I.S.Mu.L.T - Rotator Cuff Tears Guidelines

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Abstract

Despite the high level achieved in the field of shoulder surgery, a global consensus on rotator cuff tears management is lacking. This work is divided into two main sessions: in the first, we set questions about hot topics involved in the rotator cuff tears, from the etiopathogenesis to the surgical treatment. In the second, we answered these questions by mentioning Evidence Based Medicine. The aim of the present work is to provide easily accessible guidelines: they could be considered as recommendations for a good clinical practice developed through a process of systematic review of the literature and expert opinion, in

order to improve the quality of care and rationalize the use of resources.

KEY WORDS: rotator cuff tears, Guidelines.

Introduction

The pathologies of the rotator cuff are common and they can be considered as a natural decline of the muscle-tendon unit in aging with statistically significant increase in frequency after 50 years. The painful shoulder is related in 30-70% of cases to disorders of the rotator cuff. The incidence of rotator cuff tears varies between 5 and 40%, although it is very difficult to establish the real incidence of these lesions, which are often asymptomatic. Currently, the pathology of the rotator cuff is considered to be multifactorial, because extrinsic and intrinsic factors play important roles, although it remains unclear the specific weight of each of these factors (Tab. 1).

Table 1. Etiological factors analyzed.

Theory	Authors	Year
Extrinsic factors		
Chronic impingement	Neer	1972
Microtraumas	Codman, McMaster	1931, 1993
Acute traumas	Keene	1983
Multifactorial theory	Soslowsky	2002
Intrinsic factors		
Ipoperfusion	Lohr	1990
Degenerative theory	Sano	1999
Degenerative-microtraumas theory	Yadav	2009
Apoptosis	Yuan	2002
TGs impaired expression	Oliva	2009
MMPs disregulation	Riley	2002
Endocrinal factors	Li	2013
	Oliva	2013
	Scutt	2006
	Wong	2004
	Denaro	2010
	Hansen	2013
Metabolic factors	Gaida	2009
	Beason	2004
Failed healing response	Sharma and Maffulli	2005

Table 2. Histopathological classification of the degeneration of the rotator cuff according to Riley.

	Organization of the fibers	Nuclei of tenocytes	Hyalinization
Grade 1			
Normal tendon	The bundles of fibers are well oriented with a wavy pattern. The single fibers are easily distinguished within the bundle.	The nuclei are elongated with a pattern of unrecognizable chromatin. The cores are arranged with their axis parallel to the bundles of collagen fibers.	No hyalinization.
Grade 2			
Little degeneration	The collagen fibers are relatively well aligned but the ripple is irregular.	The nuclei are shorter but more oval. It can be observed a darker chromatin. The cores are often arranged in short chains that have an aspect in Indian file.	No hyalinization.
Grade 3			
Moderate degeneration	Loss of orientation of the collagen fibers.	The cell nuclei are round or oval and often increased in number. There is a loss of orientation of the cores in relation to the bundles of collagen fibers. Chromatin has a dark color.	Moderate hyalinization, areas of staining eosinophilic homogeneous preparation with hematoxylin/eosin.
Grade 4			
Severe degeneration	Complete loss of orientation of the collagen fiber bundles.	The cores are reduced in number, small, dark and round.	Hyalinization with a homogeneous appearance.

Table 3. Histopathological classification of tendinopathies of the rotator cuff according to Bonar.

	Tenocytes	Amount of substance	Collagen	Vascularization
Grade 0	Nuclei lengthened without clear cytoplasm to optical microscopy.	No colorable substance.	Collagen arranged in bundles tightly cohesive and well demarcated with a pattern of polarization net, dense, uniform and clear and with normal ripple.	Not conspicuous blood vessels running between the beams.
Grade 1	The nuclei become more oval or round in shape without large cytoplasm.	Colorable mucin between fiber bundles but still discrete number.	Decreased polarization fibers: separation of the individual fibers with maintenance of the demarcation of the beams.	Occasional clusters of capillaries, less than one per 10 fields at high magnification.
Grade 2	The nuclei are circular, slightly widened and a small amount of cytoplasm becomes visible.	Colorable mucin between the fibers with loss of demarcation of the beams.	Separation of the fibers with loss of demarcation and a clear loss of normal polarization.	1-2 cluster of capillaries for 10 fields at high magnification.
Grade 3	The nuclei are round, wide with abundant cytoplasm and the formation of a gap (chondroid change).	Abundant mucin among poor colorable collagen.	Demarcated separation of fibers with complete loss of architecture.	More than two clusters to 10 fields at high magnification.

Table 4. Geometric classification according to Burkhart.

Type	Description	Pre-operative MRI	Treatment	Prognosis
1	Crescent shape	Short and wide break	Repair end-to-bone	Good or excellent
2	Longitudinal (L or U)	Long and narrow break	Convergence of margins	Good or excellent
3	Massive contracted	Long and large, >2 × 2 cm	Partial repair	Good
4	Arthropathy of the rotator cuff	Arthropathy of the cuff	Arthroplasty	Good

Table 5. References Guidelines present in literature.

Paper	Authors	Journal	Year of publication
Clinical practice guidelines for the surgical management of rotator cuff tears in adults.	Beaudreuil J, Dhénain M, Coudane H, Mlika-Cabanne N	Orthop Traumatol Surg Res.	2010;96(2):175-179.
Optimizing the management of rotator cuff problems.	Pedowitz RA, Yamaguchi K, Ahmad CS, Burks RT, Flatow EL, Green A, Iannotti JP, Miller BS, Tashjian RZ, Watters WC 3rd, Weber K, Turkelson CM, Wies JL, Anderson S, St Andre J, Boyer K, Raymond L, Sluka P, McGowan R	American Academy of Orthopaedic Surgeons. J Am Acad Orthop Surg.	2011;19(6):368-79
Rehabilitation after arthroscopic rotator cuff repair: current concepts review and evidence-based guidelines.	van der Meijden OA, Westgard P, Chandler Z, Gaskill TR, Kokmeyer D, Millett PJ	Int J Sports Phys Ther.	2012; 7(2): 197–218.
Clinical Practice Guidelines for the Management of Rotator Cuff Syndrome in the Workplace.	Hopman K, Krahe L, Lukersmith S, McColl A, Vine K	by The University of New South Wales Rural Clinical School, Port Macquarie	Australia. 2013
AAOS appropriate use criteria: optimizing the management of full-thickness rotator cuff tears.	Pappou IP, Schmidt CC, Jarrett CD, Steen BM, Frankle MA	J Am Acad Orthop Surg.	2013;21(12):772-775.

The natural history of rotator cuff tears is to progress over time. Lesions may develop a tendon retraction and a fatty degeneration that make it more uncertain to repair. The final stage is the Rotator Cuff Arthropathy.
Few studies were performed to quantify the histopathological alterations of tendon ruptures and different histopathological (Tabs. 2, 3) and geometric (Tab. 4) classifications were drawn in order to feature tendinopathies.
Despite the high level reached in the field of shoulder surgery in our country, Italian orthopaedic surgeons have never produced a Consensus Protocol on this topic.
To the best of our knowledge in literature we found several attempts to simplify the management of the tears of the rotator cuff through the compilation of guidelines or documents (Tab. 5).

Approach to Guidelines

These recommendations developed through a process of systematic review of the literature and expert opinion, that can be used to improve the quality of care and rationalize the use of resources. Clinical decisions on individual patients require the application of the recommendations, based on the best scientific evidence and clinical experience of the physician.

Methodology

The Authors were divided into four groups:
- Coordinator: he conceived and organized the work and the group and selected the most important QUESTIONS (**Q**) on this topic.
- Control group: controlled the development of the work and discussed the recommendations.
- Group of the experts: they individually received a question and developed the ANSWERS (**A**) according to the rules of EBM, when it was possible.
- Group of preparation and evaluation of literature: drew up the text and assisted the group of experts in evaluation the literature.

Methods and criteria study selection

For research were consulted the following databases:
- PubMed
- Embase
- Google Scholar
- Cochrane Library

Randomized controlled trials (RCTs); Systematic reviews; to follow if missing the first two, the other levels of evidence. The literature is updated at December, 2014.

Level of evidence

Level of evidence	Criteria for analysis and inclusion
I	Meta-analyzes and systematic reviews of randomized controlled trials (RCTs) of high quality, or RCTs with minimum or low risk of bias. Systematic reviews of high quality relative to cohort studies or case-control.
II	Cohort studies or randomized case-control high quality, with minimal risk of confounding or bias and with high or discrete probability of causation.
III	Case-control studies and retrospective comparison of well-conducted with reasonable probability of causation.
IV	Non-analytic studies as case series or individual cases.

Level of recommendation

Level of recommendation	Criteria for analysis
A	Supported by at least two studies of level Ib or from a review level Ia ("it was shown").
B	Supported by at least two independent studies of level II or extrapolations from studies of level I ("it is possible").
C	Not supported by adequate studies of level I or II ("indications").
D	Indications of experts ("there is no evidence").

Question n. 1: Clinical tests

Though many tests have been described for the clinical evaluation of the shoulder, they should be applied in a selective way, according to the clinical suspicion.

According to the literature, there is not a general consensus regarding the diagnostic criteria and the validity of the physical examination in patients with shoulder pain caused by rotator cuff diseases.
In patients with a suspected lesion of the rotator cuff,

the clinical tests are not accurate in distinguishing rotator cuff disorders compared to other diseases. Information about the mechanism of injury and type and onset of pain should be collected; therefore, conventional X-ray and MRI studies provide additional details.

Level of recommendation: A

Key points:

The most reliable and sensitive tests for the proper evaluation of the rotator cuff lesions are:

- The *Jobe test*, for supraspinatus tendon.
- The *Patte test* for infraspinatus tendon.
- The *lift off* and *belly press* test, according to the range of movement, for the subscapularis tendon.

Key words: diagnostic accurancy, clinical test, physical examinations, crossed with rotator cuff tears.

Question n. 2: Instrumental diagnosis

Scientific literature focuses on three points:

a) After the clinical suspicion of RCT what is the gold standard imaging technique to confirm the diagnosis?
b) Is there an imaging recommended technique to improve the diagnostic accuracy of RCT?
c) What are the relevant informations that could be provided by each imaging modality and that could encourage therapeutic decision?

Conventional radiography (RX): its use for soft tissue injuries of the shoulder is not validated. X-rays can be useful to exclude other possible causes of shoulder pain.

Ultrasound: the diagnostic accuracy of the ultrasound is good and comparable to that of conventional MRI to identify and quantify the complete injuries (full thickness) of the rotator cuff, although there are contrasting results about its validity in partial RCT.

Magnetic Resonance Imaging (MRI): the diagnostic accuracy of MRI for the detection of full-thickness RCT is excellent, but it is more limited for partial tears.

Arthro-MR: despite Arthro-MR is a less invasive techniques, it has a limited usefulness if compared to MRI and ECO. However, it may still be considered for its high sensitivity and specificity. The use of diagnostic imaging is useful after 6 weeks of symptoms suggestive of RCT and Ultrasound (combined or not with conventional radiography to determine osteoarthritis, bone abnormalities and the presence/absence of calcification) has been recommended as the most valid method of imaging to exclude a rupture of the rotator cuff after an unresponsive conservative treatment.

Key points:

- A complete physical examination help to correctly select the most appropriate imaging technique for accurate diagnosis.
- MRI or ECO can confirm a possible full-thickness tears, but however, if a patient has an implantable device that does not allow the execution of MRI, conventional radiography should be considered as a viable alternative.
- Actually, there is no consensus on which approach is more precise, convenient, appropriate or not invasive for the diagnosis of a complete or partial RCT.
- The best imaging test is based on several factors such as: sensitivity and specificity, operator's experience in the performance and interpretation of the study, timing, cost and contraindications of the test for the patient.

Key words: controlled randomised trials and systematic reviews, rotator cuff tear in combination with imaging OR X ray OR ultrasound OR magnetic resonance OR radiological diagnoses.

Question n. 3: Rehabilitation approach in the rotator cuff tears

It is difficult to obtain double blind studies analyzing the most appropriated rehabilitation approach in the rotator cuff tears.

In literature, different conservative treatments were studied. Comparing addiction or not of proprioceptive stimuli to stretching and muscular strengthen exercises, followed by cryotherapy, there were not statistically significantly differences. According to literature, there are no differences between occupational therapy and home-based exercises in conservative treatment of rotator cuff tears.

There are also studies which are in favor of surgery in small and medium-sized tears of rotator cuff, while other ones support conservative treatments.

However, it is not possible to establish which is the better treatment because high quality clinical randomized studies are necessary.

Level of recommendation: B

Key points:

- There are some advantages from the utilization of Therapeutic Exercise (TE), singularly or in an Individual Rehabilitation Project (PRI), in patients with rotator cuff tears.
- Despite its efficacy, it is unknown when PRI should be started, what programs should include or time necessary for a surgery indication.
- High quality Clinical Randomized Studies, utilizing standard outcome scores, are necessary to establish the best PRI, including TE.

Key words: rotator cuff, supraspinatus, infraspinatus, subscapolaris, teres minor, in combination with other words such as tear, lesion, pathology, injury, exercise, exercises, physiotherapy, rehabilitation, intervention.

Question n. 4: Drug therapy

In patients affected by symptomatic rotator cuff tears, the aim of treatment is the pain's reduction and the improvement of movements and life's quality. In literature, drug therapy is still debated.

NSAIDs (Non Steroid Anti-Inflammatory Drugs) are the most studied drugs used in this pathology. The *Non Specific NSAIDs* were compared with *Placebo*,

Corticosteroid injections and *COX-2 inhibitors*.
NSAIDs therapy reduces pain in the first 3-4 weeks, however it is necessary planning a different treatment for a complete pain's suppression and to improve functions.
Level of recommendation: C
Key points:
- There is not a definitive drug therapy for rotator cuff tears.
- NSAIDs therapy reduces pain in the short term, while does not improve functions.
- Corticosteroid injections and NSAIDs have similar effects in the short term.

Key words: shoulder, gleno-humeral joint, rotator cuff, acromion, supraspinatus muscle, crossed with lesion, rupture, tendinophaty, impingement, deficiency, disorder.

Question n. 5: Shoulder injections

Shoulder injection is an argument of different studies yet. According to literature, injective treatment with glucocorticoids, local anaesthetic, hyaluronic acid (HA) or Platelet-Rich Plasma (PRP) is efficacious to reduce pain and to improve functions in patients with rotator cuff tendinopathy. However, it is not possible recommending a particular type of injections through those studied.
According to literature, glucocorticoid or HA injective treatment is indicated in patients with complete or partial rotator cuff tear because it reduces pain and improve functions. Also in this case, it is not possible to indicate which type of injective drug is more efficacious.
Level of recommendation: B
Key points:
- Glucocorticoids, local anaesthetics, HA or PRP are used to improve pain and performance in patients with rotator cuff tendinopathy.
- No sufficient evidences in comparison between different injective therapies.
- Glucocorticoids and local anaesthetics have cytotoxic effects on tenocytes.
- HA decreases pain in patients with partial tear of the rotator cuff tendons.
- At the moment, there are no evidences that PRP injections must be used in patients with partial or complete tear of the rotator cuff tendons.

Key words: rotator cuff tendinopathy injection, rotator cuff tendinopathy glucocorticoids injection, rotator cuff tendinopathy hyaluronic acid injection, rotator cuff tendinopathy Platelet-Rich Plasma injection, rotator cuff tear injection.

Question n. 6: Surgery indications and reparability criteria

It is not easy to decide the most appropriated surgery treatment in rotator cuff tears. It is an unclear and discussed argument yet.
The outcome depends on different factors such as age, gender, symptom's duration, "surgery timing", functionality, tear's anatomy and the presence of "worker compensation". Thus, it is necessary evaluating these variables to make an adequate surgery choice.
Level of recommendation: D
Key points:
- There is no a "cut-off" age for surgery indication, which must be evaluated basing on patient's activities and on difference between chronological and physiological age.
- Despite women being epidemiologically more affected, this is not a limitation to surgery indication.
- In traumatic tears, it is suggested surgery reparation by 4 months.
- Anatomical and anatomopathological severity of the tear is a determining factor for the clinical outcome.
- A preserved preoperative functionality is a positive prognostic factor.

Key words: rotator cuff repair, rotator cuff tears, subject headings, surgical indication, operative indication and indication surgery, prognostic factors.

Question n. 7: Miniopen *vs* arthroscopy

Scientific studies do not demonstrate statistically significant differences in the outcomes between the all-arthroscopic and mini-open rotator cuff repair. The outcomes have been evaluated with different methods: VAS, Costant-Murley, DASH, UCLA, ASES, RMN, etc.
The main differences between the two techniques are total cost and operating room time which are both increased in arthroscopy technique.
In literature, there is not a consensus on these results. The small number of patients is the only limit of the precedent randomized studies; the number of patients increases only in retrospective studies.
Level of recommendation: B
Key points:
- Surgical technique depends on surgeon's and patient's preference because the outcome is not influenced by surgical decision.
- There are no statistically significant differences between the two techniques considering relapse, complications and functional outcomes.
- Arthroscopy is more expensive and requires more operative time than miniopen technique.

Key words: rotator cuff miniopen arthroscopy, rotator cuff tear miniopen arthroscopy, rotator cuff repair miniopen arthroscopy, rotator cuff tear repair miniopen arthroscopy.

Question n. 8: Arthroscopic treatment of partial tears of the rotator cuff: where and when

Current scientific evidence does not allow to determine which is the best treatment for symptomatic partial lesions of the rotator cuff (LPSCR). The arthroscopic debridement with or without acromioplasty, and the repair techniques (transtendinous or "completion and repair" technique) are the most frequent

treatments. Debridement is generally indicated as a treatment of injuries involving less than 50% of the tendon thickness or tendon lesions of grade I/II according to Ellman.
It is hard to compare the results of different treatments for the LPSCR because of the heterogeneity of the type of lesions and the tools used in evaluating the results. It is impossible to propose treatment guidelines due to the low level of evidence proposed by the studies in the literature.
Key points:
LPSCR grade I-II of Ellman (involvement of less than 50% of the thickness tendon):
- Lack of studies of level I, II and III.
- The arthroscopic debridement with or without acromioplasty results in clinical improvement in patients with grade III of LPSCR Elmann.
- There are no studies that compare repair to debridement in these patients.

Level of recommendation: D
LPSCR grade III of Ellman (involvement of more than 50% of the thickness tendon):
- In one study (level of evidence IV), Weber demonstrates the superiority of repair compared to debridement in patients with grade III LPSCR Ellman.
- There are three studies evaluating the results of the trans-tendon repair and three studies evaluating the results after completion of the repair. All studies report a clinical improvement after the repair of the lesion.
- There are no studies of level I, II, III that compare repair to debridement in these patients.

Level of recommendation: D
Repair technique in patients with LPSCR grade III of Ellman:
- The presence of two prospective randomized studies level II allows us to conclude that there is no statistically significant difference between the repair techniques.

Level of recommendation: C
Key words: partial rotator cuff, rotator cuff, rotator cuff tears, rotator cuff lacerations, arthroscopic cuff repair, partial thickness rotator cuff.

Question n. 9: Management of the condition of the long head of the biceps in association with lesions of the rotator cuff

When long head of the biceps (LHB) tears are associated with rotator cuff tears, surgical exploration and possible treatment is recommended if symptoms persist for more than 3 months after conservative treatment. The two main treatments involve the tenodesis of the LHB and tenotomy of the LHB.
Many studies suggest tenotomy of the LHB as a fast treatment, well tolerated by the patient, with the possibility to reduce the time of rehabilitation after surgery. Other studies suggest that tenodesis of LHB leads to a better ability to return to activity sports and to a good restoration of the anatomy of the LHB despite the longer-term rehabilitation and the greater difficulty in the surgical technique.
According to the results reported by the literature it is not possible to give an absolute recommendation on which is the best type of treatment for the pathology of the LHB. Tenotomy of the biceps is indicated in older patients with a sedentary lifestyle and low functional demand, and in obese patients who can accept cosmetic problems. Tenodesis of the LHB is instead recommended in young patients under the age of 40 years who practice physical activity.
Key points:
- The tenotomy and tenodesis of the LHB have shown clinical and functional overlap.
- The tenotomy hesitates more often in aesthetic alterations compared to tenodesis.
- Among the different types of tenodesis present in the literature it is not possible to decide which is the best technique because there is no literature about this.

Level of recommendation: C
Key words: biceps tenotomy, biceps tenotomy *versus* tenodesis or tenodesis, biceps tendon, long-head biceps lesions.

Question n. 10: Surgical suture

In the past, open repair surgical techniques were considered the gold standard. Concerning arthroscopic repair, there was an evolution of the repair techniques in “single row”, “double row” and “transosseous equivalent” towards the idea of reproducing the area of reinsertion of the tendons of the rotator cuff.
Key aspects for effective repairs of the rotator cuff include:
- good initial stiffness and strength of the surgical repair;
- good stability during the movement of intra and external rotation occurring in the immediate postoperative period;
- optimization of the contact tendon-bone surface.

The most common technique is the “single row” (SR). The documented failure rate with these repair techniques appeared high, up to 90% in the case of large and massive injuries, at the tendon-suture interface. The “double-row” (DR) repair is more resistant than a “single-row”, but it is important to consider the greater strain on the repaired tendon. Trans-bone repair techniques (without anchors) have been introduced in arthroscopy in order to restore a tendon insertion at least 20% stronger than any other surgical technique, even if the concentration of the stress is moved from the tendon-suture junction to the bone.
In conclusion, at this time, there is no evidence that could support the use of a repair technique over another.
Level of recommendation: B
Key points:
- The double-row techniques increase costs in terms of materials and time of the operating room (EBM).
- Current evidence of the literature lead to consider a repair type single-row in the lesions less than 3

cm and in the presence of a good quality of tendon tissue, while the double-row repair would be considered in cases of injury larger than 3 cm and with poor quality of tendon tissue.
- In large lesions, chronic and retracted, even a double-row repair has a high risk of failure.
- The transbone techniques seem biomechanically promising, but not yet supported by sufficient randomized clinical trials.

Key words: rotator cuff, cuff tears, cuff repair, associate a suture anchor, double-row, single-row, arthroscopically repair.

Question n. 11: Massive and irreparable rotator cuff tears

There are different types of treatment utilized for massive and irreparable rotator cuff tears. However it is not possible to identify an ideal treatment.
Conservative treatment, *arthroscopy debridement* and *reverse prosthesis* are useful above all in the elderly, while *tendon transposition* is usually used in the young people.
Other two types of treatment are *long head of the biceps tenotomy* and *partial reparation* of the tear: they are both useful to decrease pain. The use of *scaffolds* is still studied.
Latissimus dorsi transposition is used for the posterior-superior tears while *pectoralis major transposition* for the anterior-superior tears.
Level of recommendation: D
Key points:
- There is not an ideal treatment for massive and irreparable rotator cuff tears.
- There are no controlled randomized studies comparing conservative and surgical treatment or the different types of surgical treatment.
- It is necessary an accurate clinical and radiological evaluation to choose an adequate treatment.
- After treatment, the results are good both in the early and in the middle time but they could decrease.

Key words: irreparable rotator cuff tear and massive rotator cuff tear crossed with randomized controller study and systematic review.

Question n. 12: Regenerative strategies in surgical repair

Three options are arising interest in rotator cuff repair strategies: PRP, scaffolds and mesenchimal cells.
PRP (Platelet-Rich Plasma)
The best evidence on PRP use in clinical practice are about the risk of a new tear that can be globally reduced or arised according to the section area and depending on the patient's age. There are no differences of the clinical outcome after a short period of follow-up. Some studies showed that PRP reduces pain after the surgical procedure and improves the functional recovery but it is not demonstrated in final follow-up.
Level of recommendation: C
Key points:
- Poor evidence on pain reduction and risk of a new tear.
- At this time, EBM does not support PRP in rotator cuff tears.
- It is necessary to classify and standardize different PRP preparations available.

Question n. 13: Use of scaffold, patch and augmentation

Autograft
Literature showed good result in using periosteal autologous flap with a low percentage of re-tears and with poor complications such as etherotopic calcifications. Positive results have been shown also in clinical and in instrumental/ultrasound outcome.
Xenograft
Some studies showed positive results using graft for not completely repairable lesions, with good results without complications at three years follow up. Other studies revealed inflammatory complications in 40% of cases and worst clinical outcome.
Allograft
Allograft are a novel technique but clinical result are still controversial. Some Authors found positive results in repairing rotator cuff with inconsistent clinical outcome; on the other hand, other studies demonstrated an improvement in functional outcome without complications.
Synthetic scaffold
Patch and synthetic scaffold are used for augmentation in non anatomically repairable rotator cuff tears. They have positive results on a clinical and instrumental point of view.
Level of recommendation: D
Key points:
- Scaffold should be used only in massive rotator cuff tears, with inconsistent tissue that does not permit a complete repair of the tendon.
- At this time, EBM does not support scaffold for lacking of RCT level I and for small number of patients.
- Patch and xenograft have significant immunological complications.

Key words: tissue, graft, augmentation, mesenchimal, stem cells, supraspinatus, rotator cuff, repair.
Mesenchimal stem cells
Clinical use approved by RTC in literature concerns fracture healing.
Level of recommendation: D
Key points:
- At this time, the use of mesenchimal stem cells is not supported by evidence.

Key words: tissue, graft, augmentation, mesenchimal, stem cells, supraspinatus, rotator cuff, repair.

Question n. 14: Latissimus dorsi transfer

The transfer of the tendon of the latissimus dorsi muscle (LDT) seems to provide a good treatment op-

tion, particularly in young patients with massive posterior-superior rotator cuff tears, when the surgical repair is no longer considered a possible solution. Today is also used in combination with reverse shoulder prosthesis implantation in older patients with a severe loss of external rotation. The length of the tendon is very important because an insufficient mobilization of the tendon can determine a limitation of the rotations, a decentralization of the humeral head and an increase in pressure of the head against the glenoid. In literature, all Authors have reported good functional results after LDT surgery, in particular in external rotation recovery. The integrity of the tendon of the subscapularis muscle is important to have a good clinical outcome. This technique showed a poor functional outcome in patients with severe glenohumeral osteoarthritis. There is no agreement on what is the best place to insert the tendon. In summary, after this procedure, we can expect an improvement of about 35° vertically, 10° of external rotation, and a recovery of abduction strength in up to about 70% compared to the contralateral shoulder healthy, but that we can not wait for a return to normality. Although the results so far are encouraging, it is not possible to establish clear recommendations on the use of the LDT.

Level of recommendation: D

Key points:

- Absence of studies of evidence level I.
- The results of this transfer in posterior superior and massive irreparable rotator cuff tears are encouraging with respect to the recovery of the ROM, external rotation, the strength and function of the shoulder.
- Negative prognostic factors appear to be the glenohumeral osteoarthritis, the glenohumeral joint space narrowing, the rupture of the tendon of the subscapularis muscle and fatty degeneration of advanced teres minor muscle.
- The follow-up is still short to assess the long-term results.

Key words: shoulder, rotator cuff tear, massive rotator cuff tear, tendon transfer, latissimus dorsi transfer, randomized controlled trial, young patients.

Question n. 15: Reverse prosthesis in irreparable rotator cuff tears

The reparation is more difficult when there is a progression of the rotator cuff tear. In literature, there is no consensus on the most appropriated treatment.

Reverse Shoulder Arthroplasty (RSA) was introduced for patients with rotator cuff arthropathy, but now it is indicated also in other pathologies such as pseudoparalysis, proximal humeral fractures, instability or oncologic surgery. Good results have been reported in patients with irreparable rotator cuff tears and in patients over and under 60 years old.

However, in literature there are many limits such as the absence of randomized prospective studies of level I and the short follow-up. Thus, there are no definitive conclusions for the long term follow-up after RSA. Furthermore, many studies include different indications for the reverse prosthesis and utilize different evaluation scales which do not allow to compare the results.

Level of recommendation: D

Key points:

- No studies with level of evidence I and II.
- Reverse shoulder prosthesis could be advise in symptomatic patients with massive and irreparable tears of the rotator cuff, if associated with one or more of these conditions:
  - pseudoparalysis
  - humeral head shifted up with subacromial space < 6 mm
  - gleno-humeral arthrosis.

Key words: rotator cuff tear, massive rotator cuff tear, reverse shoulder arthroplasty, reverse shoulder replacement, hemiarthroplasty, randomized controlled trial, reverse in young, young patients.

Question n. 16: Rehabilitation protocol after rotator cuff repair

Despite the growth of the clinical interest and of the studies, there is a partial scientific evidence on the therapeutic strategies to improve post-operative outcome after reparation of the rotator cuff tears.

The type of surgical and rehabilitative treatment must be personalized considering factors such as size and type of the tear, age of the patients, presence of comorbidities, compliance to treatment. A rational rehabilitative approach is based on a gradual mobilization of the shoulder. The aim is the articular preservation and the prevention of the excessive tension on the repaired tendons.

The different types of exercises and of treatment must be introduced at the right time during the rehabilitation protocol. It is also recommended a gradual restart of sportive and recreational activities, only after an adequate functional re-education and without pain. Articulation and strength are complete and similar to the contralateral arm only 6 months after surgical repair of the rotator cuff, with consequent restart of the sportive activities.

Key points:

- The rehabilitation program must be personalized in each patient. It depends on intrinsic and extrinsic factors which could influence tendons healing and functional recovery. For example, early or late mobilization could both lead to negative effects on biomechanical properties of the healed tissues.
- The basic knowledge and the mechanobiological studies have led to scientific evidences. This knowledge help us taking the correct clinical decision to control post-operative pain, deciding shoulder immobilization time, time and type of neuromuscular rehabilitation.

Key words: rotator cuff tear, rotator cuff surgical repair, rotator cuff post surgical rehabilitative treatment

crossed with randomized controlled trial and systematic review.

Question n. 17: Return to sport after repair of the rotator cuff tears

Shoulder tear management is based on conservative or surgical treatment and on rehabilitation until functional recovery of the state before the trauma. In athletes, there are 2 phases: the first leads to recovery of the physical activities in the daily life (normal population), while the second leads to return to the sportive performance.
However, in literature the most of the studies have a level III of evidence or they are expert opinions, so there are not univocal data and Evidence Based Recommendations are necessary for the athletes.
The I.S.Mu.L.T. guidelines for the muscular trauma recovery have introduced the concept of motor re-education in phases IV and V as the final part of the rehabilitation period, which gradually leads the athlete to training again. The aims during these two phases are:

- Recovery of the proprioception and the coordination in the specific sports.
- Metabolic specific readjustment (aerobic-anaerobic-mist).
- Recovery of the most important strength's characteristic for the performance (maximum, explosive, elastic, resistant).

Level of recommendation: C
Key points:

- In the sportive population, there are no studies which describe methodologic approaches for the different physiological variables to recover the sportive performance after rotator cuff tear.
- Physical trainer must choose personalized protocols for the athletes considering detraining effects during the sport interruption period and the temporal progression in the sportive performance's recovery.

Key words: management of rotator cuff lesion in athletes, rehabilitation of rotator cuff lesion, return to sport after rotator cuff repair, rotator cuff lesion in athletes, recovery after rotator cuff lesion.

Question n. 18: Rotator cuff tears in the childhood

The incidence of the rotator cuff tears in the childhood is about 1%, but it could be underestimated. Typically, the young patient has a persistent pain, not associated with a particular trauma. The overuse activities of the upper extremities is the main risk factor, e.g. in tennis, basket and volleyball players and in the pitchers. Pathogenic mechanism is usually gleno-humeral internal impingement and MRI (Magnetic Resonance Imaging) is the diagnostic examination of first level.
According to the literature, it is indicated the conservative treatment. The surgical treatment is used when symptoms don't disappear. Arthroscopy treatment is still debated.
Level of recommendation: D
Key points:

- Rotator cuff tears are rare but probably underestimated in the childhood.
- The tears are often partial.
- MRI is examination of first level.
- Conservative treatment is the first choice.
- Arthroscopy is more advisable after conservative treatment failure.

Key words: rotator cuff tears, sport injuries in combination with pediatric, adolescent, adolescent athletes.

Answer n. 1: Clinical tests

Supraspinatus tendon tests

Tests	Author	Result	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy
Jobe test	Noel et al. 1989 (1)	Strength deficit	95	65	86	85	85
	Itoi et al. 1999 (2)		77	68	44	90	70
	Itoi et al. 2006 (3)		87	43	79	67	79
	Leroux et al. 1995 (4)		79	67	56	85	73
	Kim et al. 2006 (5)		76	71	92	51	69

(to be continued)

Cont.

Tests	Author	Result	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy
	Kelly at al. 2010 (6)		89	60	-	-	53
Jobe Test	Itoi et al. 1999 (2)	Pain	63	55	31	82	57
	Itoi et al. 2006 (3)		78	40	-	-	71
	Leroux et al. 1995 (4)		86	50	96	22	
	Kim et al. 2006 (5)		94	46	46	94	62
	Kelly at al. 2010 (6)		80	60	81	58	73
Full can test	Itoi et al. 1999 (2)	Strength deficit	77	74	49	91	75
	Itoi et al. 2006 (3)		83	53	-	-	78
	Kim et al. 2006 (5)		77	68	54	86	71
	Kelly et al. 2010 (6)		45	75	-	-	49
Full can test	Itoi et al. 1999 (1)	Pain	66	64	37	85	64
	Itoi et al. 2006 (3)		80	50	-	-	74
	Kim et al. 2006 (5)		71	68	52	91	69
	Kelly et al. 2010 (6)		34	25	-	-	33

Infraspinatus tendon tests

Tests	Author	Result	Sensitivity %	Specificity%	PPV %	NPV %	Accuracy
Patte test	Itoi et al. 2006 (3)	Strength deficit	84	53	-	-	-
	Kelly et al. 2010 (6)		52	67	-	-	53
	Leroux et al. 1995 (4)		83	61	21	97	
Patte test	Itoi et al. (3)	Pain	54	54	-	-	-
	Kelly et al. 2010 (6)		34	100	-	-	42
	Leroux at al. 1995 (4)		92	30	29	93	-
External rotation lag sign	Hertel et al. 1996 (7)		70	100	100	56	78
	Castoldi et al. 2009 (8)		12	98	73	73	73
	Walch et al. 1998 (9)		98	98	-	-	-
	Bak et al. 2010 (10)		45	91	87	57	65
	Miller et al. 2008 (11)		46	94	77	78	-
Drop sign	Hertel et al. 1996 (7)		21	100	99	32	43
	Bak et al. 2010 (10)		45	70	65	50	56
	Miller et al. 2008 (11)		73	77	61	85	-
Atrophy	Litaker et al. 2000 (12)		55	73	81	43	-

Subscapularis tendon tests

Tests	Author	Result	Sensitivity %	Specificity%	PPV %	NPV %	Accuracy
Lift off test	Itoi et al. 2006 (3)	Strenght deficit	79	59	-	-	-
	Leroux et al. 1995 (4)		0	61	0	88	-
	Barth et al. 2006 (13)		18	100	100	77	78
	Itoi et al. 2006 (3)	Pain	46	69	-	-	-
Internal rotation lag sign	Hertel et al., 1996 (7)	Strenght deficit	97	96	97	96	96
	Scheibel et al. 2005 (14)		75	-	-	-	-
	Rigsby et al. 2010 (15)		98	94	-	-	-
	Bak et al. 2010 (10)		31	87	75	50	56
	Miller et al. 2008 (11)		100	84	28	100	-
Belly press test	Barth et al. 2006 (13)		40	98	89	80	81
	Scheibel et al. 2005 (14)		38	-	-	-	-
	Rigsby et al. 2010 (15)		88	97	-	-	-
Napoleon test	Barth et al. 2006 (13)		25	98	83	76	77
	Scheibel et al. 2005 (14)		69	-	-	-	-
	Rigsby et al. 2010 (15)		98	97	-	-	-

Answer n. 2: Instrumental diagnosis

Authors (year)	N. of cases or studies included	Type of study	Imaging techniques	Sensitivity	Specificity
Lenza et al. (16) (2013)	20 studies (1147 shoulders)	**Systematic review**	- Magnetic resonance (MRI) - Arthro-MR - Ultrasound (US)	- for any rupture of the cuff: **MRI 98%** (6 studies, 347 shoulders); **US 91%** (13 studies, 854 shoulders); - full thickness tears: **MRI 94%** (7 studies, 368 shoulders); **ArthroMR 94%** (3 studies, 183 shoulders); **US 92%** (10 studies, 729 shoulders)	- for any rupture of the cuff: **MRI 79%** (6 studies, 347 shoulders); **US 85%** (13 studies, 854 shoulders); - full thickness tears: **MRI 93%** (7 studies, 368 shoulders); **ArthroMR 92%** (3 studies, 183 shoulders); **US 93%** (10 studies, 729 shoulders)
Smith et al. (17) (2012)	44 studies (2751 shoulders in 2710 patients)	**Systematic review and misanalysis**	MRI in full thickness or partial rotator cuff tears	- partial tears: **0.80;** **-** full thickness**:** **0.91**	- partial tears: **0.95;** - full thickness**: 0.97**
Smith et al. (18) (2011)	62 studies (6066 shoulders in 6007 patients)	**Systematic review and misanalysis**	Ultrasound in full thickness or partial rotator cuff tears	- partial tears: **0.84;** - full thickness**:** **0.96**	- partial tears: **0.89;** - full thickness**: 0.93**
Ottenheijm et al. (19) (2010)	44 studies: - 22 full thickness tear; - 15 partial tear; - 3 subacromial bursitis; - 2 tendinopathies; - 2 calcifications	**Systematic review and misanalysis**	Ultrasound in subacromial disorders	- partial tears: **0.72;** - full thickness**:** **0.95;** **-** subacromial bursitis: **0.79-0.81;** - tendinopathies: **0.67-0.93;** - calcifications: **1.00**	- partial tears: **0.93;** - full thickness**:** **0.96;** **-** subacromial bursitis: **0.94-0.98;** **-** tendinopathies: **0.88- 1.00;** **-** calcifications: **0.85-0.98**
Kelly, Fessell (20) (2009)	67 studies	**Systematic review**	- US - MRI - ArthroMR	- partial tears: **US 0.67;** **MRI 0.44** - full thickness**:** **US 0.87;** **MRI 0.89;** **Arthro-MR 0.95**	- partial tears: **US 0.94;** **MRI 0.90** - full thickness**:** **US 0.96;** **MRI 0.93;** **Arthro-MR 0.93**
Dinnes et al. (21) (2003)	**10 cohort studies**	**Systematic review and misanalysis**	**- US** **- MRI** **- ArthroMR**	**- all tears:** **US 0.33-1.00** **MRI 0.83** **ArthroMR 0.95**	**- all tears:** **US 0.43 to 1.00** **MRI 0.86** **ArthroMR 0.93**

(to be continued)

Cont.

Authors (year)	N. of cases or studies included	Type of study	Imaging techniques	Sensitivity	Specificity
Ardic et al. (22) (2006)	59 shoulders in 58 patients	**Transversal study**	- US - MRI (compared to clinical tests)	- all supraspinatus tears: **US 98.1%; clinical tests for impingement 78.3%** - full thickness: **US 54.2% in underestimation *vs* MRI 71.2%** (10 cases) - partial tears: **US 37.3% in overestimation *vs* MRI 27.1%** (6 cases)	- all supraspinatus tears: **US 60%; clinical tests for impingement 50%**
Blanchard et al. (23) (1999)	104 patients	**Transversal study**	- MRI - ArthroMR	full thickness: **RM 81%**; **ArtroMR 50%**	full thickness: **RM 78%; ArtroMR 96%**
Singson et al. (24) (1996)	177 MRI images	**Randomized retrospective study**	- RM fast spin-echo T2 with fat suppression - RM fast spin-echo T2 without fat suppression	- full thickness: with fat suppression **100%;** without fat suppression **100%** - partial tears: with fat suppression **92%;** without fat suppression **67%**	Normal tendons: **both the techniques 86%**

Answer n. 3: Rehabilitation approach in the rotator cuff tears

Studies comparing conservative treatments in rotator cuff tears

Author (year)	No	Type of study	Follow-up period	Outcome
Martins, Marziale (25) (2012)	18 participants: - 9 in the control group - 9 in the experimental group	Randomized Clinical Study	Follow-up absent	- Shoulder ROM measurement with goniometer; - Western Ontario Rotator Cuff Index (WORC); - Occupational Stress Indicator (OSI); - Visual Numeric Scale (VNS)
Krischak et al. (26) (2013)	43 participants	Randomized Clinical Study	2 months after therapy	- Primary outcome: VAS (Visuo Analogic 10-point Scale); - Constant-Murley score; - Shoulder ROM; - Clinical impingement; - Grade of strength in abduction/adduction and rotation
Moosmayer et al. (27) (2010)	103 participants	Randomized Clinical Study	6-12 months after surgery	- Primary outcome: Constant score; - American Shoulder and Elbow Surgeons (ASES) score; - Short form (SF-36) Health survey; - Subscores on grade of movement, pain, shoulder strength and grade of satisfaction of the patient
Kukkonen et al. (28) (2014)	180 participants	Randomized Clinical Study	3-6-12 months after surgery	- Primary outcome: Constant score; - Subjective evaluation comparing pre and post-surgery; - Subjective grade of satisfaction
Seida et al. (29) (2010)	3 Reviews Cochrane and 14 Randomized Clinical Studies	Systematic Review	—	—
Huisstede et al. (30) (2011)	137 Studies	Systematic Review	—	—

Answer n. 4: Drug therapy

Authors	Analyzed drugs	*n. studies (f.u. days)*	*n. pt*	*Results*	*Evidence*
Boudreault et al. (31)		**12 RTCs**			
	FANS *vs* Placebo	4 (14)	120	In favour of FANS for pain	II
	NS FANS *vs* Cox2	3 (14)	608	Similar both in pain and in tolerance	III
	FANS *vs* Corticost. Injections	3 (33)	200	No differences	III
van der Sande et al. (32)		**3 SR + 5 RCTs**			
	FANS *vs* laser (Naproxen 550 mg x2/die 14 gg *vs* Laser 902 nm)	1 RCT (14)		Moderate evidence in favour of laser	II
	Ibuprofen (600 mg 4/die) *vs* Ibuprofen slowly released (1200 mg 2/die)	1 RCT (168)	147	In favour of traditional ibuprofen	II
	FANS *vs* Corticost. Injections	3 RCTs (28-42)	120	No differences	II
Van der Windt et al. (33)		**18 RCTs**			
	FANS *vs* Corticost. Injections	4 RCTs (28)	N.D.	In favour of injections both for pain and for functions	III
	FANS *vs* Placebo	4 RCTs (14)	N.D.	In favour of FANS	III

Answer n. 5: Shoulder injections

Randomized studies indicating efficacy of injective treatments in rotator cuff tendinopathy

Author (year)	No	Type of study	Follow-up	Result	Outcome	Level of evidence
Adebajo et al. (1990) (34)	Corticosteroid (n=x) Diclofenac per os (n=x)	Randomized	//	Major efficacy with injective treatment	//	II
Alvarez et al. (2005) (35)	Corticosteroid (n=30) Xilocaine (n=28)	Randomized	2,6,12,24 weeks	No statistically significantly differences between the 2 groups in each follow-up	WORC, DASH, Shoulder and Elbow Surgeons, active ROM	I
Eyigor et al. (2010) (36)	Corticosteroid + Mepivacaine (n=20) TENS (n=20)	Randomized	1,4,12 weeks	Statistically significantly differences in favour of group I after 1 week	VAS for pain, ROM, Shoulder Disability Questionnaire (SDQ), Short Form-36 (SF-36), Beck Depression Scale (BDS)	II
Rha et al. (2013) (37)	PRP (n=20) Dry Needling (n=19)	Perspective Randomized	24 weeks	PRP treatment more efficacious than dry needling treatment	Shoulder Pain and Disability Index, passive ROM, global health state questionnaire	II
Holt et al. (2013) (38)	Corticosteroid + Lidocaine (n=19) Lidocaine (n=21)	Randomized	2,4,12 weeks	No statistically significantly differences between the 2 treatments in the middle-long term	Oxford Shoulder Score (OSS)	II
Kesikburun et al. (2013) (39)	PRP (n=20) Placebo (n=20)	Randomized	3,6,12,24 weeks 1 year	No statistically significantly differences between the 2 groups	Western Ontario Rotator Cuff Index (WORC), Shoulder Pain and Disability Index (SPADI), 100-mm VAS for pain, ROM	I
Rabini et al. (2012) (40)	92 patients Corticosteroid (group 1) Local Microwave Diathermy (group 2)	Randomized	24 weeks	No statistically significantly differences between the 2 treatments	DASH, Constant-Murley score, VAS for pain	II

Randomized studies indicating injective treatments efficacy in partial or complete tear of the rotator cuff tendons

Author (year)	No	Type of study	Follow-up	Result	Outcome	Level of evidence
Shibata et al. (2001) (41)	78 patients HA (group 1) Dexametasone (group 2)	Randomized	24 weeks	No statistically significantly differences between the 2 treatments	UCLA score and articular ROM	II
Chou et al. (2010) (42)	HA (n=25) Placebo (n=20)	Randomized Double blind	5 weeks and 33.1 months	No statistically significantly improvement in the group treated with HA	Constant-Murley and VAS for pain	II

Answer n. 6: Surgery indications and reparability criteria

Correlations between demographical and clinical variables to make an adequate surgery decision for rotator cuff tears reparation

Author	No	Follow-up	Variable studied	Result	Level of evidence
Rhee et al. (43)	238	14.6-13.2 months	Age (60-79 years)	Patients < or > 70 years old have an equivalent increased in clinical scores	III
Dwyer et al. (44)	344	24 months	Age (< 55 years)	Patients < or > 55 years old have equivalent results	II
Cofield et al. (45)	105	13.4 years	Gender	Less pain and major abduction mobility in male	IV
Petersen et al. (46)	36	31 months	Surgery “timing”	Traumatic tears’ reparation is recommended by 4 months	IV
Bartolozzi et al. (47)	136	20 months	Symptoms period	Symptoms period > 1 year: bad response to surgery	IV
Gladstone et al. (48)	38	12 months	Fat infiltration in the cuff with RMN	Tear size influences reparation. Fat degeneration is not improved by tendinous suture	II

Answer n. 7: Miniopen *vs* arthroscopy

Author (year)	No	Type of study	Follow-up	Outcome	Level of evidence
Chul-hyun et al. (49) (2012)	ASC (n=30) MO (n=30)	Randomized	6 months	Similar ROM, rehabilitation period, shoulder stiffness, complications; VAS < in ASC first week	I
Peer van der Zwaal et al. (50) (2013)	ASC (n=47) MO (n=48)	Randomized	13 months	Similar DASH, Costant-Murley, active flex/rotat ext, pain, ROM	II
Kasten et al. (51) (2003)	ASC (n=17) MO (n=17)	Randomized	6 months	Similar ROM, RMN, Costant-Murley, pain < in ASC first week	III
Kim et al. (52) (2003)	ASC (n=42) MO (n=34)	Retrospective	2-6 years	Similar UCLA, ASES, VAS, strength, ROM	
Warner et al. (53) (2005)	ASC (n=9) MO (n=12)	Retrospective	5 years	Similar active flex/rotat ext, pain, strength	III
Severud et al. (54) (2003)	ASC (n=35) MO (n=29)	Retrospective	4 years	Similar UCLA, ASES; MO some cases adhesive capsulitis	
Youm et al. (55) (2005)	ASC (n=42) MO (n=42)	Retrospective	3 years	Similar UCLA, ASES	
Shan et al. (56) (2014)	ASC (n=422) MO (n=348)	Meta-analysis	4 years	Similar UCLA, ASES, Costant, VAS	IV

Answer n. 8: Arthroscopic treatment of partial tears of the rotator cuff: where and when

Author	Study	N° lesions	Grade	Tretament	Follow-Up (months)	UCLA score Pre-op/ Post-op	Analog pain scale Pre-op/ Post-op	ASES Score Pre-op/ Post-op	Costant score Pre-op/ Post-op	Satisfactor Neer Score Post-op	*L'Insalata* score Post-op	Level of evidence
Snyder et al. (57)	Case series	31	NI	Debridement	23	32	nr	nr	nr	93%	nr	IV
Gartsmann et al. (58)	Case series	111	Ellman I,II,III	Debridement	32	nr	6.7/1.2	nr	nr	nr	nr	IV
Cordasco et al. (59)	Case series	52	Ellman II	Debridement	53	nr	nr	nr	nr	nr	90	IV
Park et al. (60)	Case series	37	Ellman I,II	Debridement	42	nr	6.2/1.1	38/88	nr	nr	nr	IV
Kartus et al. (61)	Case series	26	Ellman II	Debridement	101	nr	nr	nr	72(post-op)	nr	nr	IV
Ozbaydar et al. (62)	Case series	19	<50%	Debridement	nr	16.8/29 p<0.05	nr	nr	nr	nr	nr	IV
Liem et al. (63)	Case series	46	Ellman I,II	Debridement	50	nr	nr	37.4/86.6 p<0.001	87.7	nr	nr	IV
Ide et al. (64)	Case series	17	Ellman III	Transtendinous repair	39	17.3/32.9 p<0.01	nr	nr	nr	nr	nr	IV
Tauber et al. (65)	Case series	16	Ellman II,III	Transtendinous repair	nr	15.8/32.8 p<0.01	7.9/1.2 p<0.01	nr	nr	nr	nr	IV
Castricini et al. (66)	Case series	31	Ellman II,III	Transtendinous repair	33	nr	nr	nr	44.4/91.6	nr	nr	IV
Deutsch et al. (67)	Case series	41	Ellman III	Completion of the repair	38	nr	6.5/0.8 p<0.001	42/93 p<0.001	nr	nr	nr	IV

(to be continued)

Cont.

Author	Study	N° lesions	Grade	Tretament	Follow-Up (months)	UCLA score Pre-op/ Post-op	Analog pain scale Pre-op/ Post-op	ASES Score Pre-op/ Post-op	Costant score Pre-op/ Post-op	Satisfactor Neer Score Post-op	*L'Insalata* score Post-op	Level of evidence
Porat et al. (68)	Case series	36	>50%	Completion of the repair	42	17.2/31.5 p<0.05	nr	nr	nr	nr	nr	IV
Kamath et al. (69)	Case series	42	>50%	Completion of the repair	39	nr	6.5/2.7 p<0.001	47.0/82.7 p<0.001	nr	nr	nr	IV
Franceschi et al. (70)	RCT	64	>50%	30 pz Transtendinous repair 30 pz completion of the repair	38	nr	nr	45.6/91 p<0001 47/90 p<0.0001	48/92 p<0.0001 46/91 p<0.0001	nr	nr	II
Shin et al. (71)	RCT	48	>50%	24 pz Transtendinous repair 24 pz completion of the repair	31	nr	nr	54.9 64.6	57.9 70.4	nr	nr	II

Answer n. 9: Management of the condition of the long head of the biceps in association with lesions of the rotator cuff

Author	Cases	Follow-up	Examined variable	Result	Level of evidence
De Carli et al. (72)	35 pz tenotomy (group A) 30 pz tenodesis (group B)	24 months	SST Costant score Strenght Popeye sign	Scales: satisfactory results in both groups, with no significant difference (ns). Popeye sign was found in 5 patients (17%) in group B and no patient in group A. The ultrasound examination showed the LHB within the bicipital groove in 80% of group A and group B. Power Doppler ultrasound showed signs of vascularization of the LHB in 20% of patients in group A and in 40% of the groups B and signs of vascularization rotator cuff repaired in 28% of group A and 40% of group B.	II
Slenker NR et al. (73)	(systematic review) 433 pz tenodesis 699 pz tenotomy	-	Clinical and functional evaluation Aesthetic evaluation	Similar results in terms: outcome good/excellent (74% tenodesis *vs* 77% tenotomy); residual pain (24% tenodesis *vs* 19% tenotomy). Higher percentage of cosmetic deformity in patients treated with tenotomy than the tenodesis (43 *vs* 8%)	IV

Answer n. 10: Surgical suture

Authors	N. of cases	Follow-up	Chosen parameter	Results	Level of evidence
Gartman et al. (74)	83 (40 SR 43 DR)	10 months (6-12)	Healing evaluatd with Ultrasounds	75% SR 93% DR (suture bridge)	I
Carbonel et al. (75)	160 (80 SR 80 DR)	24 months	UCLA ASES RM	Better clinical outcome (UCLA ASES) in DR No differences in RM	I
Lapner et al. (76)	80 (40 SR 40 DR)	24 months	Constant, ASES US RM	No clinical differences DR Better healing	I
Ko et al. (77)	71 (37 SR 34 DR)	Not less then 24 months	ASES CONSTANT UCLA RM	No clinical differences No differences in healing	I
Burks et al. (78)	40 (20 SR 20 DR)	1 yars	ASES UCLA CONSTANT	No clinical differences No differences in healing	I
Ayadin et al. (79)	68 (34 SR 34 DR)	Not less then 2 years	CONSTANT SCORE	No differences	II
Charousset et al. (80)	66 (35 SR 31 DR)	6 months	Constant score Arthro-TC	No clinical differences Better healing in DR	II
Grasso et al. (81)	80 (40 SR 40 DR)	2 years	DASH Constant	No clinical differences	II
Franceschi et al. (82)	60 (30SR 30 DR)	2 years	UCLA ROM Arthro-RM	No differences	I

Answer n. 11: Massive and irreparable rotator cuff tears

Author	No	Follow-up	Treatment	Result	Level of evidence
Zingg et al. (83)	19	48 months	Conservative treatment	Improved functions also if arthrosis progression Constant: 83% SSV: 68%	IV
Levy et al. (84)	17	9 months	Physiokinesitherapy	Improved movement and functions. Constant 26-60 Anterior elevation 40°-160°	III
Franceschi et al. (85)	68	7.8 years	Arthroscopy debridement with decompression and partial reparation	Decreased pain. Higher functional results in partial reparation	III
Berth et al. (86)	42	24 months	Arthroscopy debridement with decompression and partial reparation	Good/optimal results in both techniques. Higher functional results in partial reparation	II
Rockwood et al. (87)	50	6 years	Open debridement with decompression	Reduced pain and improved functions. Satisfying outcome in 83% of the patients. Anterior elevation 105°-140°	III
Zvijac et al. (88)	25	45.8 months	Arthroscopy debridement with decompression	Decreased results (pain and functions) in the long period UCLA score: 84 to 68%	IV
Kempf et al. (89)	210	26.6 months	Arthroscopy debridement with decompression and CLBO tenotomy	CLBO tenotomy useful to reduce pain and increase functions. Limited results with debridement and decompression	III
Klinger et al. (90)	33	31 months	Arthroscopy debridement with decompression	Successful in the elderly with low functional necessities. Constant 30- 67. Satisfied patients: 82%	IV
Boileau et al. (91)	68	35 months	CLBO tenotomy	Successful to reduce pain and to improve functions. Constant 46.3-66.5. Satisfied patients: 78%	III
Walch et al. (92)	307	57 months	CLBO tenotomy	Successful to reduce pain and to improve functions. Constant 48.4-67.6. Satisfied patients: 87%	III
Porcellini et al. (93)	67	5 years	Partial reparation	Good clinical and functional results. Constant 44-73, SST 4.6-9. Increased humerus-acromial distance from 6.1 to 9.1 mm	IV
Burkhart et al. (94)	14		Partial reparation	Successful to improve strength, movements and functions. Strength improved 2.3 scores (range 0-5), UCLA from 9.8 to 27.6, Anterior elevation from 59.6° to 105.4°	IV

(to be continued)

Cont.

Author	No	Follow-up	Treatment	Result	Level of evidence
Kim et al. (95)	27	41.3 months	Partial reparation	Improved pain and functions. SST from 5.1 to 8.8, Constant from 43.6 to 74.1, UCLA from 10.5 to 25.9. Lower strength than the controlateral.	IV
Malavolta et al. (96)	54	24 months	PRP	No better clinical results. No lower risk for a new tear.	I
Charousset et al. (97)	70	24 months	PRP	No better clinical results. No lower risk for a new tear.	III
Jo et al. (98)	48	12 months	PRP	Improved functions and lower risk for a new tear (20% and not 55.6%).	I
Gumina et al. (99)	80	13 months	Scaffold with PRP	Higher healing percentage with PRP membrane. No differences in clinical and functional results.	I
Barber et al. (100)	42	24 months	Scaffold with acellular matrix from human derma	Better clinical results and higher healing percentage with scaffolds (85% and not 40%)	II
Rodeo et al. (101)	79	12 months	PRP	No better clinical results. No modifications of percentage for a new tear.	II
Iannotti (102)	14	24 months	Latissimus dorsi transposition	Satisfied patients: 64% Improved PENN score from 40 to 66. Limited or worst clinical results in patients with low preoperative functions and with severe muscular weakness.	II
Gerber (103)	46	147 months	Latissimus dorsi transposition	Improved functions and reduced pain. SSV from 29% to 70%, Constant from 56% to 80%, pain range: 7-13 scores. Anterior elevation 118°-132°, abd 112°-123°, RE 18°- 33°. Abd strength 1.2- 2kg. No effects on arthrosis evolution.	IV
Irlenbusch et al. (104)	52	50 months	Latissimus dorsi transposition	Reduced pain, improved movements, strength and functions. No effects on arthrosis evolution. Insufficient results if subscapularis tear.	IV
Gavriilidis et al. (105)	15	37 months	Pectoralis majior transposition	Improved functions and reduced pain. No effects on movements. Constant from 51.7 to 68.1	IV

(to be continued)

Cont.

Author	No	Follow-up	Treatment	Result	Level of evidence
Jost et al. (106)	28	32 months	Pectoralis major transposition	Improved functions and reduced pain. Constant from 47% to 70%, SSV from 23% to 55%.	II
Elhassan et al. (107)	11	57 months	Pectoralis major transposition	Mediocre results. Satisfied patients: 7/11. Constant from 28.7 to 52.3. VAS from 7.9 to 4.2.	IV
Galatz et al. (108)	14	17.5 months	Pectoralis major transposition	Improved functions and reduced pain. VAS from 6.9 to 3.2. Ant elevation 24.4°- 60.8°. ASES from 27.2 to 47.7.	IV
Guery et al. (109)	57	69.6 months	Reverse prosthesis	Successful in patients > 70 years with low functional necessity. Implant lifetime after 120 months: 84%. Progressive deterioration in 6 years after implant.	IV
Simovitch et al. (110)	42	43 months	Reverse prosthesis	Improved functions and reduced pain in patients with rotator cuff arthropathy. Teres minor disfunction influences results.	II
Wall et al. (111)	186	39.9 months	Reverse prosthesis	Improved functions and reduced pain. Constant from 23 to 60.	II

Answer n. 12: Latissimus dorsi transposition

Authors	*Cases (shoulders)*	*Age*	*F-U (months)*	*Outcome*	*Level of evidence*
Castricini et al. (2014) (112)	27 (27)	60	27	CMS, VAS	retrospective (level IV)
Gerber et al. (2013) (113)	44 (46)	59	147	SSV, CMS, VAS	retrospective (level IV)
Lehmann et al. (2013) (114)	57 (57)	65	36	CMS	retrospective (level IV)
Lichtenberg et al. (2012) (115)	34 (34)	57 e 61	58 e 51	CMS, EMG	retrospective case-control (level III)
Tauber et al. (2010) (116)	42 (42)	58	47	CMS, ASES	retrospective case-control (level III)
Gerhardt et al. (2010) (117)	20 (20)	55	70	CMS, VAS, EMG	retrospective (level IV)
Debeer et al. (2010) (118)	25 (26)	56	43	CMS	retrospective (level IV)
Valenti et al. (2010) (119)	25 (25)	55	22	CMS	retrospective (level IV)
Weening et al. (2010) (120)	16 (16)	60	26	CMS, OSS	retrospective (level IV)
Moursy et al. (2009) (121)	42 (42)	58	47	CMS, ASES, VAS	retrospective (level IV)
Nové-Josserand et al. (2009) (122)	26 (26)	55	34	CMS, VAS, SSV	retrospective (level IV)
Zafra et al. (2009) (123)	18 (18)	54	28	CMS	retrospective (level IV)
Birmingham et al. (2008) (124)	18 (18)	60	25	ASES	retrospective (level IV)
Boileau et al. (2008) (125)	11 (11)	60	19	CMS, ADL	perspective (level III)
Irlenbusch et al. (2008) (126)	52 (52)	60	50	CMS, VAS	perspective (level III)
Costouros et al. (2007) (127)	22 (22)	58	34 m	CMS, VAS, SSV	retrospective (level IV)
Boileau et al. (2007) (128)	13 (13)	70	22	CMS, SSV	retrospective (level IV)
Habermeyer et al. (2006) (129)	14 (14)	61	32	CMS, EMG	retrospective (level IV)
Iannotti et al. (2006) (130)	14 (14)	54	34	PENN, EMG	retrospective (level IV)
Degreef et al. (2005) (131)	12 (12)	59	39	CMS	retrospective (level IV)
Miniaci et al. (1999) (132)	17 (17)	55	51	VAS, ULCA	retrospective (level IV)
Aoky et al. (1996) (133)	10 (12)	64	35	UCLA	perspective (level III)

Legend: CMS: Constant Murley Score, ASES: American Shoulder and Elbow Surgeon Scale; UCLA: University of California, Los Angeles score; ADL: activity daily living score; Penn (University of Pennsylvania) shoulder score; OSS: Oxford Shoulder score; Quick DASH score: ROM: Range of movement; SSV: Subjective Shoulder Value; EMG: electromyography.

Answer n. 13: Reverse prosthesis in irreparable rotator cuff tears

Studies about RSA implantation in irreparable tears of rotator cuff and in rotator cuff arthropathy

Author	N. RSA	Age	F-U	Outcome	Level of evidence
Young et al. (2013) (134)	102 HA 102 RSA	71.6 (HA) 72 (RSA)	31 m (HA) 37 m (RSA)	OSS	Comparative **(Level III)**
Leung et al. (2012) (135)	56 (20 HA – 36 RTSA)	64 (HA) 72 (RSA)	4,4 y	SPADI	Retrospective, case-control **(Level III)**
Teissier et al. (2014) (136)	105	73	4 y	CMS, ASES, ROM	Prospettico **(Level III)**
Atalar et al. (2014) (137)	14	74	32 m	ROM, Quick DASH, CMS, VAS	Case series **(Level IV)**
Middleton et al. (2014) (138)	97	67	50 m	OSS, VAS, ROM	Case series **(Level IV)**
Castricini et al. (2013) (139)	80	78	60 m	CMS, ROM, SF-36	Case series **(Level IV)**
Favard et al. (2011) (140)	506 254 RC arthropathy 229 massive RCT	73	7,5 y	CMS	Case series **(Level IV)**
Naveed et al. (2011) (141)	50	81	39 m	ASES, OSS; Short-form SF-36	Case series **(Level IV)**
Mulieri et al. (2010) (142)	72	74	2 y	ASES, VAS, ROM	Case series **(Level IV)**
Young et al. (2009) (143)	49	79	3 y	ASES, OSS	Case series **(Level IV)**
Sayana et al. (2009) (144)	19	72	30 m	CMS, ROM	Case series **(Level IV)**
Boileau et al. (2009) (145)	42	71	2 y at least	CMS, ROM	Case series **(Level IV)**
Cuff et al. (2008) (146)	70	72	28 m	ASES, SST	Case series **(Level IV)**
Frankle et al. (2007) (147)	60	71	2 y at least	ASES, VAS	Case series **(Level IV)**
Guery et al. (2006) (148)	60	71	5 y	CMS	Case series **(Level IV)**
Vanhove et al. (2004) (149)	32	71	31 m	CMS	Case series **(Level IV)**

Legend: SPADI: Shoulder Pain and Disability Index: CMS: Constant-Murley score, ASES: American Shoulder and Elbow score, SST: Simple Shoulder Test; OSS: Oxford Shoulder Score; ROM: Range of Movement.

Studies in patients with average age < 60 years

Author	*N. RSA*	*Age*	*F-U*	*Outcome*	*Level of evidence*
Ek (2013) (150)	64	60 y	93 m	CMS, ROM, Subjective shoulder value	Case series **(Level IV)**
Muh (2013) (151)	67	52 y	36 m	ASES, VAS	Case series **(Level IV)**
Sershon et al. (2014) (152)	36	54 y	2,8 y	VAS, SST, ASES, CMS, ROM	Case series **(Level IV)**

Legend: SPADI: Shoulder Pain and Disability Index: CMS: Constant-Murley score, ASES: American Shoulder and Elbow score, SST: Simple Shoulder Test; OSS: Oxford Shoulder Score; SSV: Subjective Shoulder Value; ROM: Range of Movement.

Answer n. 14: Rehabilitation protocol after rotator cuff repair

Author/type of study	No of patients	Methods	Outcome	Complications
Raab et al. (153) **RCT**	64	Medium/large tears Group with "aggressive" treatment (2 sessions/die of manual therapy in the first 6 weeks with unlimited stretching) Group with passive continuous limited mobilization.	Better articular ROM in the group with "aggressive" treatment, but no differences after 1 year follow-up.	23.3% new rupture in the group with aggressive treatment comparing with the group with limited treatment 8.8%
Garofalo et al. (154) **PRCT**	100	Immediate passive mobilization *vs* strict immobilization.	Immediate passive mobilization leads to a better functional score and to a reduced incidence of adhesive capsulitis.	No differences in the healing
Garofalo et al. (154) **Systematic review**	4 RCT (comparison between continuous passive mobilization and standard rehabilitation)	N/A	Continuous passive mobilization leads to a better articular ROM (2 studies). Pain reduction (1 study). Better muscular strength recovery (1 study).	N/A
Lastayo et al. (155) **PRCT**	31	Continuous passive mobilization (4 weeks) *vs* manual passive articular. ROM	No differences in articular ROM, pain, functional scores and strength.	N/A
Osbahr et al. (156) **RCT**	50	Efficacy of the cryotherapy in all the patients after shoulder surgery (stabilization, arthroplasty and cuff repair) *vs* no cryotherapy.	Pain reduction in the group treated with cryotherapy. Pain reduction improves rehabilitation.	N/A
Brady et al. (157)	18	Aquatic and terrestrial combined exercises *vs* terrestrial exercises only.	Both the programs improve articular ROM. Aquatic exercises improve early flexion but no significantly differences after 12 weeks.	N/A

Rehabilitative post-operative protocols: traditional vs prolonged immobilization

Time	Group with traditional rehabilitation	Group with immobilization
Immediate post-surgery	Pendular exercises and shoulder, wrist and hand AROM	Shoulder, wrist, and hand AROM
1-6 weeks	Shoulder PROM supervised by therapist	Shoulder immobilization
6-12 weeks	Start of the shoulder AAROM and AROM	Shoulder PROM supervised by therapist
3-4 months	Start of the cuff, deltoid and shoulder stabilising enhancement	Start of the shoulder AAROM and AROM
>4 months	Full activity between 4 and 6 months, based on the individual progresses	Start of the cuff, deltoid and shoulder stabilising enhancement: full activity between 5 and 6 months, based on the individual progresses.

Legend: AROM = Active Articular Excursion, PROM = Passive Articular Excursion, AAROM = Active-Assisted Articular Excursion.

The 4 healing phases during rehabilitative treatment after surgical repair of the rotator cuff

Phase 1: immediate postoperative (0-6 weeks)	Phase 2: Protection and active movement (6-12 weeks)
Aim Maintainment/protection of the reparation integrity Gradually PROM increasing Pain and inflammation reduction Prevention of the muscular inhibition Independence with modified ADL	**Aim** Leading to soft tissues healing No stress for healing tissues Gradually improving of the PROM (4-5 weeks) Pain and inflammation reduction
Precautions Arm maintained in abduction with an adequate support, removed only during the exercises No shoulder AROM, objects or weight lifting, posterior movements of the shoulder, excessive stretching or suddenly movements, body weight lifting with the hands Keeping the incision clean and dry	**Precautions** No lifting No body weight lifting with the hands or the arms No suddenly movements No excessive posterior movements of the shoulder Avoiding bicycle and ergometer for the upper extremities
Criteria for the progression to phase 2 Passive flexion until ≥125° Passive ER on the scapular plane until ≥75° (if no compromised shoulder PROM >80°) Passive IR on the scapular plane until >75° (if no compromised shoulder PROM >80°) Passive abduction on the scapular plane until >90°	**Criteria for the progression to phase 3** Complete AROM

(to be continued)

Cont.

Phase 1: immediate postoperative (0-6 weeks)	Phase 2: Protection and active movement (6-12 weeks)
Day 1-6	**Week 5-6**
Abduction with support	Continuing full time with an adequate support
Pendular exercises	for the arm from the end of the 4° week
Fingers, wrist and shoulder AROM	Between the 4° and the 6° weeks, using
Isometric exercises for the scapular muscles; cervical ROM	the support only for a major comfort
Cryotherapy for pain and inflammation	Leaving the support at the end of the 6° week
Day 1-2	Starting flexion AAROM in supine position
Doing as much as possible (20 min/h)	Progressive PROM until complete ROM
Day 3-6	at week 4-5
After activities or for the pain	Delicate scapular/glenohumeral mobilization to
Sleepimg with support in abduction	recovery a full PROM
Educating the patient to posture, articular protection, hygiene	Starting pronation until neutral position
Day 7-28	of the arm
Continuing with support in abduction	Continuing cryotherapy if necessary
Pendular exercises	It is possible to warm up before ROM exercises
Starting PROM for the tolerance: (patient supine and free from pain)	Aquatherapy only for light exercises AROM
Flexion until 90°	Ice after exercises
ER on the scapular plane ≥35°	**Week 6-8**
IR until the body/chest	Continuing AROM, AAROM stretching
Continuing AROM against resistance for shoulder,	exercises
wrist and fingers	Starting isometric exercises for the rotator cuff
Cryotherapy if necessary to control pain and inflammation	Continuing periscapular exercises
A general program can be started (e.g.walking, bicycle)	Starting AROM exercises (flexion
Aquatherapy/therapy in swimming-pool can be started 3 weeks after surgery	on the scapular plane, abduction, ER, IR)

Legend: ROM: Range of Motion. AAROM = Active-Assisted Articular Excursion. ADL = Daily Life Activities. AROM = Active Articular Excursion. ER = External Rotation. IR = Internal Rotation, PROM = Passive Articular Excursion.

Answer n. 15: Return to sport after repair of the rotator cuff tears

Studies on different types of rehabilitative exercises

Author/Article	LV of Evidence	Patients (No)	Sport	Outcome
Ruotolo et al. 2006 (158)	III - review		baseball	Pain reduces articular capacity
Myers et al. 2005 (159)	III - descrittive study	15	various	Exercises selection to reinforcement
Hurd et al. 2011 (160)	III - descrittive study	165	baseball	IR more strength than ER
Stickley et al. 2008 (161)	III - case-control	38	volleyball	Excentric strength program to prevent injuries
Baumgarten et al. 2009 (162)	II - systematic review		various	No differences between autonomous and guided therapy
Reinold et al. 2007 (163)	III - repeated measures	22	various	Selection of exercises with a major use of the supraspinatus
Hand et al. 2009 (164)	I - randomized clinical study	13	various	Vibrations don't add more advantages than muscular reinforcement only
Reinold et al. 2013 (165)	V - expert opinion		pitchers	Mobility - distensibility - muscular reinforcement - postural rieducation and dynamic stabilization exercises are useful
Dreinhofer et al. 2014 (166)	II - systematic review			No according data and necessity of evidence based recommendations
Kim et al. 2014 (167)	I - randomized clinical study	13		Data support eccentric work in the rehabilitative protocols

Answer n. 16: Rotator cuff tears in the childhood

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Author contributions

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