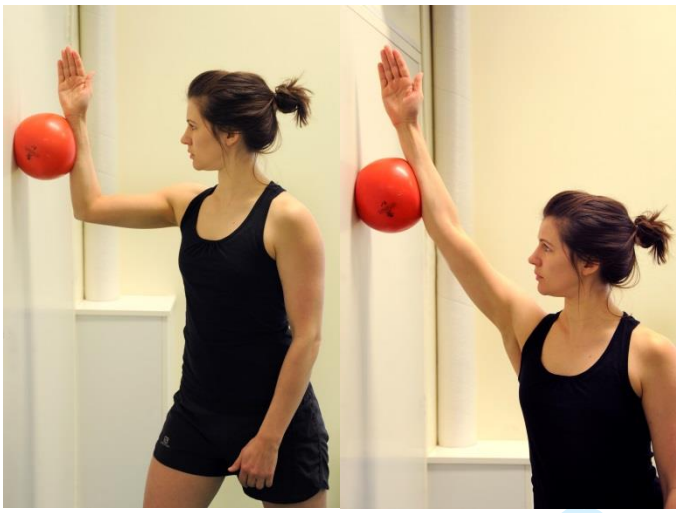
Flexion and abduction with a short level arm.

Start with 5 repetitions and increase to 8 within a week.

Phase 2, weeks 7-11

Exercises in this phase should be performed twice daily. While performing the exercises, it is important to start with and maintain a good posture and also to avoid compensating with elevation of your shoulders and/or trunk movements. Do your exercises in front of a mirror if it is possible.

Active range of motion in elevation and exercises with pre-activation in elevation



Exercise No: 12
Ball against the wall.

Press against the ball and elevate the arm while rolling the ball against the wall. Start with 5 repetitions and then increase to 10.

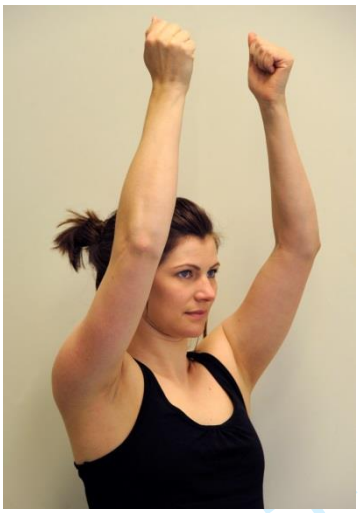
Exercise No: 13

Lift up your arms against the wall. Slide against the wall as far up as possible. Stay in that position for a few seconds.

5-8 repetitions.

Exercise No: 14

Perform a small external rotation by stretching the rubberband. Lift up your arms while keeping the rubberband stretched
5-8 repetitions

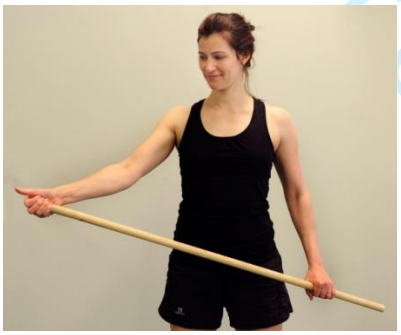


Exercise No: 15

Active flexion in the whole range of motion.

7-10 repetitions.

Active abduction concentric and eccentric exercises



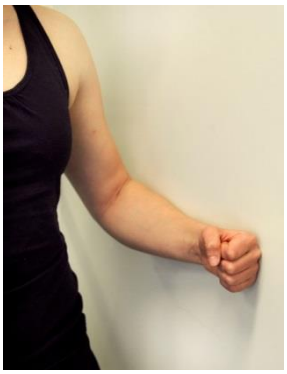
Exercise No: 16

Assist concentric abduction and then lowering the arm against resistance and work in the eccentric phase. 10 repetitions.

Exercise No: 17

Active abduction with thumbs pointing against the ceiling. Keep your shoulders down.

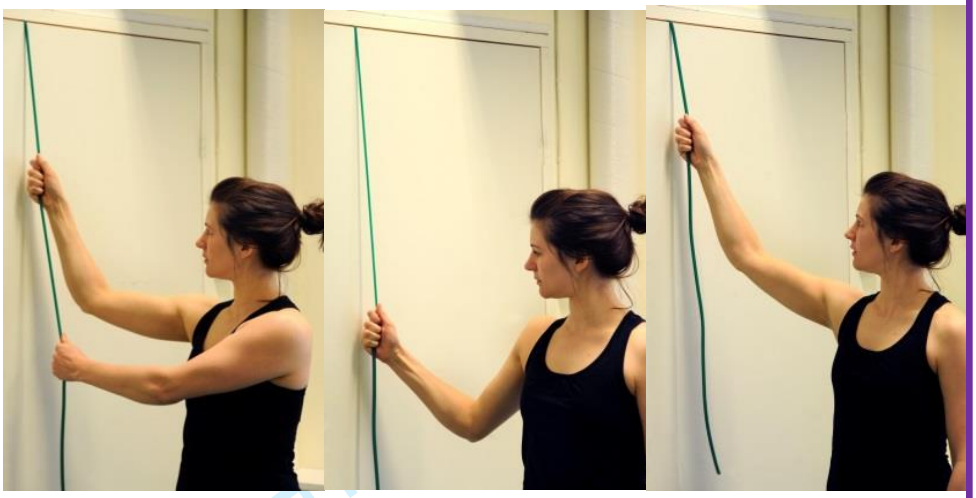
10 repetitions.



Exercise No: 18

Isometric abduction. Press the underarm against the wall for about 3 seconds

5 repetitions in three



Exercise No: 19

Assisted abduction with pre-activation of the shoulder depressors. Pull the rubber band down by using the non-affected arm in purpose to get at strain in the rubber band. Let the arm passively get into abduction.

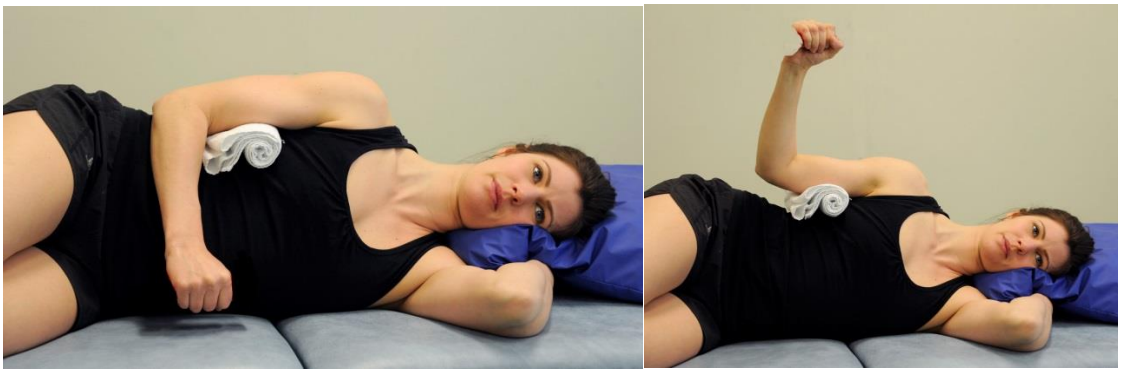
5 repetitions in three sets.

External/internal rotation exercises

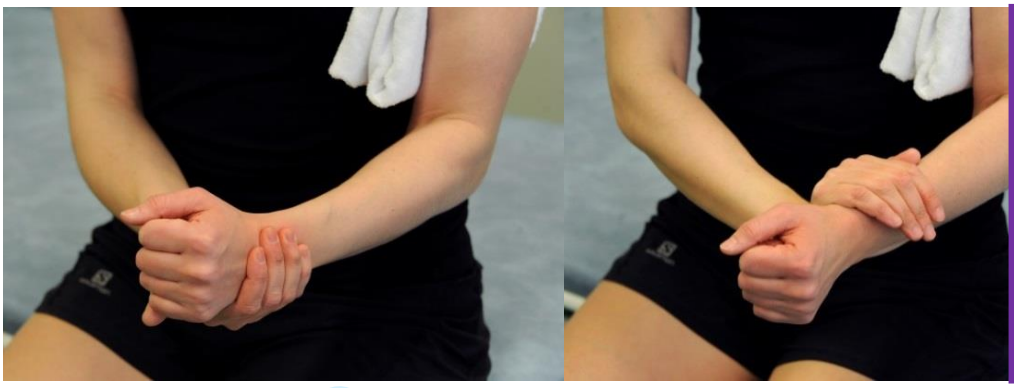
Exercise No: 20 and 21

Active external and internal rotation in standing or in side-lying.

Start with 15 repetitions then within 1 week increase to 2 sets.



Isometric exercises for the rotator cuff in external/internal rotation



Exercise No: 22 and 23
Isometric external (no 21) and internal rotation. Press the affected arm against the unaffected hand for 3 seconds. 5 repetitions in three sets.

Scapula positioning and retraction

Exercise No: 9

Scapula retraction with a short level arm. Lower your shoulders and do a small external rotation in the shoulders in purpose to retract the scapula

Start with 5 repetitions and increase to 10 within 1 week.

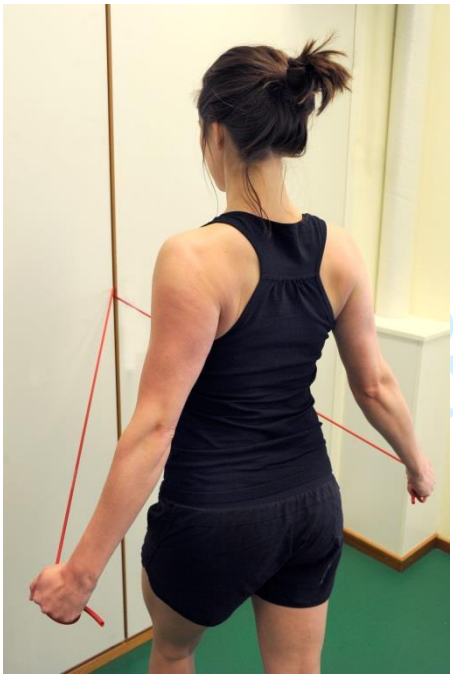
Exercise no: 10

Scapula retraction. Lower your shoulders and do a small external rotation in the shoulders in purpose to retract the scapula

Start with 5 repetitions and increase to 10 within 1 week.

Phase 3, weeks 12-20

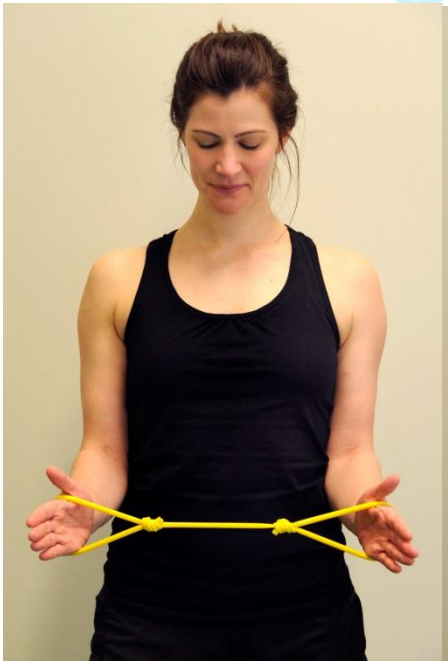
Exercises in this phase should be performed daily or once every other day. While performing the exercises, it is important to start with and maintain a good posture and also to avoid compensating with elevation of your shoulders and/or trunk movements. Do your exercises in front of a mirror if it is possible.



Exercise No: 24
Low row exercise.

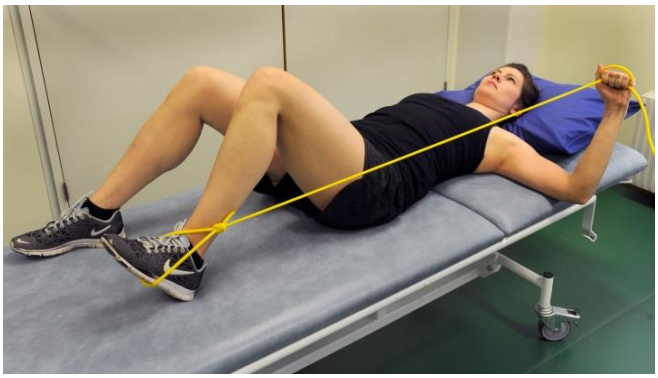
With thumbs pointing out from the body and some abduction in the shoulder pull the rubber band back and reach behind the hip. Start with 10 repetitions in 1-2 set and then add another third set.

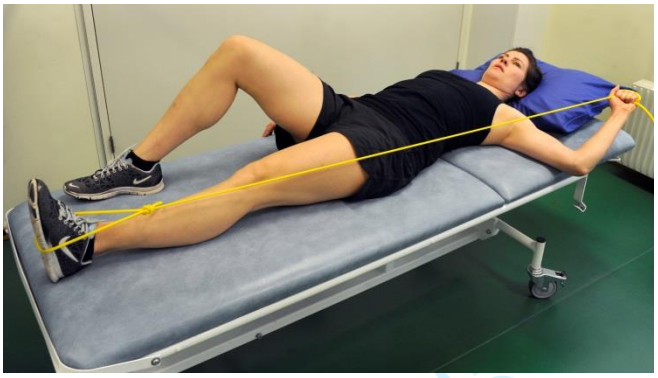
Exercise No: 25
Side-lying external rotation.
Start with eccentric work and come up in position by extension in elbow and then up in position of external rotation and lower the arm slowly. Start with 10 repetitions in 1-2 set and then add another third set. Start to work concentric /eccentric when the patient can perform the exercises with quality.



Exercise No: 26 and 27 External rotation with elevation in sitting (no 26) or in standing (no 27).

A small pre-activation through external rotation and then elevate the arms while keeping the external. Start with 5 repetitions in 1-2 set and add another third set.

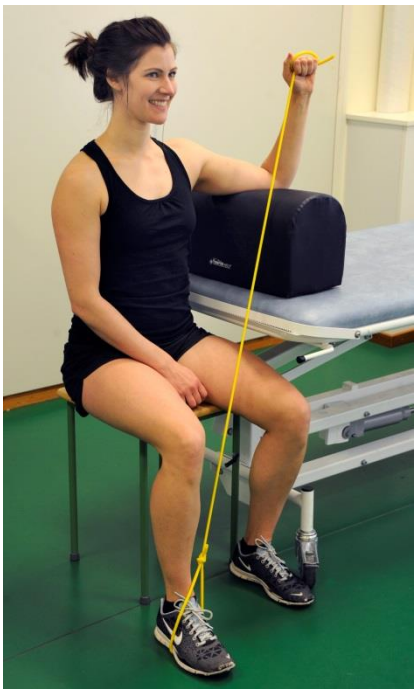




Exercise No: 28

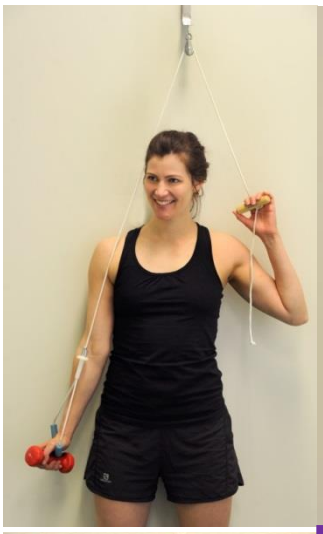
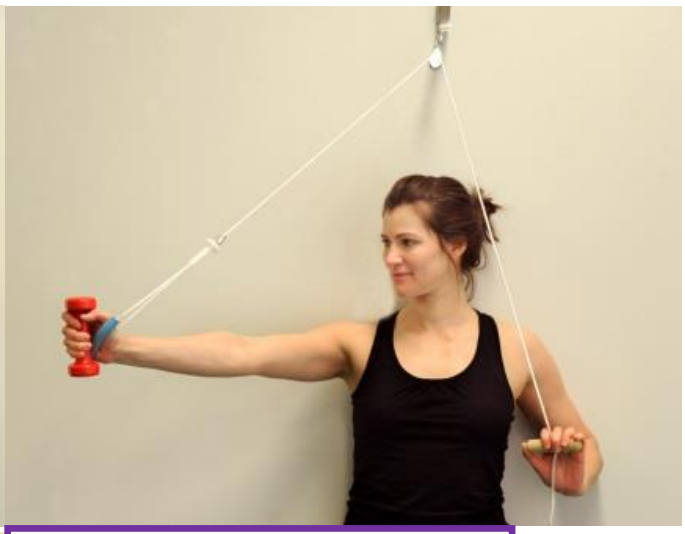
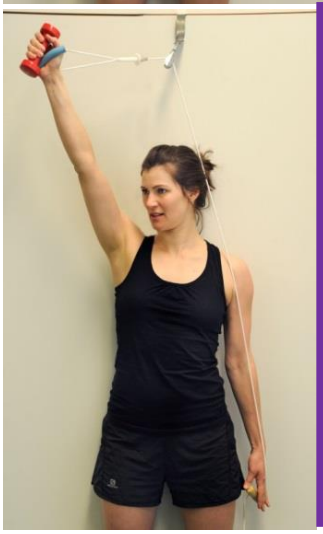
External rotation in 90 ° of shoulder abduction. Focus on the eccentric phase.

Bend the knee while pulling the rubber band and perform an external rotation in the shoulder. Extend your knee while you slowly lower your underarm towards the bench into an internal rotation of the shoulder. Start with 10 repetitions in 1-2 set and then add another third set.



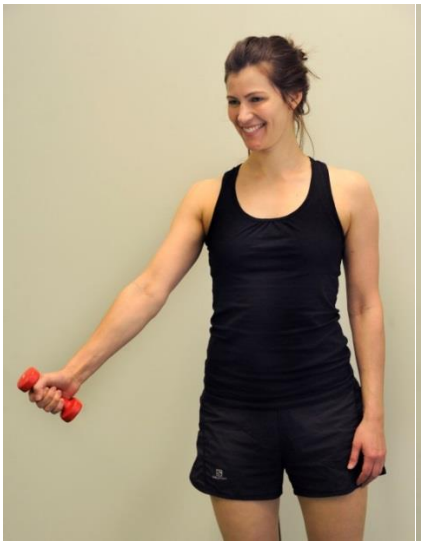
Exercise No: 29

External rotation in 90 ° of shoulder abduction. Pull the rubber band and perform an external rotation in the shoulder. Lower the arm slowly into internal rotation of the shoulder. Start with 10 repetitions in 1-2 set and then add another third set.

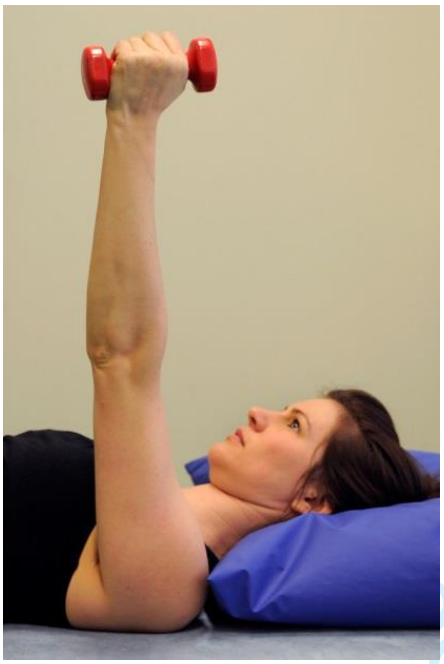
Exercise No: 30

Full can eccentric elevation in the scapula plane. Thumbs pointing up. Use the pulley to get into position. Lower your arm slowly. Start with 10 repetitions in 1-2 set and then add another third set




Exercise No: 31

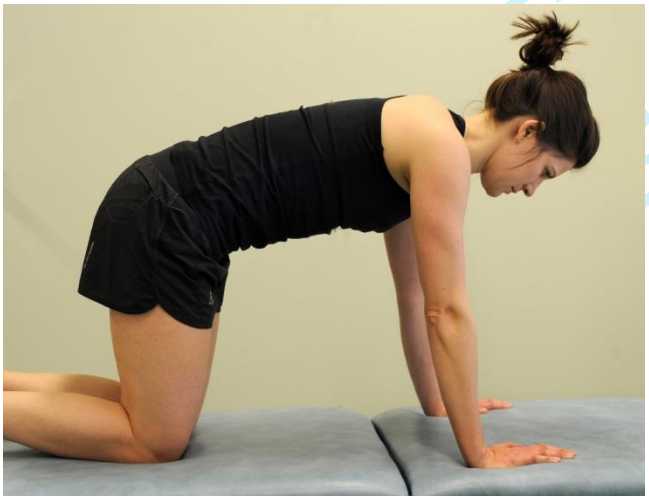
Full can concentric/eccentric elevation in the scapular plane. Thumbs pointing up. Start with 10 repetitions in 1-2 set and then add another third set



Exercise No: 32

Serratus press.

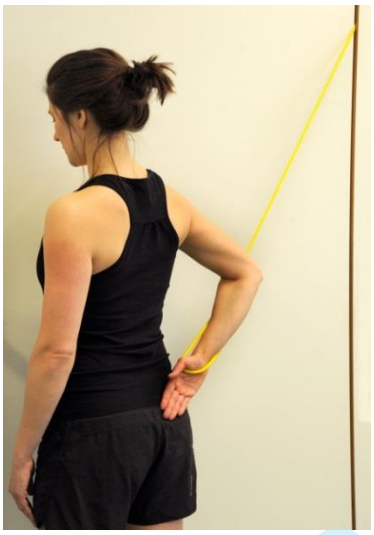
Raise the straight arm against the celling. Lower it slowly into position with the back of the shoulder resting at the bench. Start with 10 repetitions in 1-2 set and then add another third set



Exercise No: 33

Push up plus exercises

Start with 10 repetitions in 1-2 set and then add another third set



Exercise No: 34

Internal rotation

Start with 10 repetitions in 1-2 set and then add another third set

Exercise No: 35

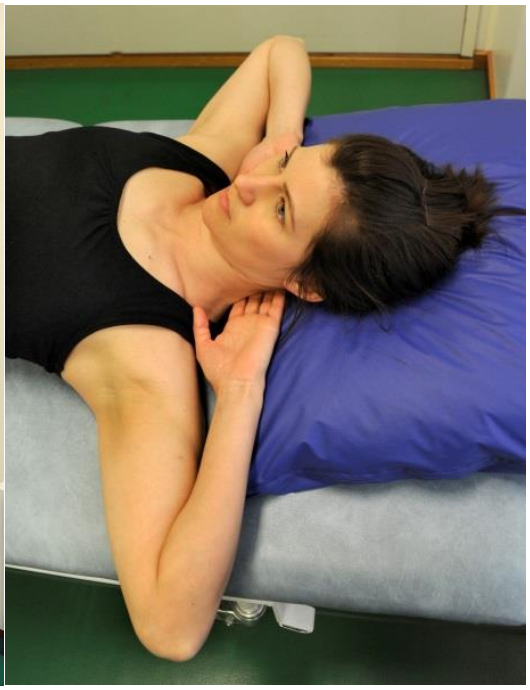
Sleepers stretch
20 seconds 3-5 repetitions.

Exercise No: 36

Posterior shoulder stretch
20 seconds 3-5 repetitions

Exercise No: 37

Internal rotation stretch
Use a towel and pull the arm along the spine as far up as possible. 3-5 repetitions.



Exercise No: 38

Corner stretch for the pectoralis muscles. Lean into a corner and hold for 20 seconds 3-5 repetitions

Exercise No: 39

Hand in neck and external rotation.

5 repetitions hold for a few seconds.

Exercise No: 40

Advanced exercise: Horizontal extension and external rotation

Exercise No: 41

Exercise for the whole kinetic chain. Launches while holding a medicine ball.

INFORMED CONSENT FORM

I have been asked to participate in a clinical trial: Treatment of acute rotator cuff tear related to trauma. The purpose of this trial is to investigate efficacy of arthroscopic rotator cuff repair in acute onset of rotator cuff tear related symptoms following a traumatic event.

I have read the written information sheet of the trial. The contents of the information sheet have been explained to me in detail and I have understood them. I have received sufficient information about the trial. I have had the opportunity to ask questions and I have received answers to all of my questions concerning the trial. I have had enough time to consider my participation, and I know who to contact if I need more information about the trial.

I understand that my participation is entirely voluntary. I understand that I may decide not to participate, or to withdraw, at any time, without giving any reason, without my medical care or legal rights being affected. If I withdraw my consent, information collected prior to withdrawal remains part of the trial database. All collected trial information including participant's name and date of birth will be transferred and stored in Turku University Hospital, Finland and kept confidential at all times. No reports and publications related to the project will contain information that could identify participants. At the end of the trial all information records will be destroyed in accordance with current government standards.

I agree to take part in the trial: Treatment of acute rotator cuff tear related to trauma.

_____

Signature

Date:

Place:

Name of the Participant:
Date of birth:
Complete postal adress:

This is to certify that the above consent has been obtained in my presence.

_____

Signature

Date:

Place:

Two copies should be made, for 1) patient, 2) researcher
(Investigators are advised to prepare the translation in simple understandable language on their own)

SPIRIT
STANDARD PROTOCOL ITEMS: RECOMMENDATIONS FOR INTERVENTIONAL TRIALS

SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description
Administrative information		
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym. Page 1
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry. Page 1
	2b	All items from the World Health Organization Trial Registration Data Set. Page 2-4
Protocol version	3	Date and version identifier. n/a
Funding	4	Sources and types of financial, material, and other support. Page 23
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors. Page 23
	5b	Name and contact information for the trial sponsor. Page 23
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities. Page 23
	5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee). Page 23
Introduction		
Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention. Page 4-5
	6b	Explanation for choice of comparators. Page 5
Objectives	7	Specific objectives or hypotheses. Page 5

Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory). Page 6

Methods: Participants, interventions, and outcomes

Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained. Page 6
Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists). Page 6
Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered. Page 7-9
	11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease). Page 16
	11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests). Page 18-19
	11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial. Page 7-8
Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended. Page 9-10 and 16
Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure). Page 34
Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations. Page 12-13
Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size. Page 6 and 18

Methods: Assignment of interventions (for controlled trials)

Allocation:

Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions. Page 11
Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned. Page 11
Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions. Page 11
Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how. Page 11
	17b	If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial. Page 11 and 19
Methods: Data collection, management, and analysis		
Data collection methods	18a	Plans for assessment and collection of outcome, baseline, and other trial data, including any related processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known. Reference to where data collection forms can be found, if not in the protocol. Page 12
	18b	Plans to promote participant retention and complete follow-up, including list of any outcome data to be collected for participants who discontinue or deviate from intervention protocols. Page 12
Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol. Page 12
Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol. Page 14-15
	20b	Methods for any additional analyses (eg, subgroup and adjusted analyses). Page 15
	20c	Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation). Page 13

Methods: Monitoring

Data monitoring	21a	Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of whether it is independent from the sponsor and competing interests; and reference to where further details about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not needed. Page 15-16 and 23
	21b	Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial. Page 16
Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse events and other unintended effects of trial interventions or trial conduct. Page 16
Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent from investigators and the sponsor. n/a

Ethics and dissemination

Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval. Page 16
Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators). Page 16-17
Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32). Page 17
	26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable. n/a
Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial. Page 17
Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site. Page 23
Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators. Page 17
Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation. Page 17

Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions. Page 17 and 23
	31b	Authorship eligibility guidelines and any intended use of professional writers. Page 17
	31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code. Page 23
Appendices		
Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates
Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable. n/a

*It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013 Explanation & Elaboration for important clarification on the items. Amendments to the protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT Group under the Creative Commons "Attribution-NonCommercial-NoDerivs 3.0 Unported" license.