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Clinical Evaluation, Treatment and Return to Work of Workers Suffering from Rotator Cuff Disorders

A Knowledge Review

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Legal Deposit
Bibliothèque et Archives nationales du Québec
2017
ISBN : 978-2-89631-911-4
ISSN : 0820-8395

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A PDF version of this publication is available on the IRSST Web site.

This study was funded by the IRSST. The conclusions and recommendations are solely those of the authors.
This publication is a translation of the French original; only the original version (R-885) is authoritative.

PEER REVIEW
In compliance with IRSST policy, the research results
published in this document have been peer-reviewed.

SUMMARY

Musculoskeletal disorders of the shoulder constitute a major problem among the general population and particularly among workers. This type of disorder affects the shoulder's functional status and the quality of life of the individuals involved. In the case of workers, it can lead to problems of absenteeism and losses of productivity. Workers who perform tasks with their arms above shoulder height or repetitive tasks are at greater risk of developing shoulder disorders, especially rotator cuff (RC) disorders. For the 2005-2007 period, the costs generated annually by shoulder injuries that were accepted by the Commission de la santé et de la sécurité du travail (CSST), including human costs and costs associated with loss of productivity, totalled $393,204,738.

Given the magnitude of the problem, a vast knowledge review was conducted on several aspects related to RC disorders. The main objective of this knowledge review was to synthesize the scientific evidence and make recommendations concerning diagnostic and clinical evaluation tools, therapeutic interventions and workplace-based interventions for workers suffering from a RC disorder. Systematic reviews or meta-analyses of relevant literature were carried out for each of these themes. A number of collaborators, including researchers and clinicians, contributed to this review.

First, this knowledge review made it possible to determine the diagnostic values of the physical tests performed during a patient's clinical examination. It appears difficult for any one clinical test to be both sensitive and specific. The diagnostic values of the tests vary greatly and do not allow any particular test to be recommended for diagnosing a rotator cuff disorder. In fact, a combination of tests and clinical variables may constitute a good diagnostic tool.

Medical imaging can be used to complement a physical examination and provide a more specific diagnosis (and above all, confirmation) of RC disorders. Ultrasound (US), medical resonance imaging (MRI) and magnetic resonance arthrography (MR arthrography or MRA) are sensitive and highly specific techniques and therefore ideal for confirming RC disorders.

Next, clinical measurement tools, which are used on a regular basis to evaluate shoulder muscle strength, range of motion, and scapular position and movement, were found on the whole to have good measurement properties. However, they should be used in combination with other tools, such as self-report questionnaires.

Lastly, self-report questionnaires were found to have excellent measurement properties for clinically assessing patients with a RC disorder. The Western Ontario Rotator Cuff (WORC) is one of the questionnaires most responsive to change. Some of the other questionnaires, including the popular Disability of the Arm, Shoulder and Hand (DASH), exist in French as well and are available free of charge. Mixed tools combining questionnaires and performance tests are also valid for clinical use, but data are lacking on their responsiveness to change.

No algorithm exists to guide professionals in their treatment of RC tendinopathy during the care process. However, based on the results of this knowledge review, certain interventions may be recommended for managing RC tendinopathy or full-thickness tears.

In the case of RC tendinopathy, taking non-steroidal anti-inflammatory drugs (NSAIDs) for a short period of time is useful for alleviating pain. Exercise programs have also shown their worth in adult and worker populations. With specific regard to workers, therapeutic exercise programs helps reduce pain, improve shoulder function and promote a faster return to work. Some studies have shown an exercise program and acromioplasty-type surgery for RC tendinopathy to have similar effectiveness. Conservative treatment is therefore recommended initially for adults with RC tendinopathy. If that fails, surgery may be contemplated. A comparison of the different types of surgery revealed similar effectiveness for an arthroscopic approach and open repair.

All repair surgeries of the rotator cuff, whether open or arthroscopic, have proven effective for full-thickness tears. Single-row and double-row suture repair surgeries show similar results. The addition of acromioplasty to cuff repair does not yield additional benefits and therefore is not recommended.

The predictive factors of absenteeism and return to work (RTW) were also explored. This knowledge review confirms the ambiguity surrounding the factors associated with both absenteeism and RTW. In fact, while a number of factors emerged from the review, no consensus was found in their regard. Based on the determinants explored in relation to other shoulder joints, it appears that psychosocial or environmental factors and the employer’s role are key components in the success of a RTW.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASES	American Shoulder and Elbow Surgeon Score
CI	Confidence interval
CIRRIS	Centre interdisciplinaire de recherche en réadaptation et en intégration sociale
CMS	Constant-Murley Score
COX-2	Cyclo-oxygenase-2
CRCHU	Centre de recherche du centre hospitalier universitaire de Québec
CRCHUM	Centre de recherche du centre hospitalier de l'Université de Montréal
CRHMR	Centre de recherche de l'Hôpital Maisonneuve-Rosemont
CSST	Commission de la santé et de la sécurité du travail
DASH	Disabilities of the Arm, Shoulder and Hand
ERLS	External rotation lag sign
ES	Effect size
ESWT	Extracorporeal shock wave treatment
Euro-Qol-5D	Euro-Qol 5 Dimensions
Euro-Qol-VAS	Euro-Qol Visual Analogue Scale
Fit-HaNSA	Functional Impairment Test-Head, and Neck/Shoulder/Arm
FSET	Functional Shoulder Elevation Test
G	Goniometer
HSROC	Hierarchical Summary Receiver Operating Characteristic
I	Inclinometer
ICC	Intraclass correlation coefficient
IRLS	Internal rotation lag sign
KSS	Korean Shoulder Score
KT	Kinesiotaping
LDS	Lateral Displacement of the Scapula
LSST	Lateral Scapular Slide Test
MCID	Minimal clinically important difference
MD	Mean difference
MDC	Minimal detectable change
MHz	Megahertz
MRA	Magnetic resonance arthrography
MRI	Magnetic resonance imaging
NET	Non-elastic taping
NLR-	Negative likelihood ratio
NPV-	Negative predictive value

NS COX	Non-specific cyclo-oxygenase
NSAIDs	Non-steroidal anti-inflammatory drugs
NS-NSAIDs	Non-specific non-steroidal oral anti-inflammatory drugs
OECD	Organization for Economic Co-operation and Development
OSS	Oxford Shoulder Score
PLR+	Positive likelihood ratio
PPV+	Positive predictive value
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSS	Pennsylvania Shoulder Score
QUADAS-2	Quality Assessment of Diagnostic Accuracy Studies 2
QuickDASH	Shortened version of the DASH
RC	Rotator cuff
RC-QOL	Rotator Cuff Quality of Life
RCT	Randomized clinical trial
ROC	Receiver Operating Characteristic
RR	Relative risk
RTW	Return to work
SDT	Scapular Dyskinesis Test
SIS	Shoulder impingement syndrome
SMD	Standardized mean difference
Sn	Sensitivity
Sp	Specificity
SPADI	Shoulder Pain and Disability Index
SRM	Standardized Response Mean
SRQ	Shoulder Rating Questionnaire
SSET	Simple Shoulder Endurance Test
SST	Simple Shoulder Test
TENS	Transcutaneous electrical nerve stimulator
UCLA	University of California – Los Angeles Shoulder Scale
UEFI	Upper Extremity Functional Index
UEFS	Upper Extremity Functional Scale
ULFI	Upper Limb Functional Index
US	Ultrasound
VAS	Visual Analogue Scale
WA	Weighted averages
WORC	Western Ontario Rotator Cuff

1. INTRODUCTION

Musculoskeletal disorders of the shoulder constitute a major problem among the general population and particularly among workers. Prevalence figures ranging from 7 to 26%[1] in the course of a lifetime have been reported in the general population. Shoulder pain ranks third among musculoskeletal disorders (MSDs) as the reason for clinical consultation, behind low back pain and cervical pain.[2] In addition to affecting the functional status and quality of life of the individuals affected, shoulder disorders in workers lead to increased absenteeism and decreased productivity.[3] Workers who perform tasks with their arms above shoulder height or repetitive tasks are at greater risk of developing shoulder disorders, particularly rotator cuff (RC) tendinopathy.[4]

According to data from the Commission de la santé et de la sécurité du travail du Québec (CSST), shoulder disorders are among the most common occupational injuries. For the 2005-2007 period, the costs generated annually by CSST-accepted shoulder injuries totalled $393,204,738.[5] These figures confirm the magnitude of the problem from the standpoint of human costs, costs related to loss of productivity and CSST payouts for this type of injury. Given these numbers, it is important that efforts be made both to prevent shoulder pathologies, which alter the health and quality of life of affected workers, and to improve their case management.

1.1 Rotator cuff disorders

Shoulder disorders can be classified under a variety of diagnoses. Those found most frequently in adults are disorders involving the RC tendons.[6] They include RC tendinopathy with no tear (including shoulder impingement syndrome and bursa disorders) and partial or full-thickness tears in one or more of the RC tendons. These disorders may have different etiologies (e.g. traumatic or overload)[7,8] and be associated with a variety of risk factors, such as repeated lifting of heavy loads,[9] which puts workers who perform this type of task regularly at risk. RC tendinopathy is the shoulder disorder most frequently treated by clinicians and represents 50 to 85% of all shoulder disorders.[6] RC tears are also a frequent condition whose prevalence increases with age, particularly in people over 50. A RC tear can be described as either partial or full-thickness and can lead to symptoms such as pain at rest and during activity, decreased range of motion and strength, and functional impairments.[10]

RC tendinopathy with no tear is a general designation for a combination of pain and decreased functional level associated with a disorder of one or more of the RC tendons.[8] The mechanisms leading to this disorder may be intrinsic, extrinsic or a combination of the two.[8] The extrinsic mechanisms are those causing compression of the RC tendons on the bursal side. The RC tendons and subacromial tissues are thus compressed in the subacromial space, particularly during arm elevation movements. The subacromial space is defined as the region between the coraco-acromial arch, the humeral head and the anterior aspect of the acromion. The subacromial space may be reduced in people with a RC disorder.[8] This mechanism is regularly referred to as shoulder (or subacromial) impingement syndrome (SIS).

The intrinsic mechanisms are those associated with tendon degeneration and are more often observed on the joint side of the RC than on the subacromial bursal side. Several hypotheses

have been advanced by various authors to explain the underlying reasons for this deterioration. They include, for example, the natural aging process, poor vascularization, tendon overload and impaired mechanical properties that result in decreased tendon strength during exposure to shear or traction forces. The symptoms frequently associated with RC tendinopathy are shoulder pain, decreased range of motion and strength, and decreased functional capacities.[11]

Partial tears of the RC produce the same clinical symptoms as those seen in RC tendinopathy with no tear (and are often included in the family of RC tendinopathies). RC tears may be of traumatic origin or result from excessive use (or overload) of the arm, mainly during elevation. A partial tear of the RC consists of the fraying of one or more of its tendons, while a full-thickness tear is an injury that crosses the full thickness of the tendon. Various classification systems exist to characterize these tears.[12] Generally speaking, they are based on the location of the lesion (posterosuperior or anterior), its extent (partial, >50% or <50%, massive), its pattern (joint or bursal side, or interstitial), the presence of fatty muscular atrophy and a retraction of the tendon (in full-thickness tears).[12]

1.2 Problems associated with evaluation, treatment and return to work

RC disorders cause symptoms that can become chronic over time.[13] It is therefore important to ensure effective management, starting with clinical evaluation right through to the return to work (RTW) and including an optimal, evidence-based intervention.

This knowledge review provides an update and overview of the latest scientific evidence on the measurement and/or diagnostic properties of clinical evaluation tools (clinical tests and diagnostic imaging modalities, clinical measurement tools, questionnaires and performance tests). Knowledge of these properties enables clinicians to choose the most appropriate tests or tools for any given situation, based not only on how the tools and tests perform but also on their specific features. A number of systematic reviews have been published in the past on the measurement and diagnostic properties of various evaluation tools, but several new studies have been published since that time. This knowledge review offers the advantage that it compiles information on a large number of evaluation tools and offers reflections on the specific role that each one may play in clinical evaluation.

To date, many studies, including systematic reviews and meta-analyses, have been published on the various aspects of the clinical treatment of RC disorders. However, many of them involved heterogeneous populations, including participants presenting with conditions other than those of interest here (e.g. capsulitis, instability and post-surgical conditions). Also, the methodologies used have varied in quality. Few of the systematic reviews have pooled the literature deemed important for formulating general recommendations that take into account the most commonly used interventions. The result is that today, few clinical guidelines exist to support clinicians in their decision-making process when evaluating and treating RC disorders. An update and synthesis appeared necessary in order to clearly identify validated evaluation methods and treatments with recognized effectiveness, and hence to support evidence-based practices.

The RTW is another issue investigated in this review. Absenteeism has many consequences. Several studies have investigated factors or determinants that may promote the RTW or reduce the problem of work absenteeism.[14,15] Clinical, sociodemographic and psychological factors (many of them related to the work environment) have been identified in these studies and already provide some direction for RTW planning. However, RC disorders constitute a specific problem and, to the best of our knowledge, very few prospective studies have focused either on such disorders in workers or on the factors that could encourage their RTW. These studies were therefore pooled in order to identify gaps in the literature and possible avenues for exploration in future studies, but also to guide clinicians involved in the RTW process of this specific population.

1.3 Objectives of the knowledge review

The main objective of this knowledge review is to synthesize the scientific evidence and make clinical recommendations about evaluation, medical and rehabilitation-related interventions, and RTW for workers with a RC disorder. The first specific objective is to summarize the scientific evidence available on the diagnostic and measurement properties of the clinical evaluation tools. More specifically, this report presents a review (meta-analyses) of data on the diagnostic validity of clinical and imaging tests in order to determine which are the most sensitive and specific for diagnosing RC disorders. It then presents an overview of systematic reviews on the measurement properties of clinical measurement tools, questionnaires and performance tests to identify which are valid, reliable and responsive to change. The second objective is to synthesize the evidence (systematic reviews with or without meta-analysis) on the effectiveness of the interventions used to treat RC disorders. Due to the variety of interventions available, only the most common are evaluated (i.e. interventions presenting enough evidence to allow for recommendations). The third specific objective is to present the evidence on the effectiveness of workplace interventions and on the prognostic factors related to absenteeism and RTW. Recommendations for clinicians are presented at the end of each section.

This knowledge review is intended for researchers and clinicians seeking to update their knowledge about the evaluation, diagnosis and treatment of RC tendinopathy and tears in workers. It also addresses health administrators and decision makers who are faced with having to make decisions regarding the financial and professional resources to be allocated to these disorders. This review will better equip clinicians to identify the methods of evaluation, diagnosis and treatment that are deemed effective in the literature for patients with RC tendinopathies or tears, and ultimately enable them to offer better support for a sustainable RTW process.

2. DIAGNOSTIC AND CLINICAL EVALUATION TOOLS

This first part presents a review of the evidence available on the diagnostic and measurement properties of clinical evaluation tools used for RC disorders. Meta-analyses were performed on the diagnostic tools, while systematic reviews were performed on the measurement tools. The most pertinent results from a clinical standpoint are presented in each section. Following the description of the methodology used to carry out the systematic reviews/meta-analyses, an analysis of the diagnostic validity and/or measurement property(-ies) is presented for the following:

- diagnostic tools: (1) clinical tests; (2) medical imaging techniques.
- clinical measurement tools: (1) range of motion; (2) muscle strength; (3) scapular movement; (4) questionnaires; (5) mixed tools combining questionnaires and performance tests; and (6) performance tests.

Lastly, clinical recommendations are presented at the end of each section to highlight the scientific evidence currently available on each tool.

2.1 Diagnostic tools

Several structures in the shoulder complex, as well as adjacent structures such as the cervical spine, can cause symptoms similar to those observed in the case of a RC disorder. It is therefore important to be equipped with diagnostic tools capable of distinguishing between the different disorders. A wide variety of diagnostic tools are available, but their use should be dictated by their diagnostic validity. For an evidence-based diagnostic process, the tools with high sensitivity serve to exclude patients who are more likely not to have the disorder while detecting those with a higher likelihood of having it. More specific tools are then used to confirm a diagnosis.[16,17] The tools used most frequently to diagnose RC disorders are explored in this knowledge review; they consist of clinical tests performed during the physical examination of the patient and medical imaging tests.

2.1.1 Research and analysis methodology

Bibliographic search
To perform an exhaustive review of the literature, three databases were consulted for the period from inception to December 2013: MEDLINE (by PubMed), Embase (by Ovid) and CINAHL (by Ebsco). A hand search was also done by reading recent literature reviews and systematically consulting the bibliographies of the articles retained.

Study inclusion criteria
The studies had to meet certain inclusion criteria regarding study population, diagnostic tools and diagnostic capacities. First, they had to include **participants** suffering from shoulder pain or suspected of having a RC disorder. Second, the **diagnostic tools** (clinical tests performed during the physical examination and imaging tests used for RC disorders) had to have been evaluated in the studies. For inclusion in the meta-analysis, the imaging studies had to use surgery (arthroscopic or open repair) as the reference test, whereas for the clinical tests, other reference

tests (such as ultrasound [US] or medical resonance imaging [MRI]) were accepted. Third, the studies had to present results on the criterion validity of the diagnostic (or index test) tools (**accuracy or diagnostic validity:** sensitivity [Sn], specificity [Sp], positive predictive values [PPV+] and negative predictive values [NPV-], positive likelihood ratio [PLR+] and negative likelihood ratio [NLR-] and overall diagnostic accuracy [expressed as a percentage]. Only studies that provided a two-by-two table (or enough data to construct one) were included in the meta-analyses.

Data extraction and assessment of risk of bias of included studies

A data extraction form was developed during the reading of the first articles in accordance with the recommendations made in the Cochrane Collaboration Handbook (http://handbook.cochrane.org/). This form was used to extract data on the population and tool under study, as well as the pertinent diagnostic qualities. A first reader performed the data extraction and a second reader then corroborated the information.

The risks of bias were assessed using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2), again as recommended in the Cochrane Collaboration Handbook.[18] The QUADAS-2 is used to assess the extent to which the results of a study are likely to have been affected by biases. The QUADAS-2 assesses four possible sources of bias: (1) **selection of the participants** of interest. In this knowledge review, studies including only patients strongly suspected of having a RC disorder were considered at high risk of bias. In fact, these studies probably performed a pre-selection of participants, which could create a bias; (2) **the diagnostic tool** of interest. This item is used to verify whether the results for the tool of interest (index test) were interpreted "blind," i.e. without taking into account the results of the reference test; (3) **the reference test**; an appropriate reference test must attain perfect diagnostic accuracy and have been interpreted blind; (4) **retention of the participants** of interest and the **time interval** between the dates when the index test and the reference test were conducted. Using this tool, two readers worked separately to assess the risk of bias of each included study, and their assessments were then compared. Any differences noted between the two assessments were discussed until consensus was obtained.

Statistical analysis

Meta-analysis was performed using the Hierarchical Summary Receiver Operating Characteristic (HSROC) model recommended by the Cochrane Group. The HSROC model allows the results of different diagnostic studies to be pooled and synthesized, while taking into account the variability between (inter-) and within (intra-) the studies.[19-22] The analyses using the HSROC model were performed using "R," the free software environment for statistical computing (http://www.r-project.org/ version 3.0.2) to produce overall estimates of the Sn and Sp for a group of studies, as well as a summary receiver operating characteristic (ROC) curve, which synthesizes variations in sensitivity and specificity based on the dichotomization threshold of a continuous variable. A confidence interval of 95% and a credible interval are also produced. The classic confidence interval assumes that the differences in the Sn and Sp between studies are caused solely by statistical instability related to sampling or measurement errors. All estimates should therefore revolve around a single Sn value and a single Sp value. In reality, for a given test, the Sn and Sp can vary over time, with different populations and different evaluators, or for any other condition that could influence test results. Under various conditions, the Sn and Sp

could fluctuate between a range of values that reflects a change in reality and a range of values arising from statistical instability. The credible interval defines how the reality causes fluctuations in the Sn and Sp for reasons other than sampling or measurement errors. In this context, the confidence interval adds the uncertainty caused by sampling and measurement errors to the credible interval. The credible interval is therefore included within the confidence interval. The positive and negative likelihood ratios were also calculated using overall sensitivity and specificity.[23] However, it was not possible to calculate the confidence interval of the likelihood ratios using the HSROC method.

2.1.2 Results – Diagnostic value of clinical tests

This section presents the results of the meta-analyses of clinical tests, followed by clinical recommendations. Next comes a discussion of the results of the meta-analyses of medical imaging diagnostics, also followed by clinical recommendations. The results are presented in terms of the different RC disorders. First, four meta-analyses were performed for the following disorders: (1) shoulder impingement syndrome (SIS); (2) full-thickness tears; (3) partial tears; and (4) subscapularis tendon tears. Also presented are the results of studies that assessed the diagnostic validity of a combination of several clinical tests.

Research results, article selection and risk of bias of included studies

The search of the three databases captured 1,020 citations (duplicates removed). Six additional articles were identified through a hand search, giving a total of 1,026 articles. Two readers (JS and CB) verified the admissibility of the articles based on the titles and abstracts, and then by reading the full articles. Further to attaining a consensus by both readers, 88 articles were retained for the full text review. After this reading, twenty-six of these articles were included in the meta-analysis [24-49] The risk of bias of each included study was then assessed. On the whole, the studies presented a low risk of bias (figure 1). Items 1 and 4 (participant selection and retention and time interval between tests) were the items most often regarded as a source of bias.

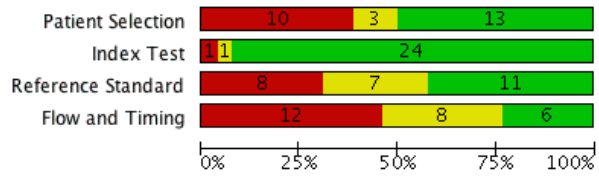


Figure 1 – Risk of bias of included studies (n = 26) – Clinical tests

1) Shoulder impingement syndrome (SIS) (table 1 and figure 2)

The pooling of the data from the SIS studies appeared to point favourably, based on the Sn and NLR-, to the Hawkins-Kennedy test (Sn: 0.86; NLR-: 0.22). This result appeared to be confirmed by the secondary analysis. In this case, the data from the studies comparing the same tests (Hawkins-Kennedy, Neer's and Painful Arc of Movement were compared in seven studies) on the same patients were pooled. These analyses also revealed the Hawkins-Kennedy test as having a slight advantage. Based on the overall Sp and the PLR+, it was the Painful Arc of Movement test that had the highest indices; it was in fact the only clinical test to present overall

Sn and Sp values higher than 0.80 for the diagnosis of SIS. However, no significant difference in the Sn and Sp was observed between the tests.[1]

Table 1 – Diagnostic value of clinical tests for detection of SIS

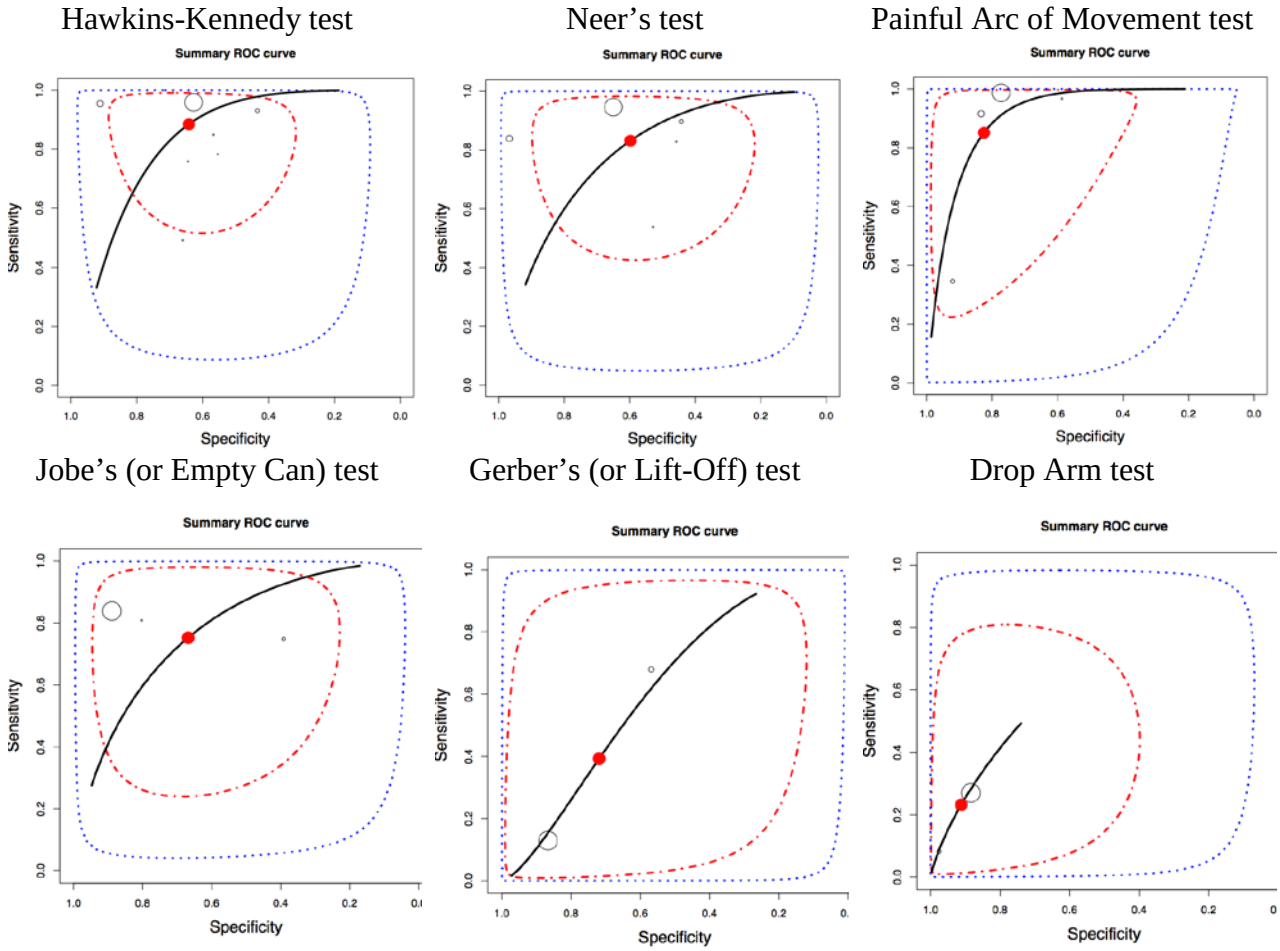
	Shoulder impingement syndrome (SIS)					
	N (study)	N (shoulder)	Overall Sn (95% CI)	Overall Sp (95% CI)	PLR+	NLR-
Hawkins-Kennedy test	8	1142	0.86 (0.65-1.00)	0.65 (0.40-0.87)	2.46	0.22
Neer's test	7	1045	0.81 (0.56-0.99)	0.60 (0.30-0.88)	2.03	0.32
Painful Arc of Movement test	5	964	0.82 (0.43-1.00)	0.82 (0.53-1.00)	4.56	0.22
Jobe's (or Empty Can) test	5	766	0.74 (0.43-1.00)	0.67 (0.35-0.95)	2.24	0.39
Gerber's (or Lift-Off) test	2	131	0.42 (0.04-0.94)	0.72 (0.23-1.00)	1.50	0.81
Drop Arm test	2	676	0.25 (0.01-0.75)	0.90 (0.48-1.00)	2.50	0.90

	Shoulder impingement syndrome	
	Neer's and Hawkins-Kennedy, for same patients	
	7 studies[24-30]	
	Neer's	Hawkins-Kennedy
N (shoulder)	1,045	1,041
Overall Sn (95% CI)	0.80 (0.56-0.99)	0.86 (0.63-1.00)
Overall Sp (95% CI)	0.61 (0.30-0.88)	0.63 (0.36-0.88)
PLR+	2.05	2.32
NLR-	0.33	0.22

[1] Overlapping credible intervals should be interpreted as an absence of significant difference between the tests. This is why we specify that our analyses suggest a *possible* advantage for the tests with higher Sn and Sp values.

	Shoulder impingement syndrome		
	Neer's, Hawkins and Painful Arc of Movement, for same patients		
	5 studies [24-28]		
	Neer's	Hawkins-Kennedy	Painful Arc of Movement
N (shoulder)	966	962	964
Overall Sn (95% CI)	0.78 (0.52-0.98)	0.83 (0.59-0.99)	0.62 (0.31-0.91)
Overall Sp (95% CI)	0.71 (0.35-1.00)	0.69 (0.37-0.97)	0.82 (0.62-1.00)
PLR+	2.69	2.68	3.44
NLR-	0.31	0.25	0.46

Abbreviations: Sn: overall sensitivity; Sp: overall specificity; PLR+ and NLR-: positive and negative likelihood ratios; CI: credible interval.



The circles represent each included study; the dotted blue line designates the confidence interval while the dotted red line designates the credible interval.

Figure 2 – ROC curves for detection of SIS

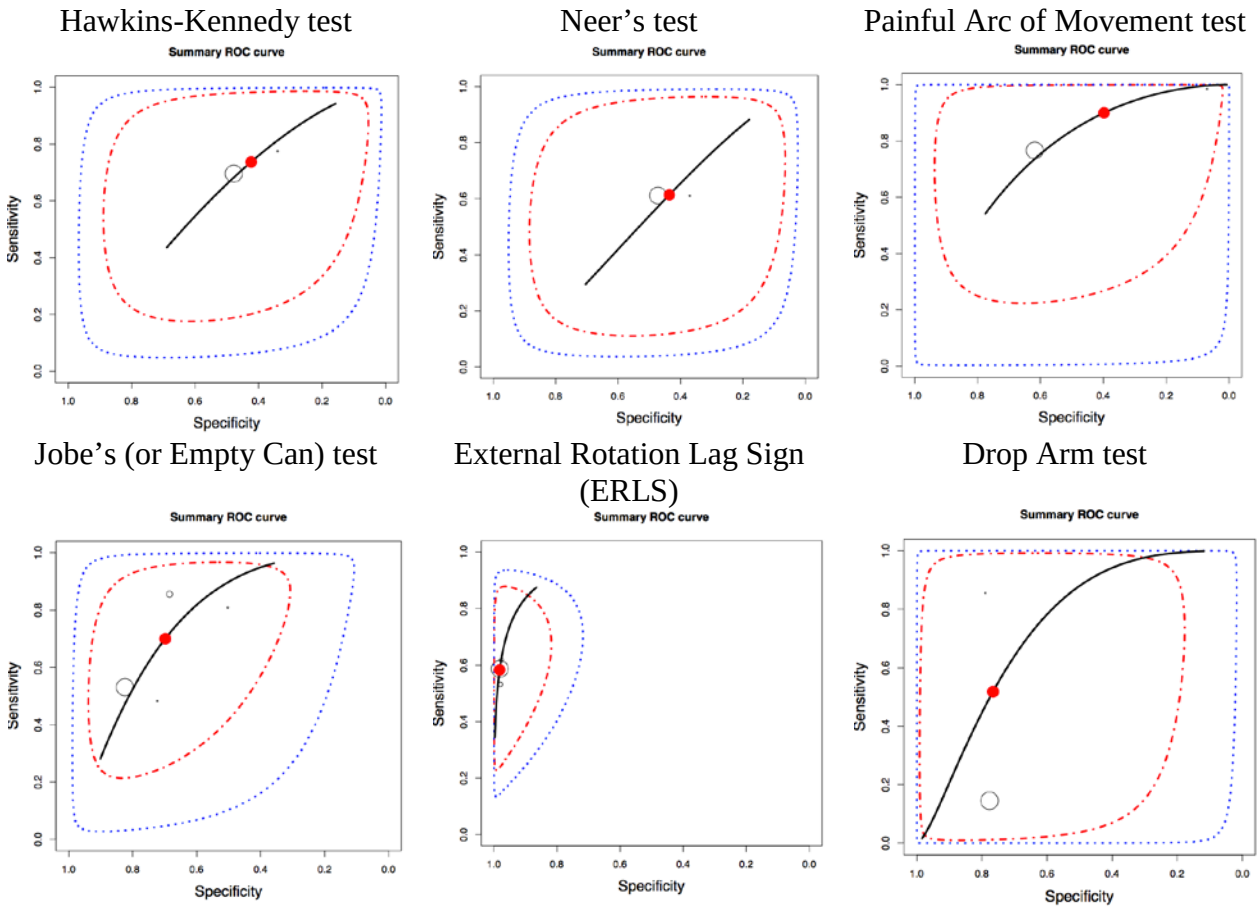
2) Full-thickness RC tears (supraspinatus and/or infraspinatus; table 2, figure 3)

For the detection of full-thickness RC tears, the Painful Arc of Movement test (Sn: 0.87, NLR-: 0.33) obtained the highest overall Sn value. For overall Sp and the PLR+, the External Rotation Lag Sign (ERLS) stood out. Its overall Sp was very high (Sp: 0.98), as was its PLR+ (PLR+: 29.0). The ERLS was also significantly more specific than both the Hawkins-Kennedy and Neer's tests. No clinical test obtained an overall Sn and Sp higher than 0.80 for diagnosing full-thickness RC tears. For the secondary analysis (pooling of studies that compared the same clinical tests used on the same patients), the Painful Arc of Movement test appeared to perform better for overall Sn (Sn: 0.87, NLR-: 0.33). For overall Sp, no test stood out (Sp < 0.70). The ERLS could not be retained in this secondary analysis.

Table 2 – Diagnostic value of clinical tests for detection of full-thickness tears of rotator cuff

	Full-thickness tear of RC (for supraspinatus and/or infraspinatus)					
	N (study)	N (shoulder)	Overall Sn (95% CI)	Overall Sp (95% CI)	PLR+	NLR-
Hawkins-Kennedy test	2	605	0.73 (0.29-1.00)	0.42 (0.07-0.83)	1.26	0.64
Neer's test	2	601	0.61 (0.20-0.98)	0.43 (0.07-0.81)	1.07	0.91
Painful Arc of Movement test	2	605	0.87 (0.34-1.00)	0.40 (0.05-0.90)	1.45	0.33
Jobe's (or Empty Can) test	4	855	0.69 (0.35-1.00)	0.70 (0.40-0.94)	2.30	0.44
External Rotation Lag Sign (ERLS)	3	247	0.58 (0.30-0.85)	0.98 (0.89-1.00)	29.00	0.43
Drop Arm test	2	598	0.25 (0.01-0.75)	0.90 (0.48-1.00)	2.21	0.62

	Full-thickness tear of RC tendon (for supraspinatus and/or infraspinatus)			
	Neer's, Hawkins-Kennedy, Painful Arc of Movement and Jobe's			
	2 studies[28,32]			
	Neer's	Hawkins-Kennedy	Painful Arc of Movement	Jobe's
N (shoulder)	601	605	605	605
Overall Sn (95% CI)	0.61 (0.20-0.98)	0.73 (0.29-1.00)	0.87 (0.34-1.00)	0.68 (0.22-1.00)
Overall Sp (95% CI)	0.43 (0.07-0.81)	0.42 (0.07-0.83)	0.40 (0.05-0.90)	0.67 (0.22-0.99)
PLR+	1.07	1.26	1.45	2.06
NLR-	0.91	0.64	0.33	0.48



The circles represent each included study; the dotted blue line designates the confidence interval while the dotted red line designates the credible interval.

Figure 3 – ROC curves for detection of full-thickness tears

3) Partial tears of the RC (supraspinatus and/or infraspinatus) (figure 4)

With the data collected, it was only possible to combine two studies (n = 602 shoulders) for partial tears; both studies evaluated Jobe's test.[28,32] However, Jobe's test had low Sn (0.47 [0.05-0.91]; NLR- = 0.94) and low Sp (0.62 [0.20-0.94]; PLR+ = 1.24) for this diagnosis.

Jobe's (or Empty Can) test

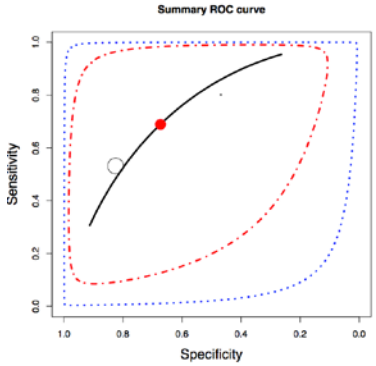


Figure 4 – ROC curve for detection of partial tears

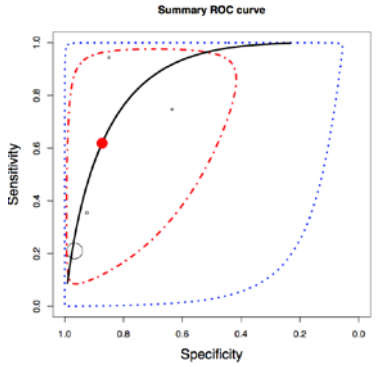
4) Subscapularis tendon tears (table 3 and figure 5)

Regarding the detection of full-thickness tears of the subscapularis tendon, it was possible to combine studies for two clinical tests: the Internal Rotation Lag Sign (IRLS) and Gerber's (or Lift-Off) test. This meta-analysis showed the IRLS as having a stronger performance in terms of overall Sn and SP values and likelihood ratios. However, the Sn for both tests was low and no significant difference was observed between the tests.

Table 3 – Diagnostic value of clinical tests for detection of subscapularis tendon tears

	Full-thickness tear of subscapularis tendon					
	N (study)	N (shoulder)	Overall Sn (95% CI)	Overall Sp (95%CI)	PLR+	NLR-
Internal Rotation Lag Sign (IRLS)	4	454	0.62 (0.25-1.00)	0.87 (0.58-1.00)	4.77	0.44
Gerber's (Lift-Off) test	5	754	0.27 (0.01-0.67)	0.83 (0.45-1.00)	1.59	0.88

Internal Rotation Lag Sign (IRLS)



Gerber's (Lift-Off) Test

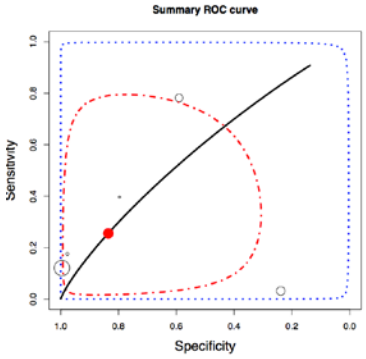


Figure 5 – ROC curves for detection of full-thickness or partial subscapularis tendon tears

5) Combination of tests and clinical variables (table 4)

It was not possible to perform a meta-analysis for this category because the tests and variables analyzed were not identical in the included studies. Seven studies[25,37-42] that assessed the diagnostic value of combinations of tests were retained. Only combinations of tests that obtained Sn or Sp values over 0.70 in the individual studies are presented.

Table 4 – Diagnostic value of combinations of tests and clinical variables

	Study	N (shoulder)	Specific tendon	Specific disorder	Sn	Sp	PLR+	NLR-
Combination of clinical tests								
Gerber's and Internal Rotation Lag Sign (IRLS)	Fodor (2009)[25]	130	Subscapularis	Tears	0.86	0.79	4.02	0.18
Neer's, Hawkins-Kennedy, Yocum, Jobe's, Patte, Gerber's, resisted internal rotation, Yergason's, Palm Up, Popeye sign	Naredo (2002)[38]	32	Infraspinatus	Tears	0.71	0.90	7.05	0.33
Three or more positive tests								
Hawkins-Kennedy, Neer, Painful Arc of Movement test, Jobe's, resisted external rotation	Michener (2009)[37]	55	-	SIS	0.75 (0.54-0.96)	0.74 (0.61-0.88)	2.93 (0.94-2.81)	0.34 (0.14-0.80)
Combination of tests and variables								
Range of motion, sensitivity to touch, laxity, Painful Arc of Movement test	Norregaard (2002)[39]	42	Supraspinatus	Tears	0.67	0.90	6.70	0.37
Atrophy of a RC muscle, sensitivity to touch, range of motion, Hawkins-Kennedy, Gerber's, Jobe's, Speed's, Yergason's and Drop Arm tests	Ostor (2005)[40]	94	Infraspinatus	Tears	0.75 (0.19-0.99)	0.94 (0.86-0.98)	12.50	0.27
Combination of clinical tests and variables – 3 or more positive tests								
SPADI, nocturnal pain, pain during external rotation or resisted abduction, pain during passive rotation, ELRS, Speed's, constant pain, Painful Arc of Movement test – **6 or more positive tests**	Cadogan (2013)[41]	203	-	Tears	0.88 (0.69-0.96)	0.66 (0.59-0.73)	2.57 (1.91-3.27)	0.19 (0.07-0.47)
7 or more positive tests					0.63 (0.43-0.79)	0.81 (0.74-0.86)	3.20 (2.08-4.91)	0.47 (0.28-0.79)
Age >39, painful arc of movement, joint crepitus (noise) – **2 positive tests**	Chew (2010)[42]	104	Supraspinatus	-	0.75 (0.62-0.84)	0.81 (0.65-0.91)	3.82 (2.02-7.24)	0.32 (0.20-0.49)
3 positive tests					0.38 (0.27-0.51)	0.99 (0.88-1.00)	32.20 (2.01-51.,46)	0.63 (0.52-0.76)

2.1.3 Discussion and clinical recommendations – Clinical tests

The results show great variability in the Sn and Sp of clinical tests for detecting RC disorders (wide and overlapping credibility intervals). No test has both high Sn and high Sp for diagnosing a RC disorder. Based on the current scientific evidence, our recommendations are therefore as follows:

- The Hawkins-Kennedy test is the test with the highest Sn for ruling out an SIS diagnosis, while the Painful Arc of Movement test has the highest Sp for confirming this diagnosis.
- The Painful Arc of Movement test has the highest Sn for ruling out a full-thickness tear of the RC, while the ERLS test has the highest Sp for confirming it.
- The IRLS has the highest Sn and Sp for ruling out or confirming a full-thickness tear of the subscapularis tendon.

Combinations of clinical tests and variables appear to offer better diagnostic capacities than clinical tests alone. However, other studies are needed to confirm this. It is important to note that diagnostic studies single out each clinical test for purposes of analysis while eliminating outside influences insofar as possible. While the pertinence of this procedure is understandable, we must stress how far removed it is from the clinical context and its consequent decrease in external validity. In the clinical context, a diagnostic test is never singled out, nor is it taken to be the only indicator of a disorder. Rather it is understood as part of an entire set of clinical variables (patient history, injury mechanism, lifestyle, occupation, etc.) and deficits noted during the examination, and it is all these factors that together guide the health professional in decision making.

The importance of diagnostic accuracy thus depends only on the implications of the entire set of clinical variables and deficits in the clinical decision. A full-thickness tear of the RC must be clearly differentiated from SIS, for example, as this will influence clinical decisions. However, these decisions will be based only partly on the diagnostic tests. It is in fact an entire set of clinical tests and variables that motivate a clinical decision. Combinations of tests and clinical variables appear to be more representative of the clinical context. Future research should be conducted in this regard. The results of this meta-analysis are comparable to those of previous systematic reviews,[50-53]; however, we performed the exercise for more disorders and included a larger number of studies. Lastly, the results of this meta-analysis are only valid if these tests are performed in a standardized manner in a clinic and using the methods described by the groups that developed the different tests.

2.1.4 Results – Diagnostic value of medical imaging

The bibliographic search in the databases captured 2,304 citations (duplications removed). Following an initial identification by title and abstract, 264 articles were retained for reading in their entirety. Eight additional articles were identified through a hand search, giving a total of 272 articles. Then, based on a reading of these articles, 80 were included in the systematic review (44 articles on ultrasound [US], 29 on magnetic resonance imaging [MRI] and 21 on magnetic resonance arthrography [MRA]; some of the articles evaluated more than one medical imaging test). The complete results were published in the *British Journal of Sports Medicine*.[54]

The results of the assessment of the studies' risk of bias, performed using QUADAS-2, reveal that the first item (selection of the participants for the study) was the item most often rated as representing a high risk of bias. There may potentially have been a pre-selection of participants in numerous studies, which risks producing an overestimation of the prevalence of RC disorders. In addition, the third item (reference test) was often rated as having a high risk of bias (figure 6). For ethical reasons, it is difficult for surgeons to perform surgery without knowing the results of the imaging tests.

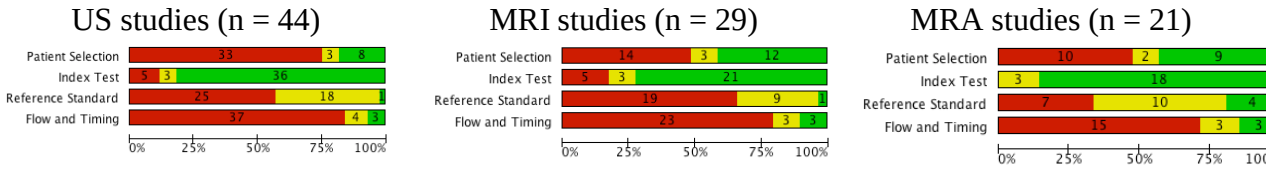


Figure 6 – Risk of bias of included studies – Medical imaging

Main analyses

Overall Sn and Sp – RC tendinopathy with no tear (*table 5*, *figure 7*)

Only one meta-analysis for US could be performed for imaging tests related to tendinopathy with no tear (five studies pooled, 325 shoulders).[55-59] Thus, while the overall Sn for US was lower (0.82), the overall Sp was very high (0.91).

Table 5 – Diagnostic value of US for detection of RC tendinopathy with no tear

	RC tendinopathy with no tear					
	N (study)	N (shoulder)	Sn (95% CI)	Sp (95% CI)	PLR+	NLR-
Ultrasound	5	325	0.82 (0.64-0.95)	0.91 (0.80-0.98)	9.11	0.20

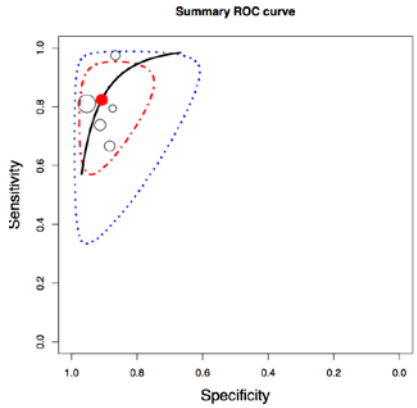


Figure 7 – ROC curve for detection of RC tendinopathy with no tear

Overall Sn and Sp – RC tears (*table 6, figures 8 and 9*)

Our results show high diagnostic values (overall Sn and Sp values equal to or higher than 0.90) for US, MRI and MRA, particularly for the detection of full-thickness tears in a RC tendon. For

the detection of partial tears, the overall Sn values for the tools were found to be lower, particularly for MRI and US. However, the overall Sp value and the PLR+ remain high for this disorder. For full-thickness tears, while the overall Sn and Sp values appear to be equivalent for the three tools, the PLR+ values indicate slight superiority for MRA. The same holds true for partial tears in terms of overall Sn, which is higher for MRA. However, no significant difference was observed between the tests for both Sn and Sp.

Table 6 – Summary of main results

	Full-thickness RC tears					
	N (study)	N (shoulder)	Sn (95% CI)	Sp (95% CI)	PLR+	NLR-
Ultrasound	30	2412	0.91 (0.86-0.94)	0.93 (0.90-0.96)	13.0	0.10
MRI	23	1581	0.90 (0.85-0.95)	0.93 (0.89-0.97)	12.9	0.11
MRA	15	1544	0.90 (0.83-0.95)	0.95 (0.91-0.98)	18.0	0.11
	Partial RC tear					
	N (study)	N (shoulder)	Sn (95% CI)	Sp (95% CI)	PLR+	NLR-
Ultrasound	22	2068	0.68 (0.52-0.81)	0.94 (0.90-0.97)	11.33	0.34
MRI	16	1195	0.67 (0.50-0.82)	0.94 (0.88-0.99)	11.17	0.35
MRA	15	1885	0.83 (0.74-0.91)	0.93 (0.88-0.98)	11.86	0.18

Abbreviation: CI: credible interval.

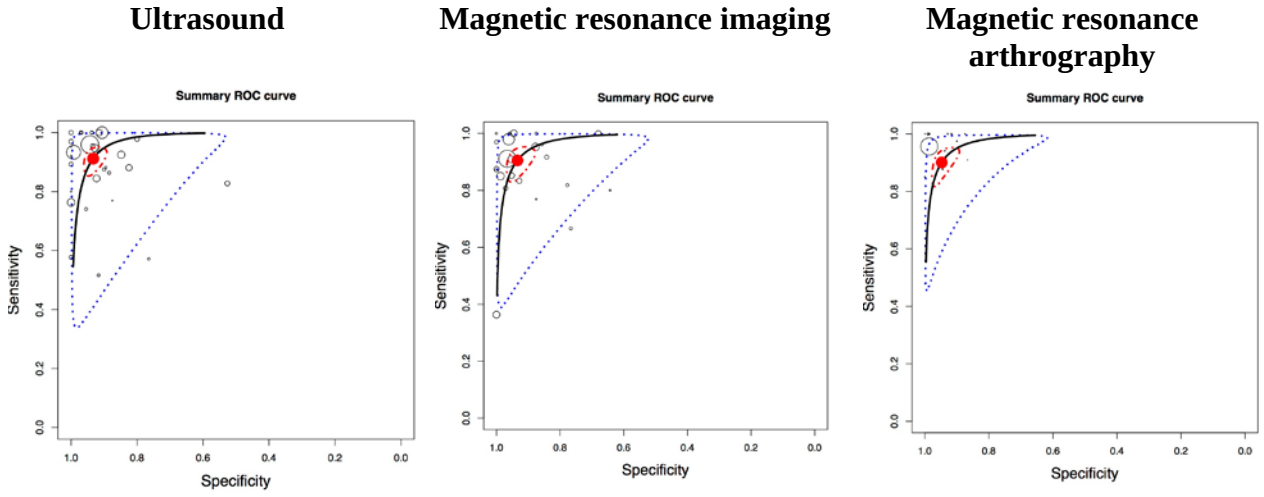


Figure 8 – ROC curves for detection of full-thickness RC tears

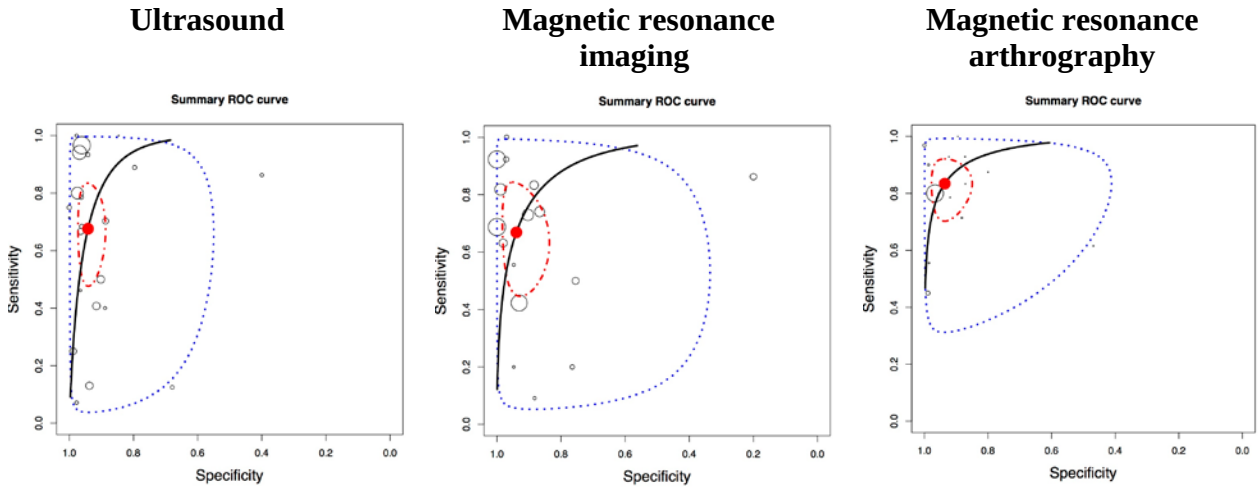


Figure 9 – ROC curves for detection of partial RC tears

Secondary analyses

Overall Sn and Sp according to equipment characteristics (*table 7*)

Our secondary analyses revealed that an electromagnetic flux density of 3.0 Tesla (T) confirms partial RC tears more effectively than a density of 1.5 T (however, the difference is not significant), whereas for full-thickness tears, a density greater than 1.5 T offers no diagnostic advantage. Regarding ultrasound, our analysis did not reveal any greater effectiveness with the use of frequencies of 7.5 megahertz (MHz) or more, across the disorder spectrum.

Table 7 – Diagnostic value of US, MRI and MRA, by equipment characteristics, for detection of partial RC tears

	Partial RC tear							
	≤ 7.5 MHz (US); ≤ 1.5 T (MRI and MRA)				> 7.5 MHz (US); 3.0 T (MRI and MRA)			
	N (study)	N (subject)	Sn (95% CI)	Sp (95% CI)	N (study)	N (subject)	Sn (95% CI)	Sp (95% CI)
Ultrasound	12	1,300	0.68 (0.49-0.85)	0.94 (0.90-0.98)	9	715	0.61 (0.33-0.86)	0.94 (0.85-0.99)
MRI	13	847	0.61 (0.42-0.80)	0.90 (0.82-0.96)	3	348	0.73 (0.44-0.97)	0.98 (0.85-1)
MRA	10	1,504	0.82 (0.68-0.94)	0.91 (0.81-0.97)	4	303	0.85 (0.63-0.98)	0.93 (0.81-1)

Abbreviation: CI: credible interval.

2.1.5 Discussion and clinical recommendations – Medical imaging

This meta-analysis confirmed that US, MRI and MRA are highly specific tools for diagnosing all types of RC disorders, as well as highly sensitive, particularly for full-thickness RC tears. Overall, our results were similar to those presented in previous systematic reviews.[16,60-64] The conclusions put forward in the latter meta-analyses and those presented in this review are very similar, despite differences in statistical methods and included studies. As was the case in the

reviews conducted by Dinnes et al.[61] and Jesus et al.,[60] the results confirm that the three tools perform similarly, although MRA may be slightly superior for partial RC tears. The evidence also shows that partial tears are the most difficult to diagnose.

Clinically, it is full-thickness RC tears that are of the greatest interest. In fact, regardless of whether imaging reveals a partial tear or tendinopathy with no tear, the therapeutic approach will generally be similar and non-surgical, whereas the presence of a full-thickness tear points to a surgical approach.[65] When the latter is recommended, the acute nature of the disorder, pain intensity, disability and size of the tear must also be taken into consideration.[65] It is therefore the results showing high and similar Sn and Sp values for the three diagnostic modalities for full-thickness RC tears that are the most pertinent from a clinical perspective.

It is therefore recommended that US, which has a diagnostic accuracy similar to that of MRI but is less costly, be used for diagnosing RC disorders. It is important to bear in mind that the health professionals (radiologists, sonographers and orthopedists) who took the ultrasonographic measures in the included studies had special training, and that a learning curve is involved in the use of US. In cases where US does not provide a specific diagnosis, MRI and MRA may offer interesting alternatives. Moreover, clinical situations in which other shoulder conditions must also be considered, such as a disorder of the joint cartilage or the labrum, and situations where it is important to assess the presence of fatty infiltration in a muscle, could justify the use of MRI or MRA. However, in most circumstances, we first recommend using a combination of different clinical evaluation tests that are non-invasive and less costly before medical imaging, as these technologies are primarily appropriate for confirming certain specific disorders.

Clinical recommendations:

- The use of imaging tests is particularly appropriate for confirming the presence of a full-thickness tear in patients suspected of having such a tear, based on clinical tests.
- While imaging can be used during the acute phase for patients who, from the clinical standpoint, are strongly suspected of having a full-thickness tear, the failure of conservative treatments also indicates the need for further investigation.
- When an imaging test is deemed pertinent, US should be given priority as it is less costly.
- If US does not provide a definitive diagnosis consistent with the clinical picture, MRI is recommended first, then MRA.

2.1.6 Conclusion

The diagnostic validity of clinical and medical imaging tests has been presented in this section. While this knowledge review revealed only moderate diagnostic effectiveness for clinical tests, they can still be useful in producing an accurate diagnosis, mainly when used in combination with other clinical variables. For its part, medical imaging offers excellent diagnostic value, particularly for identifying full-thickness RC tears.

Following the diagnosis of a RC disorder, clinicians will use a variety of tools to follow and observe the progression in a patient’s condition. The next section looks at the measurement properties of clinical measurement tools, self-report questionnaires and performance tests.

2.2 Clinical measurement tools

Several evaluation tools can be used to assess a patient's condition as well as changes in his or her condition over time (improvement, stability or deterioration). These tools are crucial in clinical decision making and in determining an intervention's effectiveness during a care episode. The tools chosen must therefore be reliable, valid and responsive to change if they are to yield an accurate evaluation of the patient's condition and progress. In the case of RC disorders, tools for measuring range of motion, muscle strength and scapular movement are generally used, along with self-report questionnaires and performance tests, to assess functional level, symptoms or quality of life. The measurement properties of these evaluation tools are discussed in this section of the report.

2.2.1 Research and analysis methodology

Bibliographic search

A systematic search for articles published before January 1, 2014 was conducted in three databases (PubMed, Embase and CINAHL) to identify literature on the subject. A hand search of additional articles was also performed.

Study inclusion criteria

Clinical measurement tools

To be included in the systematic reviews, the studies had to meet the following criteria: **(1)** the muscle strength or range of motion measures had to involve the shoulder in symptomatic patients (regardless of the disorder) or asymptomatic patients. We chose to include asymptomatic disorders in these systematic reviews because there would have been an insufficient number of articles otherwise; **(2)** the measurement tools included in the systematic reviews were the goniometer, inclinometer, manual muscle testing, stationary and hand-held dynamometers, and clinical tests for evaluating scapular position or movement; **(3)** the studies had to focus on the tools' measurement properties and contain analyses of their reliability, validity or responsiveness to change.

Self-report questionnaires, performance tests and mixed tools

(1) The first inclusion criterion for the studies concerned the population under study; the population (all or part) had to present with a RC disorder; **(2)** for inclusion in the systematic reviews, the studies had to focus on one of the following self-report questionnaires on the shoulder or upper extremities: Disabilities of the Arm, Shoulder and Hand (DASH) or its shortened version (QuickDASH); Upper Limb Functional Index (ULFI); Upper Extremity Functional Scale (UEFS); Upper Extremity Functional Index (UEFI); American Shoulder and Elbow Surgeon Score (ASES); Shoulder Pain and Disability Index (SPADI); Simple Shoulder Test (SST); Oxford Shoulder Score (OSS); Pennsylvania Shoulder Score (PSS); Rotator Cuff Quality of Life (RC-QOL); Western Ontario Rotator Cuff index (WORC); or on one of the following performance tests or mixed tools combining a questionnaire and performance tests: Constant-Murley Score (CMS); Functional Impairment Test-Head, and Neck/Shoulder/Arm (Fit-HaNSA); Functional Shoulder Elevation Test (FSET); Korean Shoulder Score (KSS); Simple Shoulder Endurance Test (SSET); and University of California – Los Angeles Shoulder Scale (UCLA). The investigation carried out in this knowledge review was limited to these

questionnaires because they are the most frequently used, and a sufficient amount of data on them has been published; **(3)** the studies had to present psychometric properties for one or more of these questionnaires.

Measurement properties of the tools

A reading of the included articles revealed that a vast amount of statistical data had been explored. However, to reduce the content of our review, only the measurement properties most pertinent from the clinical standpoint will be presented. The same measurement properties were extracted – reliability, validity and responsiveness to change – for the clinical measurement tools and self-report questionnaires. First, reliability refers to a tool's capacity to provide a stable measure free of random error.[66] It is usually quantified by Cohen's kappa coefficient or the intraclass correlation coefficient (ICC), and the minimal detectable change (MDC). Next, validity refers to the absence of systematic error in the measure; it evaluates whether the tool truly assesses what it is supposed to.[66] Several types of validity exist, but the one presented here is a type of construct validity, namely, discriminant validity. Lastly, responsiveness to change is the ability of a tool to assess clinically important change in a patient over time.[66] It can be quantified in terms of the minimal clinically important difference (MCID), effect size (ES) or standardized response mean (SRM).

Data extraction and assessment of the methodological quality of the studies

A data extraction form was developed in accordance with the recommendations of the Cochrane Collaboration. A first reader performed the extraction, which was then corroborated or completed by a second reader. Both readers assessed the methodological quality independently. The Critical Appraisal of Study Design for Psychometric Articles form,[67] designed for studies evaluating the psychometric properties of measurement tools, was used. This form contains 12 items (one item on the research question, five items on the study design, two on questionnaires and their application, three on statistical analyses and one on recommendations). Two points was awarded if the article included the aspects required for each item, one point if it partially satisfied the requirement, and no point if the aspect was either not covered at all or inadequately covered. The score was expressed as a number over 100 (low methodological quality: 0-49%, moderate: 50-74%, and high: 75-100%).

Statistical analysis

Comparable data were pooled and weighted averages (WAs) over all studies (weighted by sample size) were calculated for the ICC, MDC, ES and SRM.

2.2.2 Results – Clinical measurement tools

For the systematic reviews on clinical measurement tools, 107 articles were retained (24 articles for scapular movement and position, 34 for range of motion, and 49 for shoulder muscle strength). The methodological quality of each article was assessed. Expressed as percentages, the methodological quality of the articles ranged from 36% to 100%. The results for the range-of-motion measures will be presented first. These will be followed by the results for muscle strength, and lastly, by those for scapular movement and position. This section presents an update of a systematic review on the same subject.[68]

Range-of-motion measures (table 8)

Range-of-motion measures play an important role in clinical examinations of the shoulder. They support the diagnosis and help in assessing movement restrictions and determining a patient's progress relative to the initial deficits.[69] Range of motion can be measured using different tools, but goniometers and inclinometers are those most often used. This section presents the measurement properties of these tools for the following movements: flexion, abduction, internal rotation at 90° of shoulder abduction and external rotation (at 0° or 90° of shoulder abduction). The measures taken in sitting, lying, or standing position were combined because the results and conclusions were similar.

Flexion (sagittal plane): The goniometer and inclinometer show excellent intrarater reliability for **active flexion**, while interrater reliability varies from good to excellent. Both tools show good to excellent intra- and interrater reliability for **passive flexion**. The MDCs are shown in table 8.[70]

Abduction (frontal plane): For **active range of motion**, the goniometer and inclinometer show excellent ICCs for intrarater reliability, and good to excellent ICCs for interrater reliability. For **passive motion**, both tools show excellent intra- and interrater reliability. The MDCs are shown in table 8.[71-73]

Internal rotation at 90° of abduction: For **active measures**, the goniometer shows excellent intra- and good interrater reliability respectively. The inclinometer shows excellent intra- and interrater reliability. For **passive measures**, the goniometer shows excellent intra- and good interrater reliability respectively, whereas the goniometer shows ICCs that are mostly good. The MDCs are shown in table 8.

External rotation at 0° and 90° of abduction: For **active measures**, the goniometer shows excellent intra- and interrater reliability, while the inclinometer shows excellent and good reliability for the intra- and interrater measures respectively. For **passive range of motion**, intrarater reliability is excellent for the goniometer and good to excellent for the inclinometer. Interrater reliability varies from moderate to excellent for both tools. The MDCs are shown in table 8.

Table 8 – Intrarater reliability of goniometer (G) and inclinometer (I) for assessing active range of motion

			All subjects		Symptomatic subject		Asymptomatic subject	
			ICC	MDC 95 (°)	ICC	MDC 95 (°)	ICC	MDC 95 (°)
Range	Flexion	G	0.53-0.96	8	0.53-0.97	11	0.89-0.96	7
		I	0.79-0.78	21	0.80-0.98	28	0.75-0.95	14
Number of shoulders		G	164	34	81	11	103	23
		I	253	32	148	32	157	32
Number of studies		G	6	1	4	1	4	1
		I	8	1	6	1	5	1
Weighted average		G	0.90	8	0.80	11	0.84	7
		I	0.90	21	0.90	28	0.88	14
Range	ABD	G	0.58-0.98	14	0.58-0.97	14	0.89-0.98	14
		I	0.56-0.97	20	0.56-0.97	15	0.61-0.97	24
Number of shoulders		G	144	34	61	11	83	23
		I	143	32	83	32	92	32
Number of studies		G	5	1	3	1	3	1
		I	6	1	4	1	3	1
Weighted average		G	0.93	14	0.91	14	0.95	14
		I	0.89	20	0.91	15	0.83	24
Range	IR	G	0.60-0.96	12-18	0.67-0.96	14-19	0.60-0.95	11-16
		I	0.59-0.99	16	0.32-0.94	16	0.77-0.99	18
Number of shoulders		G	202	93	109	48	113	45
		I	193	32	103	32	122	32
Number of studies		G	6	2	4	2	5	2
		I	8	1	5	1	4	1
Weighted average		G	0.83	16	0.83	18	0.85	13.2
		I	0.93	16	0.81	16	0.90	18
Range	ER	G	0.65-0.98	14	0.65-0.97	14	0.86-0.98	14
		I	0.59-0.99	16	0.59-0.97	3	0.85-0.99	16
Number of shoulders		G	133	34	80	11	73	23
		I	193	32	51	41	142	32
Number of studies		G	5	1	4	1	3	1
		I	8	1	3	1	5	1
Weighted average		G	0.92	14	0.94	14	0.92	14
		I	0.93	16	0.92	3	0.94	16

Abbreviations: ICC: intraclass correlation coefficient; MDC (95): minimal detectable change (based on a confidence interval of 95%); G: goniometer; I: inclinometer; ABD: abduction; IR: internal rotation; ER: external rotation.

In summary, the universal goniometer and the inclinometer both have excellent intrarater reliability and moderate to excellent interrater reliability. The MDC values do not appear to favour one over the other. Values vary between 8° and 23° for active range of motion (all positions and all subjects combined) and between 3° and 21° for passive range of motion. However, no studies were found on responsiveness to change or on minimal clinically important difference (MCID) in measures of the shoulder's range of motion. Additional data are needed on the MDC to confirm the results obtained since, for the most part, those obtained were based on very small study samples.

Muscle strength

Muscle strength assessment is an important part of shoulder assessment as the scapulothoracic and scapulohumeral muscles are essential to shoulder mobility and stability.[74] Shoulder muscle strength can be estimated by means of a manual muscle assessment or measured more objectively with a hand-held dynamometer, which allows maximal voluntary strength to be measured during an isometric contraction, or with a stationary dynamometer, which allows maximal voluntary isometric strength and maximal isokinetic strength to be measured.

Manual muscle assessment

Although manual muscle assessment is widely performed in the clinical setting, few studies have investigated its validity and reliability. Its validity has in fact been questioned, since only 20% of maximal strength is needed to obtain a score of 4 (out of 5).[75] Only one study was found on the intra- and interrater reliability of manual muscle assessment of the shoulder.[76] The results obtained showed good to excellent intrarater reliability (for flexion, ICC: 0.76; for external rotation; ICC: 0.86), and moderate to good interrater reliability (flexion, ICC: 0.72; external rotation, ICC: 0.55).

Hand-held dynamometer

For hand-held dynamometers, the validity of maximal isometric strength testing was investigated using a stationary dynamometer as the reference test. However, the various studies presented conflicting results, with correlations ranging from low to high ($0.28 \leq r \leq 0.94$).[74,77,78] The main differences between these studies concerned the brand of device used, populations studied and muscle groups tested. That said, the only study that analyzed symptomatic subjects obtained the strongest correlation ($r \geq 0.81$, n = 38).[74] Generally speaking, intrarater reliability (for the flexors, abductors, and internal and external rotators of the shoulder) varied from good to excellent, with weighted averages (WAs) greater than 0.86 (WA of the ICCs: 0.87 to 0.97). Interrater reliability, which was assessed for the same muscle groups, also varied from good to excellent, with weighted averages greater than 0.83 (WA of the ICCs: 0.83 to 0.93). The intrarater MDC was assessed at 31.5 N (newton) in only one study (n = 20).[79] Lastly, one study examined responsiveness to change of the measures of strength obtained using a hand-held dynamometer in a population with a variety of shoulder disorders (n = 107). The authors obtained a moderate responsiveness to change (SRM: 0.6) for the abductors, flexors and external rotator muscles of the shoulder.[79]

Stationary dynamometer

For flexion, abduction and external rotation, the weighted averages for intrarater reliability varied from good to excellent (WA of the ICCs excellent for flexion and abduction: 0.86 to 0.94;

good for external rotation: 0.75 to 0.76). Only one study examined interrater reliability for abduction; it obtained an ICC of 0.93 for symptomatic subjects (n = 17).[80] Another study compared maximal concentric strength and maximal eccentric strength during internal and external rotation, showing excellent test-retest reliability for both types of contraction (concentric: ICC: 0.88 to 0.94, eccentric: ICC: 0.87 to 0.94).[81] The MDC for maximal isokinetic strength was assessed for internal and external rotations and for abduction and adduction. It varied between 21% and 43% (n = 20),[82] which limits its use for measuring the effectiveness of a treatment. More studies are needed to confirm this assertion.

Overall, intra- and interrater reliability of both hand-held and stationary dynamometers varied from good to excellent, thus supporting their use in the clinical setting. Additional studies are needed, however, particularly on the MDC and responsiveness to change. Lastly, manual muscle assessment should also be performed, bearing in mind its limitations.

Scapular movement and position

Scapular movements are essential to shoulder mobility as more than 35% of its mobility depends on the scapulothoracic joint (combined movement of the sternoclavicular and acromioclavicular joints) during elevation movements. In fact, the posterior tilting and external rotation of the scapula create adequate space under the acromion for the RC to pass underneath during arm elevation, thus preventing an abutment phenomenon, and secondarily, RC disorders. Certain alterations in scapular position and movement may serve as an indication of a shoulder disorder for clinicians.[83,84] Three types of clinical measures can be used for evaluation purposes: linear measures, angular measures and qualitative observation of movement.

Linear measures of scapular position (*table 9*)

The Lateral Scapular Slide Test (LSST) is used to evaluate scapular position relative to a fixed point on the spinal column with the arms in three positions: arms in resting position, hands on the hips, and arms at 90° of abduction.[85-87] The measure is taken bilaterally between the inferior angle of the scapula and the thoracic spinous process on the same horizontal plane. It has been established that, to be positive, a bilateral difference of more than 1.5 cm must be observed.[88] The validity of this threshold is questioned, however, by a study which shows such asymmetry (≥1.5 cm) in 73% of asymptomatic athletes for at least one of the LSST positions.[89] Moreover, by using this threshold, the Sn of the LSST is limited (between 4 and 50%) for discriminating between individuals with a shoulder disorder and those without. Its reliability results are nonetheless acceptable. The weighted averages for intra- and interrater reliability of the LSST are excellent and moderate respectively.

The Lateral Displacement of the Scapula (LDS) test evaluates the protraction of the scapula in resting position. It is measured as the distance between the posterior angle, the acromion or the base of the scapular spine, and the spinous process.[85,86,90] Intrarater reliability is excellent while interrater reliability is good. A method for measuring scapular depression (the vertical distance) has also been proposed, and that is, quantifying the vertical distance between the posterior angle of the acromion and the C7 spinous process.[85] Both the intra- and interrater reliability for this measurement are good in asymptomatic subjects.[85] Lastly, normalized scapular position is used to determine the normalized horizontal distance between the scapula and the spinal column. The intra- and interrater reliability for this measure are good and moderate respectively. The LSST

and LDS showed a strong correlation ($r > 0.70$) with measures taken radiographically,[91] while no association was shown between linear measures of scapular position and the self-report questionnaires on pain and functional limitations.[90] The linear measures presented here should not therefore be used as a test for discriminating between patients with these problems and those without, but rather as a tool for clinically measuring scapular position.

Table 9 – Intrarater reliability of linear measures of scapular position and movement

		All subjects	Symptomatic subject	Asymptomatic subject
		ICC	ICC	ICC
Range	LSST	0.52 – 0.97	0.52 – 0.96	0.75 – 0.95
Number of shoulders	LSST	426	215	263
Number of studies	LSST	10	4	10
Weighted average	LSST	0.85	0.82	0.84
Range	LDS	0.77 – 0.98	0.91 – 0.97	0.77 – 0.98
Number of shoulders	LDS	293	45	248
Number of studies	LDS	7	1	7
Weighted average	LDS	0.91	0.95	0.90
Range	Normalized scapular position	0.34 - 0.97	0.75 - 0.82	0.34 - 0.97
Number of shoulders	Normalized scapular position	235	90	190
Number of studies	Normalized scapular position	5	1	5
Weighted average	Normalized scapular position	0.72	0.79	0.70
Range	Vertical distance	0.72 - 0.78	-	0.72 - 0.78
Number of shoulders	Vertical distance	30	-	30
Number of studies	Vertical distance	1	-	1
Weighted average	Vertical distance	0.75	-	0.75

Abbreviations: ICC: intraclass correlation coefficient; LSST: lateral scapular slide test; LDS: Lateral displacement of the scapula.

Angular measures of scapular position

Two methods were proposed for evaluating the angular position of the scapula in external rotation (or upward rotation) in static position.[91,92] To carry them out, the inferior angle of the scapula and spinous process located on the same horizontal plane as the root of the scapular spine and as the inferior angle of the scapula must be palpated and marked. The main differences between the two methods used in these studies pertain to the mathematical formulas and instruments used to measure the distances between the marks. Conflicting results emerge from the two studies that assessed the reliability of these measures. In the case of the first method, intra- and interrater reliability were excellent for asymptomatic subjects (ICC: 0.97). Moreover, this measure showed strong correlation with a radiographic measure ($r \geq 0.88$).[92] In the second method (n = 15), interrater reliability varied from moderate to excellent (ICC: 0.64 and 0.84), while its correlation with a radiographic measure varied from low to moderate (r: 0.43 and 0.60).[91]

Different types of inclinometers can be used to measure the external rotation of the scapula in static position. Johnson et al.[93] examined a digital inclinometer attached to the shoulder bone in subjects with or without a shoulder disorder (n = 39) and found excellent intrarater reliability (ICC: 0.89 to 0.96). Construct validity was assessed by comparing the static or dynamic measures obtained with a digital inclinometer (with the arm at rest, and at 60°, 90° and 120° of arm elevation) and a three-dimensional motion analysis system. A higher correlation between the inclinometer and motion analysis system (*r*: from 0.74 to 0.92) was obtained for static measures than for dynamic measures (*r*: from 0.59 to 0.73).

Two other studies investigated measures of external rotation of the scapula obtained using an inclinometer, in subjects with or without shoulder disorders (n = 116).[86,94] The inclinometer was manually positioned along the scapular spine (with the arm at rest, or at 0°, 45°, 90° or 135° of elevation).[94] Both studies showed excellent intrarater reliability (ICC > 0.90; standard error of measurement [SEM]: 0.8 – 1.0°). Lastly, Lewis et al.[86] studied measures of scapular tilt, with the arm at rest, using an inclinometer. The device was placed between the root of the scapular spine and the inferior angle of the scapula. The study showed excellent intrarater reliability for this measure (ICC > 0.90; SEM: 0.8 – 1.0°). All these studies suggest good reliability for tools measuring scapular position and movement. However, the validity and clinical usefulness of most of these measures has yet to be established.

Qualitative observation of scapular movement
Kilber et al.[95] developed an observation-based clinical test that allows scapular movement to be assessed during arm elevation. Three abnormal movement patterns were described (prominence of the inferomedial angle, medial border or superior scapular border). This method yielded low to moderate intra- and interrater reliability (intra-: *k*: 0.59 and 0.49; inter-: *k*: 0.42 and 0.31; [n = 26]).

Another test, the Scapular Dyskinesis Test (SDT) has also been proposed for evaluating scapular movement through observation.[96,97] When the patient elevates his or her arm with a dead weight in hand, the clinician rates the movement as being (a) normal, (b) slightly abnormal, or (c) abnormal. Performed on healthy athletes, this test yielded moderate interrater agreement (k_w: 0.48 and 0.61).[96] Discriminant validity was evaluated by means of a three-dimensional (3D) measure of scapular movement.[97] A 3D analysis revealed that the subjects with “abnormal” scapular movement presented external rotation of the scapula and more limited clavicular elevation along with greater clavicular protraction ($p<0.05$) compared to subjects with normal movement. Other studies on symptomatic subjects are needed, however, before this test can be recommended for use.

2.2.3 Discussion and clinical recommendations – Clinical measurement tools

Based on this knowledge review, most of the clinical measurement tools presented in these systematic reviews appear to show acceptable reliability. That said, little data exist on their responsiveness to change, which limits their usefulness for evaluating the effects of an intervention. If combined with other assessment tools (such as self-report questionnaires),

clinical measurement tools still appear to have an important role to play. The following conclusions were reached:

- Measures of range of motion using the goniometer and inclinometer, as well as those of muscle strength using hand-held and stationary dynamometers, are reliable and should be used to quantify range of motion and strength. However, the responsiveness of these measures to change has yet to be confirmed.
- Priority should be given to measuring isometric strength using a hand-held dynamometer rather than to manual muscle assessment, which is not valid.
- Linear measures of the scapula should not be used to discriminate between injured and uninjured shoulders. Their use should be limited to characterizing scapular position.
- The reliability and validity of qualitative observation of scapular movement needs to be confirmed in symptomatic subjects before it can be recommended for use.

2.2.4 Results – Self-report questionnaires

A total of 714 articles were retrieved as a result of the bibliographic search. After a reading of the titles, abstracts or articles themselves, 120 were included in the systematic review. The results of the assessment of the methodological quality of the studies ranged from 33% to 96%. The complete results for this part of the knowledge review were published in the journal *Disability and Rehabilitation*.[98]

Reliability of the questionnaires

Test-retest reliability (*table 10*)

Test-retest reliability for all included questionnaires ranged from good to excellent, with excellent weighted averages for the ICCs ($0.89 \leq ICC \leq 0.96$). The weighted average of the MDCs (90%) was established for each questionnaire except the RC-QoL. They varied between 6.4% and 20.8% of the total score.

Validity of the questionnaires

Content validity

Generally speaking, all the included questionnaires were seen by the patients or committees of experts as clear and pertinent to the evaluation of shoulder conditions.

Construct discriminant validity

This validity was evaluated for seven of the questionnaires included in the review. The ASES distinguishes between various levels of functional limitation.[99] The SST, DASH, UEFI and UEFS questionnaires differentiate patients on the basis of their level of compensation.[100-102] The DASH discerns various levels of limitations.[103,104] Lastly, the WORC discriminates between patients based on the severity of their symptoms[100] and patients whose disorders may or may not affect their work.[105]

Responsiveness to change

Effect size (ES) and standardized response mean (*SRM*) (*table 11*)

All the included questionnaires showed high responsiveness to change for populations suffering from a RC disorder, with the weighted means for the SRM and the ES all above 0.92.

Minimal clinically important difference (*MCID*) (*table 12*)

This type of responsiveness to change was explored for most of the questionnaires (SPADI, DASH, *Quick*DASH, SST, ASES, OSS, PSS, UEFI and WORC) administered to patients with a RC disorder. It varied from 8% to 20.3% of the total score.

Table 10 – Test-retest reliability of self-report questionnaires

	Questionnaire specific to RC disorders		Questionnaire specific to shoulder					Questionnaire specific to upper extremities				
	RC-QOL	**WORC**	**SST (/12)**	**OSS (/48)**	**PSS**	**ASES**	**SPADI**	**UEFI (/80)**	**UEFS (/80)**	**ULFI**	**DASH**	***Quick*DASH**
ICC												
Range	0.94	0.84 – 0.99	0.86 – 0.99	0.83 – 0.99	0.94	0.75 – 0.96	0.66 – 0.96	0.85 – 0.95	0.92 – 0.96	0.93 – 0.98	0.77 – 0.98	0.82 – 0.94
Number of shoulders	22	500	314	294	40	444	730	81	65	132	841	528
Number of studies	1	8	3	5	1	9	13	2	2	4	15	7
Weighted average	0.94	0.91	0.89	0.95	0.94	0.90	0.90	0.90	0.95	0.96	0.88	0.91
MDC (90%)												
Range	–	5.8 – 16.1	2.4 – 2.8	6.5	12.1	6.4	16.3 – 18.1	9.1	12.9	7.9 – 10.5	6.6 – 13.7	12.9 – 14.4
Number of shoulders	–	185	116	79	40	63	242	43	22	174	237	121
Number of studies	–	3	2	1	1	1	3	1	1	4	4	2
Weighted average (% du score total)	–	12.8 (12.8%)	2.5 (20.8%)	6.5 (10.8%)	12.1 (12.8%)	6.4 (6.4%)	15 (15.0%)	9.1 (11.4%)	12.9 (16.1%)	8.4 (8.4%)	11.7 (11.7%)	14.0 (14.0%)
MDC (95%)												
Range	–	7.1 – 19.1	2.8 – 3.3	7.7	–	–	13.8 – 19.4	17.6	15.3	12.5	7.9 – 16.3	17.1
Number of shoulders	–	185	116	79	–	–	164	38	22	28	129	91
Number of studies	–	3	2	1	–	–	2	1	1	1	2	1
Weighted average	–	15.2	3	7.7	–	–	16.0	17.6	15.3	12.5	13.8	17.1

Table 11 – Responsiveness to change of self-report questionnaires

	Questionnaire specific to RC disorders		Questionnaire specific to shoulder					Questionnaire specific to upper extremities				
	RC-QOL	WORC	SST (/12)	OSS (/48)	PSS	ASES	SPADI	UEFI (/80)	UEFS (/80)	ULFI	DASH	*Quick*DASH
ES – all subjects												
Range	–	0.45 – 1.37	0.50 – 2.23	0.96	1.01	0.77 – 1.87	1.06 – 2.10	–	0.93	–	0.44 – 1.19	0.74 – 1.40
Number of shoulders	–	128	813	110	109	905	801	–	91	–	915	77
Number of studies	–	4	4	1	1	5	9	–	2	–	9	3
Weighted average	–	1.12	0.95	0.96	1.01	1.42	1.41	–	0.95	–	1.07	1.14
ES – improved subjects												
Range	–	0.92	2.23	–	–	1.39	1.21 – 1.64	–	–	–	1.06 – 1.41	–
Number of shoulders	–	20	94	–	–	5	281	–	–	–	449	–
Number of studies	–	1	1	–	–	1	3	–	–	–	3	–
Weighted average	–	0.92	2.23	–	–	1.39	1.36	–	–	–	1.16	–
SRM – all subjects												
Range	1.43	0.48 – 2.02	0.47 – 1.79	1.32 – 1.52	1.27	0.54 – 1.59	1.08 – 1.81	1.54	1.20 – 1.28	1.13	0.38 – 1.76	0.46 – 1.40
Number of shoulders	41	591	968	144	109	1301	858	41	115	16	1244	369
Number of studies	1	9	7	2	1	10	10	1	3	1	16	5
Weighted average	1.43	1.42	0.93	1.41	1.27	1.18	1.41	1.54	1.25	1.13	1.17	0.93
SRM – improved subjects												
Range	–	0.76 – 2.02	0.87 – 1.79	1.32 – 1.52	–	0.93	1.08 – 2.19	–	–	–	1.08 – 1.76	1.08
Number of shoulders	–	250	213	144	–	33	631	–	–	–	657	121
Number of studies	–	3	3	2	–	1	9	–	–	–	6	1
Weighted average	–	1.60	1.62	1.41	–	0.93	1.34	–	–	–	1.45	1.08

Table 12 – Minimal clinically important difference obtained with self-report questionnaires

Questionnaire	Study	MCID	ROC AUC	Sensitivity	Specificity
SPADI (/100)	Ekeberg 2010	20	0.92	0.80	0.91
	Schmitt 2004	13.2	–	–	–
	Paul 2004	8	0.87		
DASH (/100)	Lehman 2010	20	0.67	0.52	0.79
	Schmitt 2004	10.2	–	–	–
	Franchigoni 2013	10.83	0.87	0.82	0.74
	Van Kampen 2013	12.4	–	–	–
***Quick*DASH (/100)**	Mintken 2009	8	0.82	0.80	0.77
	Franchigoni 2013	15.91	0.86	0.79	0.75
	Van Kampen 2013	13.4	–	–	–
SST (/12)	Tashjian 2010	2.05 (17.08%)	–	–	–
		2.33 (19.41%)	–	–	–
	Van Kampen 2013	2.2	–	–	–
ASES (/100)	Michener 2002	6.4	–	0.91	0.75
	Tashjian 2010	12.01	–	–	–
		16.92	–	–	–
		16.72	–	–	–
OSS (/48)	Ekeberg 2010	4.0 (8.3%)	0.87	0.87	0.71
	Van Kampen 2013	6.0 (10%)	–	–	–
		4.7 (7.8%)	–	–	–
UEFI (/80)	Hefford 2012	8.5 (10.6%)	0.88	0.88	0.79
	Lehman 2010	15 (18.75%)	-	0.45	0.77
WORC (/100)	Ekeberg 2010	269 (12.80%)	0.95	0.85	0.97

Abbreviations: MCID: minimal clinically important difference; ROC AUC: area under the curve (ROC curve: receiver operating characteristic).
*The questionnaires have a total score of 100 points; otherwise, the score is specified.

2.2.5 Discussion and clinical recommendations – Self-report questionnaires

While some questionnaires have been the focus of less study (notably the PSS, RC-QoL and UEFS), data on reliability, validity and responsiveness to change were collected on all the included questionnaires. This review showed that they all have good measurement properties and can be used for patients with a RC disorder. While each of the questionnaires is appropriate for clinical use, some of them stand out. First, the DASH and the *Quick*DASH are the questionnaires most often analyzed with this population, and the fact that they have been translated into 40 different languages indicates a degree of consensus regarding their quality. Next, the ASES and ULFI questionnaires generated the smallest absolute errors of measurement (MDC under 10% of the total score), which can be taken into account when evaluating changes in a patient's condition over time. Lastly, the WORC appears particularly responsive to change for patients with a RC disorder.

The clinician's decision to use one questionnaire or another may also be informed by the construct measured by the questionnaires. For example, some questionnaires include more details about symptoms, while others concentrate more on evaluating functional capacities. The clinician must make sure that the questionnaire selected evaluates the characteristics desired. Lastly, when time is an important factor as in a clinical setting, the time required to complete the questionnaire may guide the clinician's choice. In such a context, questionnaires that take longer to complete, such as the WORC and the DASH (10 to 15 minutes), will require organizing care in such a way as to allow the patient to answer the questionnaire before actual evaluation by the health professional. In clinical situations, however, which do not allow for questionnaire completion prior to evaluation, questionnaires involving a shorter response time (such as the *Quick*DASH) offer a worthwhile option.

Regarding the language barrier, few questionnaires have been translated into French or adapted and validated with the Québec population, which poses an additional obstacle for practitioners. In-house versions of several questionnaires may exist, but based on the document searches performed, only the DASH, *Quick*DASH and WORC have been validated in the Québec population.[106,107]

Clinical recommendations:

- All the questionnaires presented in this review are valid, reliable and responsive to change and can be used with confidence in the clinical setting.
- Questionnaires are the clinical evaluation tools with the highest responsiveness to change.
- The DASH questionnaire is available in various languages (40), including French. These different versions may be useful in multicultural contexts.
- The ASES and ULFI may be preferable for re-evaluation purposes; however, no French versions are currently available.
- The WORC is particularly responsive to change and has been validated in French.
- Given their measurement properties, questionnaires should be incorporated into the clinical evaluation of patients with a RC disorder to assess the progression in their symptoms and their functional status.

2.2.6 Results – Performance tests and mixed tools combining questionnaires and performance tests

The following mixed tools and performance tests are presented in this section: Constant-Murley Score (CMS), Korean Shoulder Score (KSS) and University of California – Los Angeles Shoulder Scale (UCLA) for mixed tools; and the Functional Impairment Test-Head, Neck/Shoulder/Arm (Fit-HaNSA), Functional Shoulder Elevation Test (FSET) and Simple Shoulder Endurance Test (SSET) for performance tests.

Mixed tools have two components: a self-report questionnaire and an objective performance measurement component such as muscle strength and range of motion (the KSS, CMS and UCLA). With the exception of the CMS, a smaller number of studies focused on the measurement properties of these tools. Other tools such as the FIT-HaNSA, SSET and FSET consist solely of functional capacity tests. The FIT-HaNSA includes three tasks used to evaluate the limitations of the functional capacities related to disorders of the upper extremities and neck. During the test, the patients must reach and place an object at different heights, including above their head, for a total of five minutes and at a set pace.[108,109] In the SSET, patients sit in front of a bolt box to which 63 bolts have been attached. They raise their arm to 45° in order to reach a rod where they must screw in and unscrew a nut. At 2, 4 and 6 minutes after the start of the exercise, a weight of 0.45 kg is added to the patient's wrist. The test ends when the patient can no longer perform the task.[110] Lastly, in the FSET, patients must lift 5% of their own weight on the scapular plane up to shoulder height and rate the degree of discomfort experienced.[111] No functional capacity test related to work performance capacity was found during the database searches.

Validity of performance tests

Only one study examined the discriminant validity of the FIT-HaNSA.[108] The researchers observed that this test differentiated between patients with a severe disorder (waiting for surgery) and those with a mild to moderate shoulder disorder, as well as those with a healthy shoulder.

Reliability of mixed tools and performance tests

For the CMS, Blonna et al. explored intrarater reliability in a population with a variety of shoulder disorders, including RC tendinopathy, (n = 103).[112] The ICCs were excellent (ICC from 0.80 to 0.97). This study also presented an MDC of 1.96 for the CMS. Kumta et al. and MacDermid et al. showed excellent reliability for the FIT-HaNSA (ICC respectively of 0.97 [95% CI: 0.95 – 0.98] in symptomatic subjects [n = 34] and of 0.98 [95% CI: 0.90 – 0.99] [n = 10] in asymptomatic subjects).[108,109] Excellent reliability was also reported for the FIT-HaNSA (ICC $\geq$ 0.96) in subjects with or without a disorder (n = 10).[109,113] The SSET showed moderate test-retest reliability (r = 0.59 to 0.60),[76] which can limit its clinical use, especially during patient follow-up.[68,110] Lastly, the FSET showed excellent intra- and interrater reliability (n = 46) (k_w = $\geq$0.80).[111]

Responsiveness to change of mixed tools

Data on responsiveness to change were collected for the UCLA, CMS and KSS. First, three studies explored the UCLA's responsiveness to change.[114-116] The first reported an SRM of 1.66

and an ES of 1.17 in subjects who improved (RC disorders) (n = 20).[114] The study by Oh et al. showed an SRM of 0.93 and an ES of 1.15 in symptomatic subjects (CR disorders, SLAP and SIS injuries) (n = 97).[116] In addition, O'Connor et al. obtained an SRM of 1.69 at a six-month follow-up, for subjects with an SIS (n = 28), again for the UCLA.[115]

For the CMS, an SRM of 1.16 and an ES of 0.89 were observed in patients with a RC disorder (n = 34).[117] In a study by Noorani et al., an ES of 0.34 was obtained for symptomatic subjects (various disorders, including several involving the RC) (n = 34).[118] Lastly, the SRM and ES were calculated at 0.58 and 0.57 in subjects with a RC disorder (n = 99).[116]

The KSS showed excellent responsiveness to change, with both an ES and SRM above 1.3.[119] No study was found on the responsiveness to change of performance tests.

2.2.7 Recommendations – Performance tests and mixed tools

Performance tests and mixed tools show good reliability. However, they have been the subject of little study in populations with a RC disorder. Since their measurement properties have been subject to less analysis than those of the self-report questionnaires discussed above, the latter should be favoured for the time being.

3. EFFECTIVENESS OF THERAPEUTIC INTERVENTIONS FOR WORKERS OR ADULTS WITH ROTATOR CUFF TENDINOPATHIES OR TEARS

3.1 Methodological approach used for the knowledge review

The following two approaches were used for the knowledge review in order to put forward recommendations regarding the effectiveness of medical and rehabilitation interventions for workers or adults in the labour market who have a RC tendinopathy or tear:

- When no systematic review had been published on the effectiveness of an intervention of interest, or a systematic review or meta-analysis had been published more than five years ago and a large number of randomized clinical trials (RCTs) had been published since, we performed a new systematic review. The recommendations presented here are therefore based on this new systematic knowledge review.
- When the evaluation of an intervention's effectiveness was the subject of at least one recent systematic review (published within the last five years) and a limited number of RCTs had been published since, the recent systematic review(s) and the results of the new RCTs were used to make recommendations. The methodological quality of the systematic reviews and the new RCTs was also evaluated.

3.1.1 Synthesis of scientific data based on new systematic review or meta-analysis

Bibliographic search

Four databases were searched to identify the pertinent literature: PubMed, CiNAHL, PeDRO, and Embase. Descriptors (such as *Mesh terms* on PubMed) related to the pathology and intervention of interest were used. Based on the results of the bibliographic search, all the article titles and abstracts were reviewed and a first selection was made by two independent readers. The complete articles were then evaluated, and once consensus was reached by the two readers, the articles with content deemed to be relevant were retained.

Study inclusion criteria

The following inclusion criteria were applied: (1) an experimental RCT-type design; (2) a study population composed of workers or adults with one of the following diagnoses: tendinopathy of the RC, subacromial bursitis, bicipital tendinopathy, and a partial or full-thickness tear of the RC; the section on RC tendinopathies includes partial RC tears since they can be considered a clinical entity similar to tendinopathy; studies in which the population had different types of painful shoulder disorders were retained if it could be determined that the majority of the study participants had a RC disorder; (3) one of the interventions under study was of interest; 4) the publications were written in either French or English.

Data extraction and assessment of risk of bias of the studies

A data extraction form was developed in accordance with the recommendations of the Cochrane Collaboration.[120] One reader extracted the data, which were then verified by a second reader. Next, the risk-of-bias assessment was performed using the Cochrane Collaboration tool. This

tool assesses the risks of bias under six domains. The first domain assesses the randomization method, while the second concerns the allocation of groups. The third assesses whether the participants, practitioners administering the treatments and assessors have been effectively blinded. The fourth domain assesses whether all the data have been properly reported, while the fifth domain verifies whether the protocol had been previously registered or published. Lastly, the sixth domain assesses other possible sources of bias. In our study, a score of 2 was assigned for each domain for which the criterion was met, a score of 1 was assigned when the criterion was partially met and a score of 0 was assigned when the criterion was not met or the information was not present. Two readers scored the articles, and the final results were obtained after consensus.[120]

Results synthesis

The studies that used similar outcome measures were identified and quantitatively pooled in a meta-analysis whenever possible. A qualitative synthesis of the results of the studies was performed if the results could not be pooled quantitatively. Fixed-effect or random-effect models were used for the meta-analyses. Weighted mean differences were calculated when the outcome measures were similar, while standardized mean differences (SMDs) were calculated when the outcome measures and scales were different. The criterion for allowing study data to be pooled included level of heterogeneity (I^2), which was set at a maximum of 60%, and a Chi-squared test for heterogeneity under the threshold of statistical significance ($p<0.10$) as recommended by the Cochrane Collaboration.[120] The strength of the evidence (low, moderate or high) is described for each intervention in the Recommendation section of this review, as proposed by the Agency for Healthcare Research and Quality.[121]

3.1.2 Synthesis of scientific evidence based on previously published systematic reviews

Bibliographic search

Four databases were consulted for the bibliographic search: PubMed, CiNAHL, PeDRO and Embase. Based on the results obtained, all the titles and abstracts of the systematic reviews were reviewed, and an initial selection was made by two readers. The systematic reviews selected were then read, and following consensus, those meeting the inclusion criteria were included in the knowledge review. A bibliographic search similar to that for the synthesis of the RCTs was also performed to determine the number of articles published since the most recent systematic review. These RCTs were included in the knowledge review if they met the inclusion criteria.

Study inclusion criteria

The following inclusion criteria were applied to the systematic reviews: (1) a systematic review-type design with or without meta-analysis; (2) published within the last five years; (3) study population composed of workers or adults with a RC tendinopathy or full-thickness tear; (4) RCT-type articles comparing a medical or rehabilitation intervention of interest to any other type of intervention; (5) written in either French or English.

Data extraction and assessment of risk of bias of the systematic reviews

The risk of bias of the systematic reviews was assessed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[122] Composed of 27 items, this tool assesses

the quality of the presentation of the results of systematic reviews and meta-analyses. The majority of its items pertain to aspects of methodology (risk of bias) and aspects of results synthesis (presentation, interpretation and data pooling). A scoring system was adapted for the purpose of obtaining an overall methodological score using this tool. A score of 2 was assigned to each item if the criterion was adequately met, a score of 1 if the criterion was partially met and a score of 0 if the criterion was either not met or not reported. The systematic reviews were assessed by two readers, who then met to compare their scores, reach a consensus on the score for each item and assess the overall quality of the systematic review based on the total score, but also on the magnitude of the methodological biases. A high total score for a systematic review means high methodological quality.

3.2 Conservative pharmacological treatments for rotator cuff tendinopathies

3.2.1 Efficacy of nonsteroidal anti-inflammatory drugs (NSAIDs) in treatment of rotator cuff tendinopathies

Of the pharmacological interventions used clinically to treat tendon injuries, oral nonsteroidal anti-inflammatory drugs (NSAIDs) are frequently administered. NSAIDs can be divided into two main categories: nonspecific NSAID inhibitors of cyclooxygenase (NS COX) and specific NSAID inhibitors of cyclooxygenase-2 (COX-2). No systematic review or meta-analysis on the efficacy of oral NSAIDs for the treatment of RC tendinopathies has been published recently. A systematic review with a meta-analysis was therefore performed. The complete results have been published in the *Journal of Rehabilitation Medicine*.[123]

Based on the bibliographic search, 12 RCTs were included in the systematic review.[124-135] The mean methodological score for the studies was 53.6% ± 8.8, representing low-quality methodology. The study populations included adults, but no study included workers specifically. The majority of the participants (in seven studies out of 12) had had a RC tendinopathy for under six weeks.[125,129,131-135] The studies had low statistical power that did not allow the detection of differences between therapeutic approaches in terms of the incidence of side effects. The main methodological biases of the evaluated studies included the following: participant adherence to drug regime not evaluated (7 of 12 studies)[125,129,131-135] and the use of non-validated or non-standardized evaluation tools (5 of 12 studies).[127-130,134] It is important to note that the follow-ups were short term (fewer than four weeks, with the exception of one study, which had a six-week follow-up) and that no long-term effect of the intervention on the variables under study and on possible side effects of using NSAIDs was reported. Figures 10, 11 and 12 show the results of the studies that were quantitatively pooled in meta-analyses according to different comparators, outcome measures and follow-up duration. Table 13 presents a synthesis of the evidence based on the quantitative or qualitative assessment of studies on the use of oral NSAIDs in the treatment of RC tendinopathies.

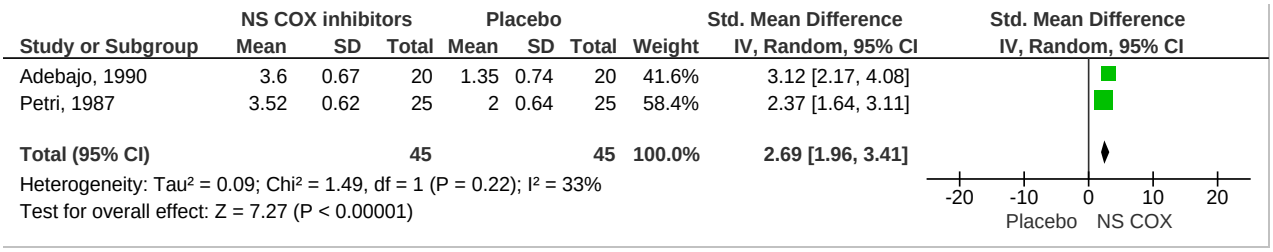


Figure 10 – Pooled data from studies comparing oral, non-selective NSAIDs to placebo, for pain-reduction effects evaluated on a visual analogue scale (re-evaluation: 2 weeks after start of intervention)

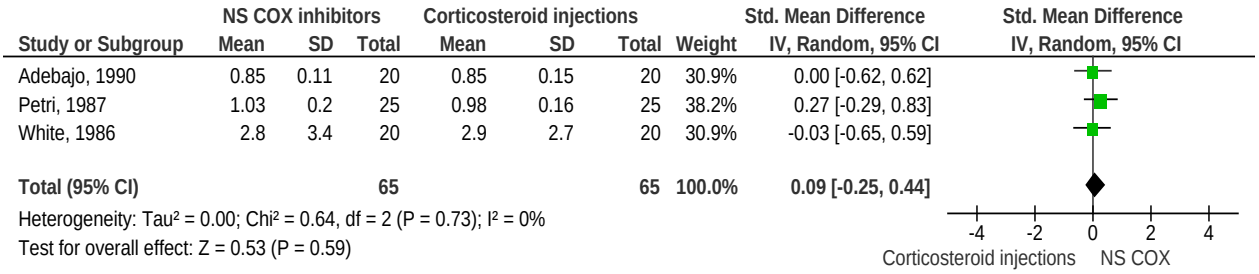
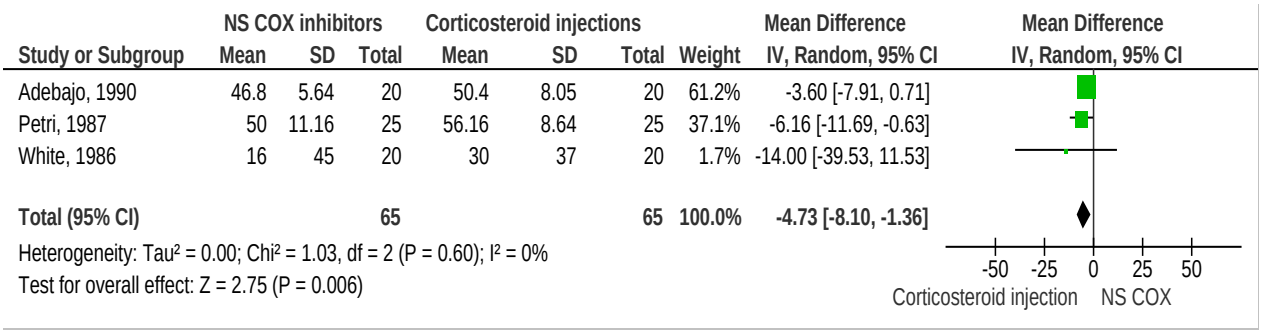


Figure 11 – Pooled data from studies comparing oral, non-selective NSAIDs to subacromial corticosteroid injections, for effects on functional limitations (re-evaluation: 3 to 4 weeks after start of intervention)



NS COX: Oral, non-selective nonsteroidal anti-inflammatory drugs; STD mean difference: Difference in standardized means of the treatment groups; Mean difference: Difference in the means of the treatment groups; SD: Standard deviation; Total: Number of participants per group; Weight: Weight assigned to each study; IV: Independent variable; Random: Random-effect model; 95% CI: Confidence interval; Test for overall effect: Test evaluating the overall effect of the treatment.

Figure 12 – Pooled data from studies comparing oral, non-selective NSAIDs to corticosteroid injections, for effects on shoulder range of motion during abduction (re-evaluation: 3 to 4 weeks after start of intervention)

Table 13 – Efficacy of anti-inflammatory drugs in treatment of RC tendinopathies

Treatment	Number of studies	Number of participants and duration of follow-up	Combined treatment effect	Recommendation	Level of evidence
NS NSAIDs/Placebo [124,126,129,130]	4	n = 120 14 days	**Pain** MD 10-cm VAS: 2.7 (95% CI: 2.0 to 3.4) favours NS NSAIDs **Shoulder function and range of motion** No pooled data	NS NSAIDs are effective for short-term pain alleviation. No scientific evidence supporting the short-term effectiveness of NS NSAIDs in improving shoulder function or range of motion.	Low to moderate
NS NSAIDs/selective NSAIDs [125,134]	3	n = 608 14 days	No pooled data	Both classes of NSAIDs show comparable efficacy in alleviating pain and improving ranges of motion. The incidence of side effects and drug tolerance appear similar for both classes of NSAIDs.	Low to moderate
NS NSAIDs/corticosteroid injections [124,130,133]	3	n = 200 3 to 4 weeks	**Pain** No pooled data **Function** SMD: 0.09 (95% CI: -0.25 to 0.44) **Range of motion in abduction** MD: -4.73˚ (95% CI: -8.1 to -1.4) favours corticosteroid injections	Oral NS NSAIDs and subacromial corticosteroid injections have similar efficacy in reducing pain and improving function. Subacromial corticosteroid injections bring about a greater improvement in range of motion during abduction; however, the difference is not clinically important when compared to NS NSAIDs.	Moderate

NS NSAIDs: Oral, non-specific nonsteroidal anti-inflammatory drugs; MD: Mean difference; VAS: Visual analogue scale; 95% CI: Confidence interval at 95%; SMD: Standardized mean difference.

3.2.2 Clinical recommendations

- Low- to moderate-level scientific evidence shows that taking oral NSAIDs reduces pain in the short term for people suffering from RC tendinopathies. However, based on the documented studies, the improvement in functional status obtained with this treatment remains undetermined.
- Low- to moderate-level evidence shows that both classes of NSAIDs (NS and COX-2) have the same efficacy in terms of pain reduction and gains in range of motion. The incidence of gastro-intestinal side effects also appears to be the same for both classes of NSAIDs when this medication is taken on a short-term basis.
- The long-term efficacy of NSAIDs for participants with a RC tendinopathy has not, however, been studied. Clinicians should therefore bear in mind that no study has investigated the potentially harmful side effects on the physiological integrity of the

tendon, whether gastro-intestinal or systemic, associated with taking NSAIDs over the long term.

3.2.3 Efficacy of subacromial corticosteroid injections in treatment of rotator cuff tendinopathies

Corticosteroid injections are a method used to alleviate pain caused by musculoskeletal disorders, including RC tendinopathy. Two meta-analyses were recently published on the efficacy of these injections in adults with a RC tendinopathy.[136,137] However, no study evaluating their specific efficacy in workers was identified the literature. The methodological quality of the included systematic reviews was good, with a score of 87% obtained for the review by Buchbinder et al. (2009) and 85.2% for the review by Coombes et al. (2010). The systematic review by Buchbinder et al. (a review done for the Cochrane Collaboration) (2009) included 10 studies (n = 524).[136] The authors concluded that corticosteroid injections may have a short-term treatment effect in terms of alleviating pain (n = 90; measured on a visual analogue scale [VAS] at four weeks) compared to a placebo with an SMD of 0.83 (95% CI: 0.39 to 1.3), but this treatment effect did not persist in the medium and long terms. Regarding improvement in function, the authors reported the injections as having a low treatment effect at the four-week follow-up (n = 90), with an SMD of 0.63 measured on a VAS (95% CI: 0.2 to 1.1).

The other meta-analysis by Coombes et al. (2010) included in this knowledge review included 13 studies, eight of which were not part of the meta-analysis done by Buchbinder et al. (2009).[137] The results showed that when the effects of the injections were compared to those of a placebo for a RC tendinopathy, a short-term decrease in pain was observed (n = 177) (SMD: 0.68 [95% CI: 0.35 to 1.0]), as well as an improvement in functional level (n = 177) (SMD: 0.62 [95% CI: 0.29 to 0.95]). Moreover, when the effects of the injections were compared to those of oral NSAIDs, no significant difference was observed in the short term between the two types of treatment in terms of either pain (n = 145) (SMD: 0.17 [95% CI: -0.19 to 0.53]) or function (n = 115) (SMD: -0.03 [95% CI: -0.44 to 0.39]). Compared to different physiotherapy methods, the injections were not superior with respect to improving functional level in the medium term (n = 256) (SMD: 0.00 [95% CI: -0.58 to 0.58]).

The authors of these reviews did not recommend the use of corticosteroid injections in adults with a RC tendinopathy. Both reviews recognized their short-term treatment effect when compared to that of a placebo. However, the treatment effect did not persist in the long term and was no better than that of taking oral NSAIDs.[137] Both reviews also recognized the lack of quality studies that take into account certain potentially confounding factors (site of the injection, use of radiology guidance), study designs evaluating the efficacy of injections combined with other interventions, lack of long-term follow-up of participants and lack of evaluation of the potentially harmful effects of injections on the mechanical integrity of the RC tendons.

Since these two systematic reviews came out, four RCTs with a mean methodological score of 80.0% ± 10.6 have been published.[138-141] One of these RCTs (n = 159) showed injections to have a treatment effect of short-term pain alleviation when compared to that of a placebo.[141] However, this effect disappeared in the long term. In the three other studies (n = 381), corticosteroid injections were not superior in terms of reducing pain or improving functional level when

compared to other interventions, such as a therapeutic exercise program, acupuncture or NSAID injections.[138-140]

3.2.4 Clinical recommendations

- High-level evidence shows that, compared to a placebo, corticosteroid injections have a low effect in terms of alleviating pain and improving functional level and that this low effect does not persist in the medium or long terms.
- High-level evidence also reveals that, compared to oral NSAIDs, corticosteroid injections do not demonstrate superior efficacy in alleviating pain and improving functional level.
- Given that corticosteroid injections have not demonstrated superior efficacy to that of other, less invasive types of interventions, these injections should not be retained as the initial treatment for adults with RC tendinopathies.

3.3 Rehabilitation treatments for rotator cuff tendinopathies

3.3.1 Effectiveness of therapeutic exercise program for workers with rotator cuff tendinopathies

Therapeutic exercises are a frequently recommended treatment modality during management of a RC tendinopathy. Their effectiveness has been studied in several systematic reviews over the past few years, including the most recent one published in 2012.[142-144] The exercise programs studied were recognized as effective in reducing pain and improving both functional level and quality of life for the general population, when compared to a control group, a placebo and other interventions.[144] One of these reviews included 16 studies (n = 1,162) and concluded that there was high-level evidence showing that an exercise program reduced pain and improved functional level in the short term.[141] The study further concluded that there was moderate-level evidence supporting the assertion that exercises lead to a short-term improvement in well-being and a long-term improvement in functional level. The authors also performed meta-analyses, concluding that there were low effects in terms of improving RC strength in the short term, with an SMD of -0.46 (95% CI: -0.76 to 0.16) p=0.003. A low effect was also observed in terms of improving long-term functional level in the long term, with an SMD of -0.31 (95% CI: -0.57 to 0.04), p=0.02.[141]

None of these reviews presented conclusions specific to worker populations. However, several of the published RCTs included workers. A systematic review was therefore performed to assess the effectiveness of exercises in worker populations with a RC tendinopathy because exercise programs could potentially, for this population, include exercises specifically related to their work tasks. Also, the treatment effect could conceivably be different.

Eleven studies were included in this systematic review, with a mean methodological score of 54.4% ± 18.8.[145-155] Only two studies had a methodological score of 75% or more. Regarding methodological biases, two studies did not evaluate participant adherence to the exercise program[145,147] and only three provided detailed descriptions of the exercises proposed in the program.[148,151,152] It was not possible, therefore, to perform a meta-analysis.

Although they differed across the studies, the exercise programs were designed primarily to use and strengthen the shoulder muscles, correct movement patterns and increase joint mobility. One study presented an exercise program specific to the shoulder (motor control, mobility and strengthening exercises) and more general exercises (cardiovascular exercises).[154] Only one study included a program of exercises specific to occupational tasks, by recreating the actions and tasks performed by the participating workers.[147]

The results of three studies of low to moderate methodological quality (n = 252) support the effectiveness of exercises in reducing workers' pain and improving their functional level, compared to that of a placebo or a control intervention.[145,151,152] One study (n = 60) of moderate methodological quality reported a significant and clinically important difference (p=0.001) in pain reduction at rest, with a mean difference of 1.8 ± 3.2 measured on a 10-cm VAS for the group doing exercises and a mean difference of 0.3 ± 4.1 for the control group. A significant and clinically important difference was also observed in pain reduction during movement (p=0.001). Regarding functional status, two studies (n = 185) reported the beneficial effect of exercises.[143,149] One study (n = 125) of low methodological quality presented results regarding the participants' return to work.[145] The group that did exercises showed the greatest improvement in terms of work absenteeism, with an initial proportion of 43% of absences related to shoulder problems, which dropped to 20% after 2.5 years. By comparison, the proportion of absences went from 55% to 36% for the placebo group; however, no statistical test was performed to verify the robustness of these data.

Exercises demonstrate a long-term effectiveness similar to that of surgery (acromioplasty) with regard to pain and function in workers with a RC tendinopathy. These results are based on two studies of low and moderate methodological quality (n = 209).[145,149] One of the two studies (n = 84) observed no significant difference between the two interventions from a functional point of view. The difference was evaluated using the Constant-Murley Score, which gave a mean difference of 23.0% (95% CI: 16.9 to 29.1) for the group that did exercises and of 18.8% (95% CI: 11.5 to 26.1) for the group that had had surgery, one year after the start of the intervention. The same study also presented the proportions of participants back at work within four to eight years of the interventions: 53% of the group that did exercises and 51% of the group that had had surgery (p=0.88).[149] In the other study, it was reported that the proportion of work absences related to shoulder problems dropped more in participants who had done an exercise program (43% to 20%) than in participants who had undergone surgery (53% to 41%). However, no statistical test was performed on these data to verify their validity.[145]

One study (n = 94) of low methodological quality compared a rehabilitation program carried out in a clinic to a program carried out in the workplace.[147] The group that did the clinic-based program benefited from muscle mobilization and strengthening exercises as well as conditioning exercises specific to their work tasks. The group that did the workplace-based program received (in addition to these interventions) training on shoulder biomechanics and workplace ergonomics, as well as the assistance of a counsellor who maintained contact with the workplace. After evaluating the participants' functional improvement with the SPADI, the authors reported a statistically significant difference of 13.8 ± 20.3 for the group doing the clinic-based exercise program and of 21 ± 11 for the group doing the workplace-based program (p=0.03), but this intergroup difference was below the minimal clinically important threshold of the SPADI.[147]

However, the proportion of participants returning to work at the end of the four-week intervention was statistically higher in the group that did the workplace-based program (72%) than in the group that did the clinic-based program (38%) (p=0.001).

Another study of low methodological quality (n = 61) evaluated a program of high-dose and low-dose exercise therapy conducted with workers.[154] A statistically significant and clinically important difference in pain alleviation was reported in the patients who had done the higher-dose exercise therapy. The mean decrease, measured on a 10-cm VAS, was -4.3 (95% CI: -3.7 to -5.0) for those who did the high-dose exercise therapy program and -1.8 (95% CI: -0.7 to -2.7) for the group that did the low-dose program. Regarding functional level, evaluated using the Shoulder Rating Questionnaire (SRQ), the group that did the higher-dose exercise therapy showed a mean improvement of 29.2% (95% CI: 21.7 to 36.0). This was statistically higher than that of the group doing the low-dose program, for whom there was a mean improvement of 7.3% (95% CI: 0.2 to 19.7). The participants in the high-dose program returned to work an average of 4.1 days faster than those in the low-dose program, a difference that was statistically significant ($p<0.05$).

Two studies (n = 189) of moderate methodological quality sought to compare an exercise program to other techniques, such as extracorporeal shock wave treatment (ESWT) and naturopathic interventions including acupuncture, natural supplements and diet (including recommendations aimed at reducing alcohol consumption and increasing intake of certain foods such as fish, fruit, vegetables, nuts, and whole grains).[148,155] Nonetheless, given the small number of studies comparing these same interventions, no conclusion can be drawn in their regard. Table 14 provides a synthesis of the effectiveness results of a therapeutic exercise program in workers.

Table 14 – Effectiveness of therapeutic exercise program in treatment of RC tendinopathies in workers

Treatment	N (study)	n (participants) and duration of follow-up	Combined treatment effect	Recommendation	Level of evidence
Exercise program/placebo or control intervention [145,151,152]	3	n = 252 2 to 6 months	No pooled data	An exercise program is effective in alleviating pain and improving function.	Moderate
Exercise program/surgery[1] [45,149]	2	n = 209 6 months to 8 years	No pooled data	An exercise program has similar effectiveness to that of surgery in alleviating pain and improving function. Regarding the proportion of people returning to work, both interventions show similar effectiveness.	Low to moderate
High-dose and low-dose exercise program[147,154]	2	n = 155 1 to 6 months	No pooled data	A high-dose exercise program appears to be superior in reducing pain and improving function. A workplace-based exercise program appears to be superior to a clinic-based program in terms of improving function and the proportion of people returning to work.	Low

Clinical recommendations

- Moderate-level data show that a therapeutic exercise program is an effective means of reducing pain, improving functional level and returning people to work, in the treatment of RC tendinopathies.
- This review does not allow for any formal conclusions regarding the type, duration or intensity of exercises to be performed to obtain an optimal treatment effect or whether the addition of other interventions carried out in the workplace offers greater effectiveness. More good-quality methodological studies are needed.
- Low- to moderate-level data suggest that a therapeutic exercise program gives similar results to those obtained with surgery in terms of reducing pain and improving functional level in a worker population. Moreover, the two interventions demonstrate similar effectiveness, judging from the proportion of workers who return to their jobs after the interventions.

3.3.2 Effectiveness of manual therapy in treatment of rotator cuff tendinopathies

Manual therapy is a treatment modality used in rehabilitation. It is administered in the form of joint mobilization and manipulation and soft tissue manipulation. Two systematic reviews were recently published on its effectiveness in the treatment of RC tendinopathies. Their authors reported being unable to express an opinion on the effectiveness of manual therapy when it is administered either alone or in conjunction with another intervention, and that further studies were needed.[156,157] Several randomized clinical trials have been carried out since the publication of these two reviews. A systematic review with a meta-analysis was therefore performed. This study was published in the *Journal of Orthopaedic & Sports Physical Therapy*.[158]

A total of 21 studies were included in the review, with a mean methodological score of 52.7% ±17.0.[159-179] None of them dealt specifically with worker populations. The meta-analyses performed for different comparators, outcome measures and follow-up durations are presented in figures 13 to 15. Table 15 provides a synthesis of the evidence based on the quantitative or qualitative evaluation of the studies on the use of manual therapy in the treatment of RC tendinopathies.

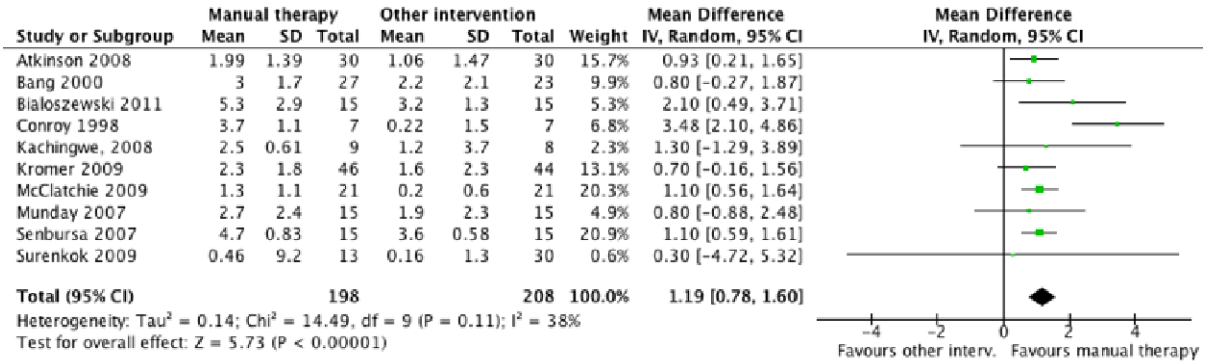


Figure 13 – Pooled data from studies comparing manual therapy administered alone or with other interventions to other types of interventions, for pain-reduction effects

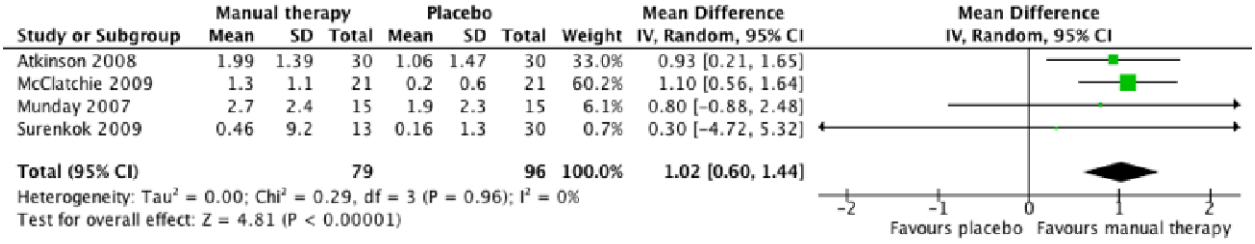
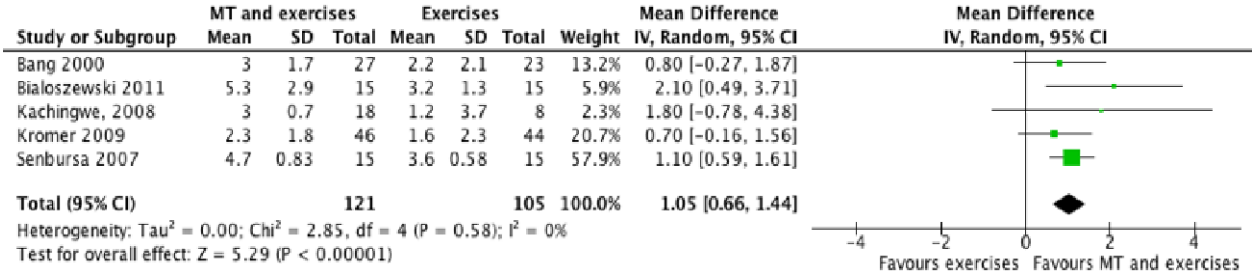


Figure 14 – Pooled data from studies comparing manual therapy to placebo intervention, for pain-reduction effects



MT: Manual therapy; Mean difference: Difference in the means for the treatment groups; SD: Standard deviation; Total: Number of participants per group; Weight: Weight assigned to each study; IV: Independent variable; Random: Random-effects model ; 95% CI: Confidence interval at 95%; Heterogeneity: Heterogeneity of the meta-analysis; Test for overall effect: Test evaluating the overall treatment effect; Favours other interv.: Treatment effect favours other interventions; Favours manual therapy: Treatment effect favours manual therapy, Favours MT and exercises: Treatment effect favours manual therapy with exercises.

Figure 15 – Pooled data comparing manual therapy plus exercise program to exercise program alone, for pain-reduction effects

Table 15 – Effectiveness of manual therapy in treatment of RC tendinopathies

Treatment	N (study)	n (participant)	Combined treatment effect	Recommendation	Level of evidence
Manual therapy administered alone or with other interventions/Any other intervention [159,160,164,166,170-174,176]	10	n = 406	**Pain** Mean difference measured on 10-cm VAS: 1.2 (95% CI: 0.78 to 1.6) favours manual therapy*	Manual therapy administered alone or with other interventions is not superior to other types of interventions.	Low to moderate
Manual therapy alone/placebo [159,172,173,176]	4	n = 175	**Pain** Mean difference measured on 10-cm VAS: 1.0 (95% CI: 0.60 to 1.4) favours manual therapy*	Manual therapy is not effective in reducing pain or improving function.	Low
	2	n = 99	**Range of motion, function, and muscle strength** No pooled data	The diverging results do not allow for any conclusion about the effectiveness of manual therapy in terms of range of motion and muscle strength.	
Manual therapy combined with an exercise program or a multimodal intervention that includes exercises [160,164,170,171,174]	5	n = 226	**Pain** Mean difference measured on 10-cm VAS: 1.0 (95% CI: 0.66 to 1.4) favours manual therapy with exercises*	The use of manual therapy in conjunction with an exercise program or multimodal intervention yields no additional benefits in terms of reducing pain and improving function or range of motion.	Low
	2	n = 88	**Range of motion** Mean difference: -6.1° (95% CI: -20.6 to 8.4)		
Manual therapy combined with other interventions/multimodal interventions [163,165,167-169,179]	6	n = 414	**Pain, function, and range of motion** No pooled data	The diverging results of the studies do not allow for any conclusion about the additional effectiveness of adding manual therapy to multimodal interventions.	

VAS: Visual analogue scale; 95% CI: Confidence interval at 95%;
* This difference is not considered clinically important.

Clinical recommendations

- Low- to moderate-level evidence suggests that manual therapy administered alone or with other modalities such as exercises is not effective in reducing pain or improving functional level.
- Further studies of better methodological quality are needed to confirm the trends observed in the current literature.

3.3.3 Effectiveness of taping in treatment of rotator cuff tendinopathies

Taping is an intervention modality used to treat RC tendinopathies. There are two types: kinesiotaping (KT) and non-elastic taping (NET). Their use is recommended to improve the subject's posture, particularly scapular positioning, or to normalize glenohumeral and scapulothoracic movements in subjects with a RC tendinopathy. As no systematic review evaluating the effectiveness of both types of taping for RC tendinopathy was found, a systematic review with meta-analysis was performed.

Nine studies were included in the review. Their mean methodological quality was 54.1%±11.3; however, only one of them obtained a score of more than 69%.[167,180-187] The participants in three studies were informed of the type of intervention they were undergoing.[182,183,186] No study included a worker population specifically.

Only one study (n = 60) of low methodological quality sought to compare NET to placebo taping.[182] In terms of reducing pain at the end of range of motion immediately following the intervention, measured on a 10-cm VAS, no significant difference was observed between the interventions in either flexion, -0.4 (99% CI: -1.1 to 0.3), or abduction, -0.4 (99% CI: -1.0 to 0.2). However, NET may be more effective in improving range of motion in active flexion, 16.2° (99% CI: 7.9 to 24.4), and abduction in the scapular plane, 14.7° (99% CI: 5.7 to 23.6), as well as in bringing about postural changes ($p<0.01$). No evaluation of functional level was reported in this study.

In three studies (n = 99) of low methodological quality, the addition of NET to multimodal interventions was compared to multimodal interventions including both a rehabilitation program and mobilization with movement.[181,183,186] Given the contradictory results obtained in these studies, no conclusion can be drawn.

Three studies (n = 89) of low to moderate methodological quality compared the effectiveness of KT to placebo taping.[180,184,187] A meta-analysis including two of these studies (n = 72) of moderate methodological quality was performed to evaluate pain-free range of motion in flexion (mean difference: 8.7˚[95% CI: 8.0 to 9.5]) (figure 16), in abduction (mean difference: 10.3˚[95% CI: 9.1 to 11.4]) (figure 17) and in abduction in the scapular plane (mean difference: 7.6˚[95% CI: 6.3 to 8.9˚]) (figure 18).[184,187] These results corroborate the effectiveness of KT, and the changes observed are considered clinically important (effect size >0.9). In terms of function, the results of the various studies are contradictory, so no conclusion can be drawn. Table 16 presents a summary of the results.

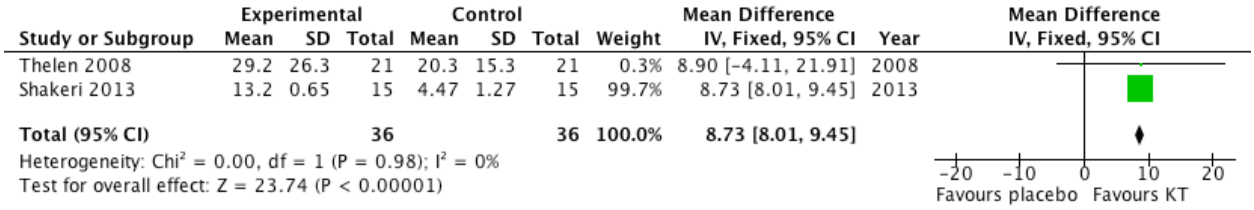


Figure 16 – Pooled data from studies comparing kinesiotaping to placebo taping, for change in pain-free range of motion during flexion

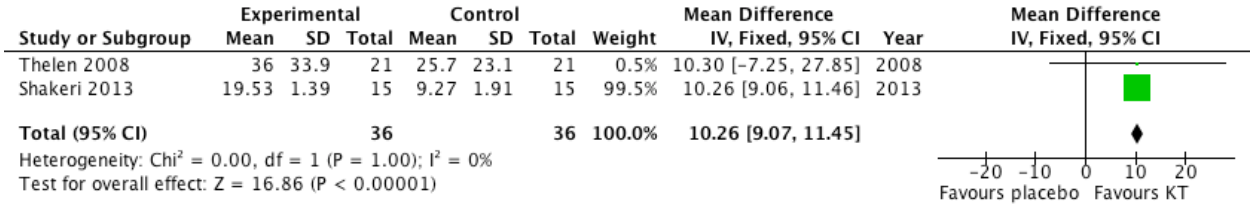
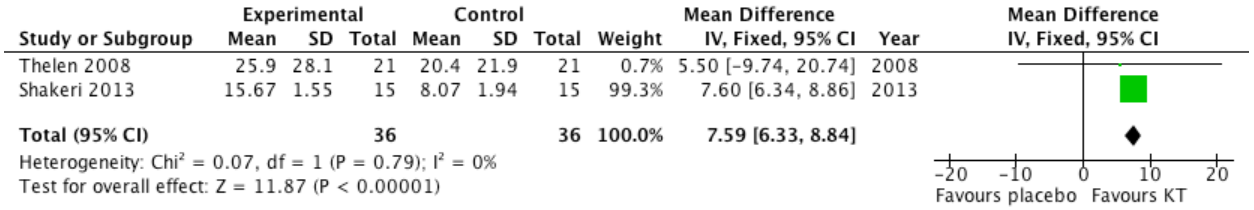


Figure 17 – Pooled data from studies comparing kinesiotaping to placebo taping, for change in pain-free range of motion during abduction



Experimental: Experimental group using kinesiotaping; Control: Control group; Mean difference: Difference in the means of the treatment groups; SD: Standard deviation; Total: Number of participants per group; Weight: Weight assigned to each study; IV: Independent variable; Fixed: Fixed-effect model; 95% CI: Confidence interval at 95%; Year: Year of the study; Heterogeneity: Heterogeneity of the meta-analysis; Test for overall effect: Test evaluating the overall treatment effect; Favours placebo: Treatment effect favours placebo group; Favours KT: Treatment effect favours kinesiotaping group.

Figure 18 – Pooled data from studies comparing kinesiotaping to placebo taping, for change in pain-free range of motion during abduction in scapular plane

Table 16 – Effectiveness of taping in treatment of RC tendinopathies

Treatment	N (study)	n (participants) and duration of follow-up	Combined treatment effect	Recommendation	Level of evidence
NET taping/ placebo taping [182]	1	n = 60 Immediate follow-up	No pooled data	NET does not appear to be more effective in reducing pain at the end of range of motion. NET appears to be more effective in improving active range of motion.	Low
NET taping/ multimodal interventions [181,183,186]	3	n = 99 1 to 6 weeks	No pooled data	The contradictory results do not allow for a conclusion as to the superiority of one intervention over the other.	
KT/placebo taping [180,184,187]	3	n = 89 Immediate follow-up at 6 days	**Pain-free range of motion** Flexion: mean difference 8.7˚ (95% CI: 8.0 to 9.5) Abduction: mean difference: 10.3˚ (95% CI: 9.1 to 11.5) Abduction in the scapular plane: mean difference 7.6˚ (95% CI: 6.3 to 8.9˚)	Kinesiotaping appears to be more effective in improving pain-free range of motion during flexion and abduction.	Low

NET: Non-elastic taping; KT: Kinesiotaping; 95% CI: Confidence interval at 95%.

Clinical recommendations

- There is insufficient scientific evidence to reach any formal conclusion about the clinical effectiveness of either KT or NET in the treatment of RC tendinopathies, given the low methodological quality of the studies and the heterogeneity of the results.
- Low-level evidence suggests that NET is not effective in reducing pain at the end of range of motion, but that it could improve active range of motion in patients with a RC tendinopathy.
- Low-level evidence suggests that NET is effective in improving pain-free range of motion; however, it has no effect in terms of reducing overall pain or improving the functional level of participants with a RC tendinopathy.
- Additional studies of better methodological quality are needed to reach a conclusion as to the effectiveness of taping in the treatment of RC tendinopathies.

3.3.4 Effectiveness of transcutaneous electrical nerve stimulation (TENS) in treatment of rotator cuff tendinopathies

Transcutaneous electrical nerve stimulation (TENS) is an electrotherapy modality that can be used by clinicians to alleviate pain related to a RC tendinopathy. Its action mechanism is based on Melzack and Wall's gate control theory, which suggests that the stimulation of large

nocioceptive Aß fibres by the electrical current of TENS promotes the peripheral inhibition of pain in the dorsal horn of the spinal cord.[188] Although widely used in clinical settings, no systematic review investigates its effectiveness in adults with a RC tendinopathy. A systematic review was therefore performed for this knowledge review.

A total of six studies were retained for this systematic review. They obtained a mean methodological score of 48.8% ± 15.6, signifying low overall methodological quality.[189-194] Only two of the studies obtained a score higher than or equal to 60%,[190,192] and only one had a design in which participants were blinded to their allocations.[192] No study specifically mentioned whether the subjects were workers or not.

The aim of one study of moderate methodological quality (n = 20) was to compare the use of TENS to that of a placebo. The authors observed an analgesic effect immediately after application of TENS, with a decrease of 1.7 cm between the groups evaluated for pain, which was measured on a 10-cm VAS (no statistical comparison between the groups).[192] However, there was no medium- or long-term follow-up. Another study of moderate methodological quality (n = 40) compared the effect of corticosteroid injections to that of TENS.[190] Regarding nocturnal pain measured at the 12-week follow-up, the group that had received the injections perceived a greater reduction in pain (mean difference on a 10-cm VAS: 3.7 ± 2.1) than the group that had a TENS treatment (mean difference: 2.2 ± 1.7); this difference was statistically significant ($p< 0.05$) and clinically important. In terms of pain during movement, the group that had received injections was statistically superior (mean difference on a 10-cm VAS: 5.4 cm ± 1.8) to the group that had had a TENS treatment (mean difference on a 10-cm VAS: 2.2 cm ± 1.7, $p<0.05$), but the difference observed was below the clinically important threshold.[190] The authors evaluated quality of life using the Short Form 36 (SF-36), and a significant difference was observed in the bodily pain subscale scores in favour of the group that had had the injections ($p< 0.05$). When a TENS treatment was compared to therapeutic ultrasound, the data were contradictory.[191,194] One study (n = 50) reported TENS as being more effective than therapeutic ultrasound in reducing pain (mean difference of 10 cm on a 10-cm VAS for the TENS group compared to a mean difference of 8.5 cm for the ultrasound group, $p<0.001$), while another study observed no significant short-term differences between the two groups ($p=0.94$). Table 17 presents a synthesis of the results concerning the effectiveness of TENS in the treatment of RC tendinopathies.

Table 17 – Effectiveness of TENS in treatment of rotator cuff tendinopathies

Treatment	N (study)	n (participants) and duration of follow-up	Combined treatment effect	Recommendation	Level of evidence
TENS/placebo	1	n = 20 Immediate follow-up	No pooled data	No recommendation can be made.	
TENS/ therapeutic ultrasound	2	n = 79 4 weeks	No pooled data	The contradictory results do not allow for any conclusion about the efficacy of these interventions.	
TENS/ corticosteroid injections	1	n = 40 3 months	No pooled data	No conclusion can be reached regarding this comparison.	

Clinical recommendations

- No recommendation can be made based on the current literature. Additional scientific evidence is needed for recommendations to be made about the effectiveness of TENS in the treatment of RC tendinopathies.

3.3.5 Effectiveness of therapeutic ultrasound in treatment of rotator cuff tendinopathies

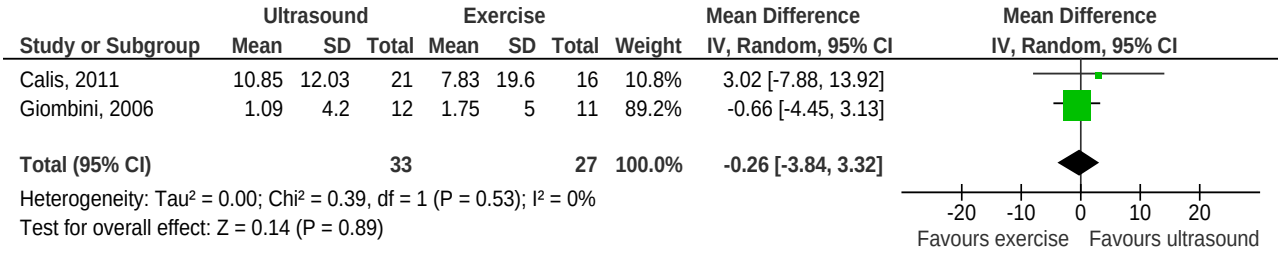
Therapeutic ultrasound is an electrophysiological modality used to treat RC tendinopathies. Rarely used alone, it is administered as part of a treatment plan including other interventions aimed at reducing pain and restoring functional status. The therapeutic effects reported are decreased inflammation and improved elastic properties of the soft tissues.[195] The energy produced by ultrasound may be absorbed mostly by those tissues having the greatest proportion of collagen, which would make therapeutic ultrasound an ideal intervention for the treatment of tendinopathies.[196] As no systematic review evaluating the effectiveness of ultrasound in treating RC tendinopathies has been published, a systematic review with meta-analysis was performed. This study was published in *Physical Therapy in Sport.*[197]

Based on the bibliographic search, 11 RCTs with a mean methodological score of 50%±15.6, (indicating low methodological quality) were retained.[161,191,194,198-205] Only two of the studies had a methodological score higher than 60%.[198,203] The majority of the studies (8 of 11) had a short-term follow-up (2 to 10 weeks).[161,191,194,199,200,203-205] None of them included a worker population specifically.

Compared to a placebo treatment or a control intervention (advice offered about the pathology), the results of two studies of low methodological quality (n = 108) showed that therapeutic ultrasound was not effective in reducing pain or improving functional level.[202,204] Three studies (n = 310) of varying methodological quality (two low quality and one high quality) found that adding ultrasound to an exercise program did not yield additional benefits when compared to an exercise program alone in terms of reducing pain or improving functional level (meta-analysis), evaluated using the Constant-Murley Score (CMS; figure 19).[198-200]

Three studies (n = 142) of low to moderate methodological quality compared therapeutic ultrasound to the use of laser. They found that laser treatment may be more effective than ultrasound in reducing pain.[199,203,204]

Three studies (n = 162) of low methodological quality compared the use of therapeutic ultrasound to other types of interventions (acupuncture, hyperthermia or massage).[161,200,201] Therapeutic ultrasound was found not to be superior to these interventions in terms of reducing pain or improving functional level and range of motion. Table 18 presents a synthesis of the results.



Mean difference: Difference in the means of the treatment groups; Total: number of participants per group; Weight: Weight attributed to each study; IV: Independent variable; Random: Random-effects model; 95% CI: Confidence interval at 95%; Heterogeneity: Heterogeneity of the meta-analysis; Test for overall effect: Test evaluating the overall treatment effect; Favours exercise: Treatment effect favours the group doing exercises; Favours ultrasound: Treatment effect favours the group doing ultrasound and exercises.

Figure 19 – Pooled data from studies comparing therapeutic ultrasound plus exercise program to exercise program alone, for improvement in function, measured using Constant-Murley Score (re-evaluation: 2 to 4 weeks after start of intervention)

Table 18 – Effectiveness of therapeutic ultrasound in treatment of RC tendinopathies

Treatment	N (study)	n (participants) and duration of follow-up	Combined treatment effect	Recommendation	Level of evidence
Ultrasound/ placebo or advice [202,204]	2	n = 108 3 weeks to 1 year	No pooled data	Ultrasound is not superior to a placebo or advice in terms of reducing pain and improving function.	Low
Ultrasound/laser [199,203,204]	3	n = 158 2 to 3 weeks	No pooled data	Laser may be superior to ultrasound in reducing pain.	Low
Ultrasound with exercise program/ exercise program alone [198-200]	3	n = 310 2 weeks to 6 months	**Pain** No pooled data **Function** Mean difference evaluated using the CMS (%): -0.3 (95% CI -3.8 to 3.3)	The addition of ultrasound to an exercise program is not superior to an exercise program alone in terms of reducing pain and improving function.	Low

CMS: Constant-Murley Score; 95% CI: Confidence interval at 95%.

Recommendations

- In light of the low-level evidence, therapeutic ultrasound administered alone or as part of a multimodal intervention in patients with a RC tendinopathy does not appear to be effective. Additional studies of high methodological quality are needed to reach any definitive conclusion about the effectiveness of therapeutic ultrasound.

3.3.6 Effectiveness of laser in treatment of rotator cuff tendinopathies

Laser is a physical modality often used to treat RC tendinopathies. Studies conducted on animals suggest that it has anti-inflammatory and fibroblast activation properties that appear to lead collagen production in the tendon.[206,207] However, few studies have been published on the effectiveness of laser in treating adults with RC tendinopathies, and no recent systematic review evaluating its effectiveness in this population was found. A systematic review with meta-analysis was therefore performed.

Based on the bibliographic search, 13 RCTs were included in this review.[126,199,203,204,208-216] The mean methodological score of the studies was 66.4%±10.0, representing moderate methodological quality. The majority of the participants suffered from a chronic RC tendinopathy (10 studies of 13).[126,199,203,204,209-211,214-216] In addition, the majority of the studies had short-term follow-up, and only three of them did follow-up after eight weeks or more.[209,213,215] Nine studies used the parameters recommended by the World Laser Therapy Association.[217] No study specifically evaluated the effectiveness of laser in treating workers.

Figures 20 to 24 present a summary of the study results that could be pooled quantitatively in meta-analyses by different comparators, for the outcome measures pertaining to pain, functional level and range of motion. Table 19 presents a synthesis of the evidence based on the quantitative or qualitative evaluation of the studies on laser use in the treatment of RC tendinopathies.

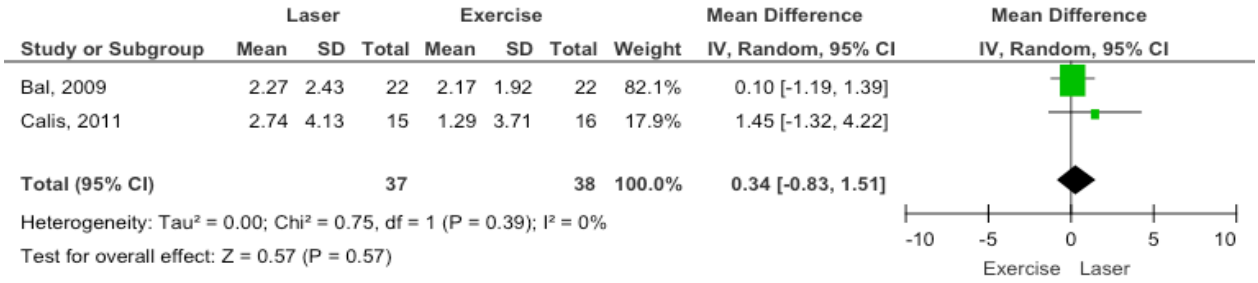


Figure 20 – Pooled data from studies comparing use of laser to exercise program, for nocturnal pain reduction, measured on 10-cm visual analogue scale (re-evaluation: 2 weeks after start of intervention)

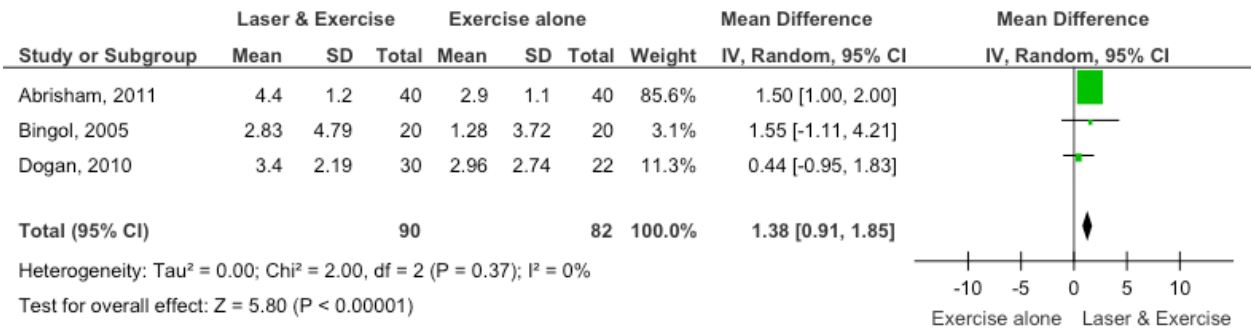


Figure 21 – Pooled data from studies comparing use of laser plus exercise program to exercise program alone, for pain reduction, measured on 10-cm visual analogue scale (re-evaluation: 2 to 3 weeks after start of intervention)

Figure 22 – Pooled data from studies comparing use of laser plus exercise program to exercise program alone, for nocturnal pain reduction, measured on 10-cm visual analogue scale

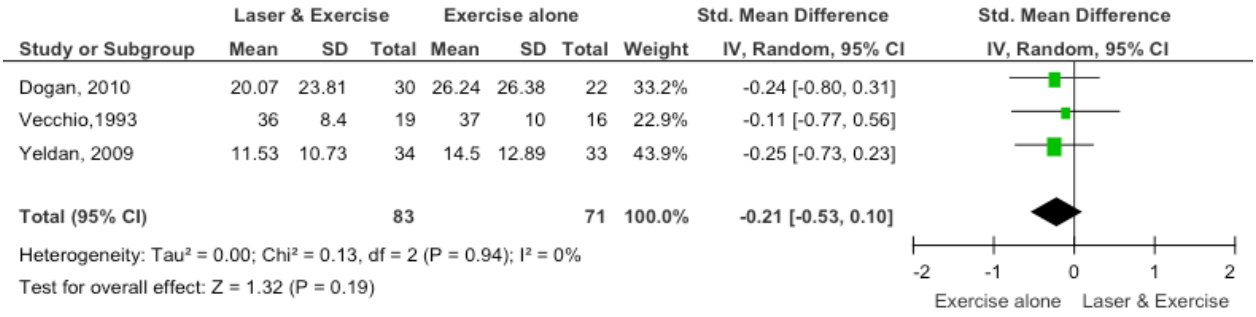
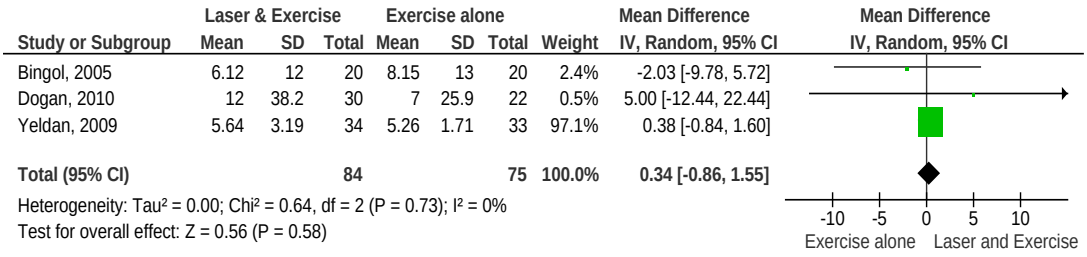
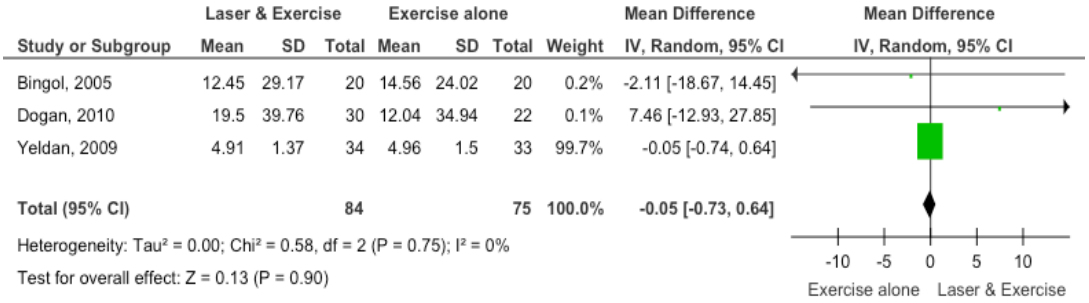


Figure 23 – Pooled data from studies comparing use of laser plus exercise program to exercise program alone, for functional improvement (re-evaluation: 2 to 4 weeks after start of intervention)

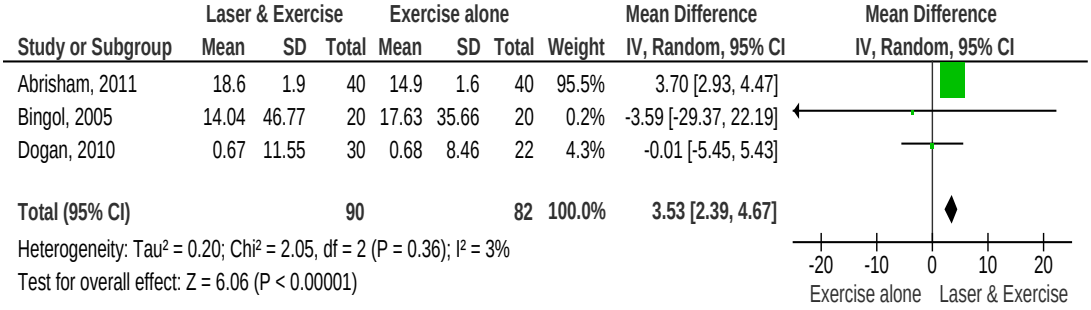
A- Flexion



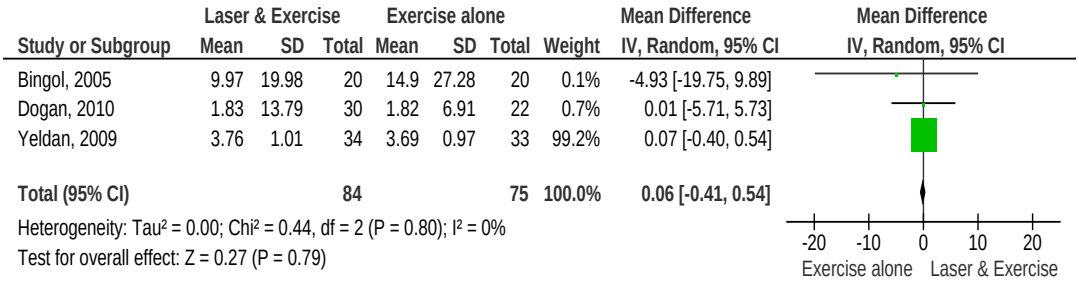
B- Abduction



C- External rotation



D- Internal rotation



Laser & Exercise: Group including both laser and exercises; Exercise alone: Group including only exercises; Std. Mean difference: Standardized difference in the means of the treatment groups; SD: Standard deviation; Total: Number of participants per group; Weight: Weight attributed to each study; IV: Independent variable; Random: Random-effect model; 95% CI: Confidence interval at 95%; Heterogeneity: Heterogeneity of the meta-analysis; Test for overall effect: Test evaluating the overall treatment effect.

Figure 24 – Pooled data from studies comparing use of laser plus exercise program to exercise program alone, for improvement in shoulder range of motion during (a) flexion, (b) abduction, (c) external rotation, and (d) internal rotation (re-evaluation: 2 to 3 weeks after start of intervention)

Table 19 – Effectiveness of laser in treatment of RC tendinopathies

Treatment	N (study)	n (participants) and duration of follow-up	Combined treatment effect	Recommendation	Level of evidence
Laser/placebo or control intervention [126,204,214]	3	n = 84 14 to 21 days	No pooled data	Laser appears to be effective in reducing pain in the short term when compared to a placebo. Laser effectiveness in terms of improving shoulder function and range of joint motion has not been demonstrated.	Low
Laser/exercise program [199,209]	2	n = 114 2 to 12 days	**Pain** Nocturnal: Mean difference evaluated with 10-cm VAS: 0.34 (95% CI: -0.83 to 1.5) During activity and at rest: no pooled data **Function and range of motion** No pooled data	Laser does not appear to be effective in alleviating pain or improving either shoulder function or range of motion, when compared to an exercise program alone.	Low
Laser/ therapeutic ultrasound [199,203,204]	3	n = 142 2 to 3 weeks	No pooled data	Laser may be more effective than ultrasound in reducing pain.	Low
Laser with exercise program/ exercise program alone or other intervention [208,210-212,215,216]	6	n = 318 2 to 12 weeks	**Pain** Overall: mean difference evaluated on 10-cm VAS: 1.38 (95% CI: 0.91 to 1.9) in favour of laser & exercise group* Nocturnal: mean difference evaluated on 10-cm VAS: 0.17 (95% CI: -0.41 to 0.75) in favour of laser & exercise group* **Function** Standardized mean difference: -0.21 (95% CI: -0.53 to 0.10) in favour of laser & exercise group* **Range of motion** External rotation: mean difference 3.5˚ (95% CI: 2.4 to 4.7) in favour of laser & exercise group * No significant difference for flexion, abduction or internal rotation	Adding laser treatment to an exercise program does not yield added benefits in terms of alleviating pain or improving shoulder function and range of motion.	Moderate

VAS: Visual analogue scale; 95% CI: Confidence interval at 95%
* This difference is not considered clinically important.

Recommendations

- There is only low-level evidence indicating that the use of laser in adults with RC tendinopathy might alleviate pain in the short term.
- Low-level evidence suggests that laser is no more effective than an exercise program alone.

- Moderate-level evidence suggests that adding laser to other treatment modalities such as therapeutic exercises or ultrasound yields no additional benefits in terms of reducing pain or improving functional level.

3.3.7 Effectiveness of extracorporeal shock wave treatment (ESWT) in treatment of rotator cuff tendinopathies

Low- or high-energy extracorporeal shock wave treatment (ESWT) is used for its possible promotion of tendon repair. This includes neovascularization, a suppressive effect on nociceptors and hyperstimulation mechanisms that appear to activate Aß non-nociceptive fibres and promote peripheral pain inhibition.[218] Prior studies have reported ESWT's effectiveness in treating RC tendinopathies with calcifications,[219] but its effectiveness has yet to be proven for tendinopathies without calcification. Few randomized clinical trials have been published since the last systematic review evaluating ESWT effectiveness in adults with RC tendinopathy. A synthesis of the scientific evidence was therefore carried out based on the most recent systematic review and the latest randomized clinical trials (RCTs) published.[220-222]

A total of six RCTs were included in the last systematic review, published in 2011, which evaluated the effectiveness of ESWT in adults with RC tendinopathy (without calcification).[221] With a methodological score of 70.4%, that review was of moderate methodological quality. Based on the findings of the studies retained, ESWT is not recommended for treating RC tendinopathy. Only one study of low methodological quality reported that ESWT was more effective than an exercise program alone or a control group. The two studies that compared ESWT to a placebo did not demonstrate the therapeutic effectiveness of this modality. Based on the studies retained, the authors of this review do not recommend that clinicians use either low- or high-energy ESWT to treat adults with RC tendinopathy.[221]

Two randomized clinical trials have been published since the last review came out. They compared the effects of ESWT to those of a placebo with follow-up at three and six months.[220,222] The two studies had moderate to high methodological quality (68.8% for the Kolk et al. study; 81.3% for the Galasso et al. study). In the first study (n = 82), the ESWT did not demonstrate greater effectiveness in alleviating pain, with a mean difference of 40.0 ± 30.5 obtained in the group receiving ESWT evaluated on a VAS (0-100) and of 29.0 ± 33.1 in the placebo group (p=0.137).[222] No significant difference was observed in terms of function, with a mean difference of 24.0 ± 20.5, evaluated using the CMS, for the ESWT group, and of 12.4 ± 23.0 for the placebo group (p=0.115).[222] In the second study (n = 20), however, a significant difference was observed in favour of ESWT (low energy) in terms of function, with a relative improvement of 74.5% in the intervention group and of 15.2% in the placebo group, measured using the CMS (%) with follow-up at three months (p=0.014).[220]

Recommendations

- Moderate-level scientific evidence does not point in favour of either low- or high-energy ESWT as a treatment for alleviating pain and improving functional level in adults with a RC tendinopathy. Only a minority of studies report a positive treatment effect, and their

methodological quality ranged from low to moderate. More RCTs are needed to reach conclusions about the effectiveness of low- or high-energy ESWT.

3.3.8 Effectiveness of surgery in treatment of rotator cuff tendinopathies

Surgery is often envisaged to treat RC tendinopathies when conservative treatment fails. Several surgical interventions are available. Subacromial decompression, rotator cuff debridement and bursectomy are those most frequently performed.[223] Subacromial decompression consists of removing part of the subacromial bursa and thinning the acromion; the coraco-acromial ligament may also be removed.[224] The aim is to reduce the friction of the rotator cuff tendons on the acromion, particularly during arm elevation movements. Bursectomy is defined as the excision of the tissues of the subacromial bursa,[225] while debridement consists of removing damaged tendon tissues or other debris in the subacromial space.[226] As no systematic review of the effectiveness of surgery has been published recently, we performed one. Meta-analysis was not possible. The complete results have been published in *Clinical Rheumatology*.[227]

Fifteen RCTs were included in our systematic review following a bibliographic search.[145,146,149,150,228-238] The mean methodological score for the included studies was 58.9% ±10.8, which represents an overall methodological quality of low to moderate. In terms of participants, no study included workers exclusively.

Effectiveness of acromioplasty versus that of exercise program

Based on four studies (n = 391) of moderate methodological quality comparing acromioplasty to a therapeutic exercise program, the evidence-based data identified during our systematic review points to the conclusion that a rehabilitation program including therapeutic exercises is as effective as acromioplasty for treating RC tendinopathies.[145,149,231,234] Open acromioplasty was the focus of one study, while the three other studies investigated arthroscopy. Only one study (n = 42) observed a difference in favour of open acromioplasty, but it was based on an non-validated evaluation tool.[234] In two studies, the authors presented an analysis of the direct health costs, reporting that surgery was 1.5 to 2 times more costly than a rehabilitation program including exercises.[145,231]

Effectiveness of open acromioplasty versus that of arthroscopic acromioplasty

Five studies (n = 192) have been published on this topic, but they obtained a low score for methodological quality.[229,232,235,236,238] Of these five studies, two (n = 66) reported similar effectiveness for both types of interventions in terms of function.[229,238] Two other studies (n = 64, results reported in three articles)[232,233,235] concluded that arthroscopic acromioplasty may yield better results than open acromioplasty in the short term, particularly with regard to range of shoulder motion during flexion and abduction and with regard to sick leave duration. However, the pain reduction results and long-term results for range of joint motion were similar for both techniques.

It should be noted that arthroscopic acromioplasty is a more complex technique than open acromioplasty. It requires superior skills on the part of the surgeon. Based on the studies reviewed, it is not clear which of the techniques takes less time to perform. A number of factors should be taken into account when choosing a surgical technique (time involved, cost, result),

and to date, the literature does not reveal any consensus regarding a particular approach. Table 20 summarizes the results on the effectiveness of surgery in treating rotator cuff tendinopathies.

Table 20 – Effectiveness of surgery in treatment of RC tendinopathies

Treatment	N (study)	n (participants) and duration of follow-up	Combined treatment effect	Recommendation	Level of evidence
Acromioplasty/ exercise program [145,149,231,234]	4	391 1 to 2½ years	No pooled data	Acromioplasty is as effective as an exercise program in reducing pain and improving function.	Low to moderate
Arthroscopic acromioplasty/ open acromioplasty [229,232,233,235,238]	5	192 6 months to 8 years	No pooled data	Both surgical techniques have proven effective, but the results for arthroscopy may yield additional short-term benefits for range of shoulder motion in flexion; however, the long-term results are comparable for both interventions.	Low

Recommendations

- Low- to moderate-level scientific evidence suggests that a therapeutic exercise program and acromioplasty are equally effective in treating RC tendinopathy.
- Low- to moderate-level evidence indicates that open surgery and arthroscopy are both effective in treating RC tendinopathy. Arthroscopy may yield additional short-term benefits in terms of range of motion in humeral flexion.

3.4 Review of interventions for treating full-thickness rotator cuff tears

3.4.1 Effectiveness of conservative interventions in treatment of rotator cuff tears

One systematic review sought to evaluate the effectiveness of an exercise program for patients ages 59 to 78 years and suffering from a full-thickness RC tear.[239] A total of ten studies (n = 304) were retained, but they included only observational studies, two of which focused on unique cases. Four studies included an exercise program alone, while the remaining six combined exercises with other interventions. The authors concluded that an exercise program alone or combined with other non-surgical interventions produced beneficial effects for conservative treatment of RC tears. However, they did not specify the outcome measures. Given the absence of RCTs and the heterogeneity of the studies concerning exercise programs, no definitive conclusion can be reached based on this review.

Another systematic review of low methodological quality (63.0%) included systematic reviews as well as randomized clinical trials evaluating various conservative interventions for treating full-thickness RC tears in the general population.[240] However, given the few published studies and reviews, the authors were unable to reach a conclusion regarding the effectiveness of the interventions studied, specifically, corticosteroid injections and subscapular nerve blocks. In fact,

one study (n = 78) undertook to compare corticosteroid injections to hyaluronate injections, but observed no significant difference in participant satisfaction after four weeks. In the other study (n = 13), the authors compared the effects of a dexamethasone nerve block to those of a placebo over a 12-week period. The group receiving the nerve block showed a relative improvement in nocturnal pain, movement and range of motion during flexion, abduction and external rotation; however, no inter-group comparison was performed.

Clinical recommendations

- Although clinically speaking surgery is indicated for young, active patients suffering from pain and functional limitations, the scientific evidence regarding these prognostic factors is poor. Moreover, there is currently little evidence to support choosing an intervention based on patient age.
- Additional studies of good methodological quality are needed to reach a conclusion regarding the effectiveness of exercises and other conservative approaches in treating full-thickness RC tears in both the general population and workers.

3.4.2 Effectiveness of surgery in treatment of full-thickness rotator cuff tears

RC repair consists of stitching the ruptured tendinous tissues together, and when the tendon(s) is/are detached from their point of insertion into the humeral head, of reattaching the tendons to the bone.[241] Surgery is indicated for young, active patients with a symptomatic RC tear and a shoulder with no stiffness.[242] Certain risk factors may result in a loss of functionality. These factors include advanced age, a large tendon tear, concomitant surgery on the biceps or the acromioclavicular joint, and for patients who are workers, the fact of receiving compensation from a public insurer following a work disability.[243] RC repair may or may not be accompanied by acromioplasty. These types of surgery may also be performed using different approaches, i.e. open, semi-open or arthroscopic, and by using different types of suture anchors, i.e. single-row or double-row repair.[244]

Effectiveness of RC repair in worker populations

A systematic review published in 2011 and of low methodological quality (56.4%) specifically evaluated the effectiveness of surgery in a worker population.[245] Eight studies were retained and a qualitative synthesis was performed by the authors. The methodological quality of the retained studies ranged from moderate to high. The authors reported that RC repair was an effective surgery for treating workers in terms of reducing pain and obtaining gains in quality of life, range of motion and strength. However, compensated workers showed fewer benefits, and a smaller proportion of them returned to their pre-injury jobs compared to participants who received no benefits during their sick leave. The exact reasons for these differences between compensated and non-compensated workers remain poorly understood.

The authors reported that in one study, a decrease was observed in the direct and indirect costs associated with surgery when an early referral system was used rather than a traditional referral system in which a front-line physician has to refer the patient to a medical specialist (orthopedist). The early referral system led a $75,000 decrease in costs per patient compared to the usual referral system ($p<0.05$) and to a decrease in the duration of sick leave: 6.6 months for

the early referral group compared to 17.1 months for the traditional referral group (however, no statistical analysis was performed).[245]

Effectiveness of RC repair by open, semi-open or arthroscopic approach

Two systematic reviews analyzed the effectiveness of the various surgical approaches used for RC repair.[246,247] According to these two recent publications, with methodological quality scores of 79.6% for the Shan et al. study (2014) and 40.7% for the Lindley et al. study (2010), there was no significant different between the results obtained with open surgery and those obtained using an arthroscopic approach in terms of pain reduction or functional disorders. In the meta-analysis by Shan et al. (2014), which included 12 studies (n = 770), the results of five of these (n = 336) were pooled to evaluate the effectiveness of arthroscopic surgery compared to that of semi-open surgery in terms of pain, and a non-significant difference was reported, with an SMD of 0.59 (95% CI: -0.21 to 0.53). In the same review, the data from seven studies were pooled to evaluate the comparative effectiveness of these two types of intervention in terms of function, and no significant different was observed, with an SMD of 0.91 (95% CI: -0.24 to 2.1) for the CMS (%) (n = 145), of 0.28 (95% CI: -0.06 to 0.62) for the UCLA score (n = 134), and of -0.04 (95% CI: -0.28 to 0.20) for the ASES questionnaire (n = 270). In addition, the incidence of anatomic failure (non-healing or re-tear) caused by rupture of the repair was not significantly different between the two surgical techniques, with an odds ratio of 0.99 (95% CI: 0.57 to 1.73).

In the systematic review by Lindley et al. (2010), which evaluated ten studies (n = 812), five of which were not taken into account in the Shan et al. review (2014), a qualitative synthesis of results was presented and similar conclusions were reached, i.e. that there was no difference between the effectiveness of open surgery and that of arthroscopy in terms of pain, function and prevalence of anatomic failure (non-healing or re-tear).[246] However, the authors recommended that further studies be conducted to evaluate the short- and medium-term results, as some studies suggest that capacities might be recovered faster in the case of arthroscopic surgery.

Effectiveness of RC repair with single-row or double-row suture anchors

Three recently published meta-analyses endeavoured to compare the use of different types of suture anchors in RC repair, namely, single-row and double-row.[248-250] The three reviews obtained methodological scores of 66.7%,[250] 75.9%[249] and 79.6%[248] respectively. The meta-analyses presented in the most recent systematic review, that by Millet et al. (2014), and which studied the effectiveness of single-row versus double-row suture anchors on the functional level, did not show any significant difference between the two types of treatment. At a follow-up conducted at 23.2 months, the mean differences in the UCLA scores (n = 331) were 1.1% (95% CI: -0.3 to 2.5); in the CMS scores (n = 431), -3.7% (95% CI: -8.8 to 1.4); and in the ASES scores (n = 351), -2.1% (95% CI: -7.3 to 3.2).[248] The other two reviews obtained similar results on the functional level, but none of the three reviews reported results for pain alone. However, two of these reviews included a comparison of the RC non-healing or re-tear rate post-surgery. Based on five studies (n = 258) with a mean follow-up at 25.6 months, the review by Xu et al. (2014) reported a relative risk of 1.7 (95% CI: 1.2 to 2.4) in the proportion of re-tears in the group that had undergone single-row repair versus the group having undergone double-row repair. In the review by Millet et al., which included six studies (n = 494) with a mean follow-up after 26.1 months, the relative risk of re-tear was also found to be very similar: RR = 1.8 (95% CI: 1.3 to 2.5).

In the Xu et al. and Chen et al. reviews, the authors also presented analyses that took into account the size of the RC tear needing repair. In the most recent review by Xu et al., of the participants with a tear longer than 3 cm (n = 157), those who had had double-row repair of the RC demonstrated significantly higher improvements in their UCLA functional score and ASES score than those who had had single-row repair (p=0.005 and p=0.001 respectively). The authors therefore recommended using double-row repair in subjects whose tears were longer than 3 cm.[250] However, in their review, Chen et al. considered that the differences observed were clinically unimportant.[248]

The conclusions reached in the three systematic reviews were similar, namely, that no significant difference was observed between the two types of suture anchors in terms of function. However, while some results suggest that double-row anchors may reduce the risk of re-tear or be more effective in patients with tears longer than 3 cm, it remains difficult to reach a formal conclusion about the advantages of double-row versus single-row repair in these specific situations.

Effectiveness of RC repair with or without acromioplasty

In a recent systematic review of high methodological quality (81.5%) and including four studies (n = 373), the authors compared the effectiveness of RC repair with or without acromioplasty.[251] The meta-analyses performed revealed no significant difference on the functional level, with a mean difference of 4.4% (95% CI: -2.0 to 10.8) in the CMS (n = 104) and of 1.9% (95% CI: -2.0 to 5.8) in the ASES (n = 199). The authors reported a similar re-operation rate for both types of intervention, with a relative risk of 0.46 (95% CI: 0.08 to 2.7). The authors concluded that RC repair with or without acromioplasty yielded the same results in terms of functional aspects.

Two randomized clinical trials have been published since this systematic review, and they obtained a mean methodological score of 59.4%± 4.4.[252,253] One of the two studies (n = 86) reported no significant difference between the two groups in terms of function and quality of life with a follow-up after two years.[253] The other study (n = 167) compared the effects of acromioplasty alone to those of RC repair including acromioplasty and an exercise program, and to those obtained for a third group that was prescribed an exercise program only.[252] The authors reported no significant difference between the three groups in terms of function, with follow-up after one year. The two studies showed that both types of surgery were equally effective in terms of function, but one of the studies recommended not performing acromioplasty during RC repair.[252]

Effectiveness of RC repair versus that of an exercise program

A systematic review of low methodological quality (63.0%) and including both systematic reviews and randomized clinical trials evaluated various interventions for treating full-thickness RC tears.[240] The authors retained one study (n = 103) of moderate methodological quality (68.8%) in which the effects of a RC repair (open or semi-open approach) were compared to those of an exercise program for patients with a mean age of 60 years. They concluded that moderate-level evidence suggested that surgery was more effective than an exercise program in the medium and long terms for reducing pain and improving functional level in this population.

One randomized clinical trial evaluated three interventions: RC repair with acromioplasty, acromioplasty alone and an exercise program in subjects over 55 years of age. [252] This study (n = 167) was of low methodological quality (62.5%). The exercise program, which was suggested by a physiotherapist, was designed to improve glenohumeral and scapulothoracic control while strengthening the rotator cuff muscles. In terms of function, the authors reported the CMS results (%), with an average improvement of 17.1 ± 21.9 after 12 months for the exercise group, of 17.6 ± 18.6 for the acromioplasty group and of 19.8 ± 17.9 for the group who had RC repair combined with acromioplasty (p=0.34). The satisfaction rate among the participants in the exercise group was 87%, compared to 96% in the acromioplasty group and 95% in the group that had both RC repair and acromioplasty (p=0.14). An evaluation of the direct health costs (in euros) associated with the interventions was also reported, with an average cost of 2,417 € ±1,443 for the group doing the exercise program, 4,765 € for the acromioplasty group, and 5,709 € for the group who underwent RC repair with acromioplasty (p<0.0001). The authors concluded that conservative treatment was as effective as surgical RC repair with or without acromioplasty in terms of function and patient satisfaction. They ultimately recommended starting with conservative treatment in older patients who have a non-traumatic RC tear.

Clinical recommendations

- Low-level scientific evidence suggests that workers who are compensated during sick leave for a RC tear that is treated with surgery may return to work more slowly than those who are compensated. Moreover, they achieve more modest gains in terms of pain reduction and improvement in function, range of motion and strength. The reasons for these differences in compensated workers have yet to be determined.
- Moderate-level evidence shows that open, semi-open and arthroscopic surgery for RC repair are equally effective in reducing pain and improving both function and range of motion in a population with a RC tear.
- Moderate-level evidence suggests that the single-row and double-row types of RC repair are equally effective in terms of function; however, double-row repair may be associated with a lower level of RC re-tear.
- Given the contradictory evidence regarding the effectiveness of RC repair versus that of an exercise program, there is no consensus as to which intervention should be recommended. Factors such as patient age, injury mechanism and functional needs should potentially be considered, although little evidence supports an association between these factors and surgical success.

3.5 Conclusion

This knowledge review highlights the recent scientific evidence on the effectiveness of medical, surgical and rehabilitation interventions for workers or adults with RC tendinopathies or full-thickness tears. Regarding the treatment of RC tendinopathies, the evidence presented suggests that an exercise program is effective in reducing pain, improving function and promoting workers' return to work. As for the other types of interventions, the small amount of data available on worker populations does not allow for a specific conclusion regarding the effectiveness of therapeutic techniques for treating this population.

Nonetheless, several interventions are effective for treating a general population with a RC tendinopathy, i.e. taking non-steroidal anti-inflammatory drugs (NSAIDs) in the short term, therapeutic exercises and arthroscopic or open acromioplastic surgery. Other interventions have been recognized as ineffective in adults with a RC tendinopathy: manual therapy, therapeutic ultrasound and extracorporeal shock wave treatment (ESWT). Corticosteroid injections have not shown themselves to be more effective than other types of less invasive interventions, and should not therefore be retained as the initial treatment for adults with RC tendinopathies. A number of interventions are not supported by sufficient scientific evidence to allow for a conclusion about their effectiveness or ineffectiveness: taping, transcutaneous electrical nerve stimulation (TENS) and laser.

Regarding the treatment of full-thickness RC tears, little scientific evidence specific to a worker population has been published. No recommendation can therefore be made regarding the effectiveness of interventions for these types of tears in this particular population. That said, some interventions, such as various types of RC repair surgery, through an open approach or arthroscopy, with or without acromioplasty and single-row or double-row repair, have demonstrated their effectiveness in the general population with full-thickness RC tears. Additional studies of good methodological quality are needed to reach a conclusion about the effectiveness of exercises and other conservative approaches in treating full-thickness RC tears in both the general population and workers.

4. THE RETURN TO WORK

The return-to-work (RTW) process depends on several factors that are specific to each situation. A worker's rehabilitation has a number of dimensions (e.g. medical, social, and psychological)[254-256] and may also require various interventions aimed at the work situation. The first section of this chapter presents a review of the literature on the effectiveness of workplace-based interventions for individuals suffering from shoulder pain. The second section presents a review of the literature on the prognostic factors of absenteeism and the RTW of individuals with shoulder pain.

4.1 Workplace-based interventions for workers with shoulder pain

According to a study conducted on the Québec population in 2007-2008, approximately 238,000 workers reported having been absent from work in the preceding year for a musculoskeletal disorder.[257] In addition, absenteeism problems are associated with a decline in productivity and have an impact on public finances, as mentioned in a study conducted on the member countries of the Organization for Economic Co-operation and Development (OECD).[258] Rehabilitation interventions have traditionally ensured the management of a worker by professionals in clinical settings. However, interventions in the workplace appear to have a beneficial effect on the RTW.[259] For example, the social, organizational and physical work environment, but also the worker's psychological situation and the physical and mental demands of the job tasks, appear to play an important role in work absenteeism and the RTW.[259]

Given the emerging data on this subject, efforts have been made to develop workplace-based rehabilitation intervention programs. In fact, contemporary approaches for treating musculoskeletal disorders tend to look at workers in their work context rather than simply treating their clinical problem. The programs thus take into account several factors related to the work situation in addition to the usual clinical approach.

The results of one systematic review suggest that multidisciplinary rehabilitation programs are potentially beneficial for a worker population on sick leave due to upper limb disorders. The authors of this systematic review reported that a multidisciplinary program including interventions focused on the worker's physical, but also psychological, condition may be beneficial for workers who are absent for four or more weeks.[260] However, given the little high-quality methodological data available, the authors were unable to make recommendations regarding the optimal treatment. In fact, the studies reported little on work-related outcomes. Future studies should therefore include the self-reported pain level and document the absences resulting from a medical condition such as musculoskeletal problems. Another systematic review evaluated the effectiveness of workplace-based interventions with a population suffering from various musculoskeletal conditions.[261] The authors concluded that moderate-level evidence indicated that interventions such as the worker's early return to the workplace, a temporary assignment including adapted tasks and the ergonomic adjustment of the work station were effective in reducing both the disability duration and the related costs. As mentioned earlier in our knowledge review, a systematic review was carried out to assess the effectiveness of exercise programs in a worker population. Exercises were deemed effective for workers in different work settings and suffering from a RC tendinopathy. However, no systematic review specifically

assessed the impact of workplace-based interventions on a worker population with painful shoulder symptoms. We therefore conducted a systematic review on this subject.

4.1.1 Research and analysis methodology

A bibliographic search was performed in the PubMed, Embase, CINAHL and Pedro databases (covering the period from the date of the database creation to May 2014) to identify the literature on workplace-based interventions involving adults with shoulder pain.

Study inclusion criteria
For inclusion in the systematic review, the articles had to meet the following inclusion criteria: (**1)** the participants had to be workers suffering from shoulder pain. Articles on workers suffering from both shoulder and neck pain were only retained if the authors presented results specific to the shoulder. Studies that included a worker sample with a proportion of subjects who were healthy but at risk of developing shoulder pain were also considered; (**2)** the articles had to be written in either French or English; (**3)** they had to include a workplace-based rehabilitation intervention for a shoulder problem. All types of research designs were retained.

Data extraction
Data extraction was performed using a data extraction form. The following information was extracted: study design, number and characteristics of the participants (diagnosis, age, gender, job type and characteristics), rehabilitation treatments and workplace-based interventions, outcome measures, and statistical analyses and results. A first reader performed the extraction, which a second reader then corroborated or completed.

Assessment of risk of bias of studies
Two readers independently evaluated the methodological quality of each study using a tool developed by one of the authors of this knowledge review. This tool is used to assess the methodological quality of experimental and quasi-experimental studies by means of 24 items that are scored from 0 to 2 (0 is assigned for a high risk of bias, 2 for a low risk, and 1 if insufficient information available to assess the bias). A high total score means high methodological quality (low methodological quality: 0-49%, moderate: 50-74%, high: 75-100%). Although not yet validated, this tool has been used in several systematic reviews in the past.[262,263] After independently assessing each article, the two readers compared their results. Any differences noted between their assessments were discussed until a consensus was reached.

Data synthesis
In light of the varied study designs, heterogeneous interventions and different measurement tools used, a qualitative synthesis of the results, without meta-analysis, was performed.

4.1.2 Results – Workplace-based interventions

Characteristics of included studies
Eleven studies with a mean methodological score of 64.2%±14.1 were retained[147,264-273] Only three of these obtained a score higher than 75%,[264,269,273] while three others obtained a score equal to or less than 50%, indicating low methodological quality.[267,270,271] The main risks of bias

identified were the absence of calculations of the sample size and the fact that patient and evaluator assignment was not blinded. Nine of the 11 studies were RCTs.[147,231,264,266,267,269,270,272,273] Four studies included office workers,[264,267-269] two studies looked at assembly-line or factory workers,[265,271] one study investigated laboratory technicians[273] and another studied garment workers.[270] Three studies compared an exercise program to a control intervention,[264,269,273] one quasi-experimental study assessed the effectiveness of an exercise program[265] and one study compared the effects of an exercise program carried out in a clinical setting to one carried out in the workplace.[147] Four studies reported and compared the results of various ergonomic adjustments to a work station.[266,268,271,272] One study analyzed the effectiveness of using an ergonomic mouse,[269] while another assessed the impact of adding more frequent rest breaks on the musculoskeletal symptoms of participants working at computer work stations.[267] The main outcome measures were the incidence of shoulder pain, proportion of participants having returned to work and self-reported function measures such as the SPADI and DASH questionnaires.

Effectiveness of workplace-based therapeutic exercise program

Five studies, including four randomized clinical trials (n = 1,290) assessed the effectiveness of an exercise program carried out in the workplace.[147,264,270,273]

One randomized clinical trial (n = 61) of low methodological quality measured the effectiveness of a workplace-based exercise program (stretching exercises and massage techniques) for garment workers who had no specific shoulder symptoms versus a control group receiving no intervention.[270] Regarding pain evaluated on a 10-point rating scale, no significant difference was reported between the groups (p=0.921), although a mean increase of 0.8 ± 1.1 in pain was observed in the control group (p=0.923) compared to a significant decrease of -2.2 ± 2.8 in pain in the exercise group (p=0.038).

A randomized clinical trial of high methodological quality and involving a population of laboratory technicians who did not necessarily have shoulder pain (n = 537) compared the effectiveness of a workplace-based progressive exercise program to that of a control group intervention consisting solely of asking them to remain physically active.[273] No significant difference was observed in the mean pain score (9-point pain rating scale) of the two groups, with a mean difference of -0.2 (95% CI: -0.5 to 0.1). The authors also compared the reduction in the proportion of subjects who still had shoulder pain at the end of the study. They noted an odds ratio of 3.9 (95% CI 1.7 to 9.4) in favour of the group doing the exercise program. The authors concluded that a progressive exercise program yielded a statistically significant and clinically important reduction in shoulder pain. They also assessed the protective effect of the exercise program on the incidence of shoulder symptoms in participants who were asymptomatic when the study began. However, the odds ratio was non-significant (odds ratio: 0.6 [95% CI: 0.3 to 1.3] in favour of the group doing the exercise program).

Another randomized clinical trial (n = 549) of high methodological quality was carried out on office workers. This study compared the pain-prevention effects of an exercise program specific to the shoulder and neck to those of non-specific physical exercises, and to the effects of advice given on healthy lifestyle habits at a single information session.[264] All the interventions were carried out in the workplace. The authors observed a reduction in pain intensity in both exercise

groups compared to the control group that had received information only (p=0.038). However, no significant difference was observed between the two exercise groups in terms of pain (p=0.53). The authors also assessed functional status at work by means of the Work Ability Index questionnaire, but no significant difference was observed among the three groups. They concluded that the two exercise groups reported greater pain alleviation than the control group. Regarding the preventive effectiveness of these programs, the authors noted a protective effect in the workers who were asymptomatic when the study began. In fact, of the workers who had no shoulder pain and who did the neck- and shoulder-specific exercise program, a smaller proportion of participants said they felt pain at follow-up than the proportions of the other two groups ($p<0.05$).

An RCT (n = 94) of moderate methodological quality compared the results of a traditional exercise program carried out in a medical clinic to those of a program carried out in the workplace.[147] The workers had a RC tendinopathy and performed tasks involving a moderate level of physical demand according to the Dictionary of Occupational Titles (the exact nature of their work was not specified). The clinic-based program included mobilization and muscle-strengthening exercises, as well as specific job coaching exercises. In addition to benefiting from the clinical program, the group doing the workplace-based program received training on shoulder biomechanics and ergonomics in the workplace, as well as the assistance of a counsellor, who maintained contact with the worker's supervisor in the workplace and proposed task adaptations. Evaluated using the SPADI (0-100), the results obtained in terms of function were statistically better but clinically unimportant for the group that did the workplace-based program, with a mean difference of 20.6 ± 11.1 for them compared to 13.8 ± 20.3 for the group in the clinic-based program (p=0.034). Regarding the RTW, a bigger proportion of workers in the workplace-based program (71%) returned to work than that of workers in the clinic-based program (38%) (p=0.001).

One quasi-experimental study (n = 49) evaluated the effectiveness of an eight-week workplace-based intervention including RC strengthening exercises and stretching in a single group of workers with a RC tendinopathy and working in the manufacturing sector.[265] The authors observed a significant impact on pain, which was evaluated using the Pain Rating Index (0-68), with a mean pre-intervention score of 24.9 ± 6.7 and a mean post-intervention score of 12.5 ± 11.5 ($p < 0.05$). In terms of function, the authors also noted a statistically significant and clinically important difference on the DASH questionnaire (mean change: 12.7% [95% CI: 2.5 to 22.8]). A significant improvement was also observed in the DASH module evaluating work disability (mean improvement of 12.9% [95% CI: 2.0 to 23.9]; $p = 0.01$).

Effectiveness of ergonomic or work organization modifications

One RCT (n = 59) of moderate methodological quality compared the effectiveness of two types of workstation adjustments aimed at reducing the prevalence of shoulder pain in the workers at a call centre.[266] One group benefited from a standard adjustment based on general recommendations concerning the adjustment of computer workstations, while the other group benefited from a personalized adjustment based on each worker's anthropometric data (position of the keyboard and desk, chair height). This adjustment was made by a professional, who also counselled the workers on how to correct their posture. During participant follow-up, no significant difference was observed between the two types of interventions in terms of pain

reduction, although some proportion of workers in both groups showed a reduction in shoulder pain relative to their situation at the start of the study (p= 0.36).

A second RCT (n = 102) of moderate methodological quality compared a group that received counselling from a physiotherapist about work organization and workstation adjustment to a group that received general instruction on ergonomics, and to a control group that received only a pamphlet explaining the musculoskeletal disorders associated with using a computer workstation.[268] The participants had a computer workstation and symptoms involving their shoulder, upper limbs or cervical spine. At the two-month follow-up, the group that had been managed by a physiotherapist perceived less shoulder discomfort (on a five-point scale) than the control group ($p < 0.05$), but there was no significant difference when compared to the group that had received ergonomics counselling ($p \geq 0.05$). At the ten-month follow-up, no intervention was found to be statistically superior to the results obtained by the control group ($p \geq 0.05$).

A third RCT (n = 38) of moderate methodological quality compared a group of hairdressers who had benefited from recommendations regarding work techniques and ergonomics to a control group that had only received a pamphlet explaining ergonomic principles.[272] In terms of the prevalence of shoulder pain in the participants, the authors reported a non-significant reduction in both groups, i.e. of 10% in the intervention group and 4% in the control group (re-evaluation done one to two months after the start of the intervention).

A retrospective cohort study (n = 184) of low methodological quality and involving workers from the manufacturing sector who had a RC disorder evaluated the effectiveness of a comprehensive RTW program including adaptations to the workstation, work tasks and work schedule if necessary, as well as co-worker assistance in learning new work techniques.[271] After four months, 84.3% of the participants had returned to their pre-injury jobs. The authors also found that the faster workers returned to work (modified or light tasks), the faster they resumed their pre-injury occupational activities, with a significant Pearson's linear correlation coefficient of $r = 0.917$ between the time of the RTW with adapted tasks and the time of the RTW with regular tasks ($p < 0.001$).

One RCT (n = 22) of high methodological quality compared a group using a computer mouse that vibrated when the user's hand was inactive for more than 12 seconds to a group using a standard mouse.[269] The hypothesis underlying this intervention was that the muscle stress caused by using a mouse could be eliminated by putting them in a less constraining position through the gesture of resting the hand and forearm. In terms of shoulder pain evaluated on an 11-point numerical scale, the mean difference between the groups was statistically significant but clinically unimportant, reaching -1.11 ± 4.5 in favour of the intervention group ($p < 0.05$).

A randomized clinical trial with crossover interventions (n = 42) of low methodological quality evaluated the addition of short, but frequent rest breaks (5 min/h) to the usual breaks (2 x 15 min/day) in workers performing data entry at computer workstations.[267] The intervention lasted 16 weeks, with alternation between the two rest break schedules. The authors observed a lower level of shoulder discomfort when the workers benefited from supplementary rest breaks as opposed to conventional breaks ($p=0.02$ for the right shoulder and $p=0.03$ for the left shoulder).

4.1.3 Discussion and clinical recommendations

A total of 11 studies (table 21) were included in this review, with a mean methodological score of 64.2% ± 14.1, signifying low to moderate methodological quality.

Effectiveness of workplace-based therapeutic exercise program

The effectiveness of workplace-based rehabilitation programs including mainly exercises was evaluated in four RCTs.[147,264,270,273] In three of these studies, the authors reported a treatment effect in favour of this type of management in terms of pain reduction,[147,264,273]while one study reported no difference between the group doing the exercise program and the control group that had no intervention.[270] A quasi-experimental study, however, found a statistically significant and clinically important difference evaluated using the DASH questionnaire at eight weeks (in the overall score and the work module score).[265] Overall, the results of the studies were favourable to the use of an exercise program as a workplace intervention for reducing pain. However, this result was expected, given the recognized effectiveness of exercise programs in workers and adults with a RC tendinopathy.[143,144] In fact, the two studies that included participants who had only a shoulder disorder concluded that there was an improvement in the pain and RTW variables.[147,265] The two studies evaluating the preventive effect of an exercise program in an asymptomatic worker population yielded contradictory results.[264,273] One study reported a significant effect in terms of the incidence of new cases of shoulder pain,[271] while the other found no effect.[262]

It is difficult to express an opinion as to whether workplace-based interventions are more effective than clinic-based interventions. Only one study specifically compared the two types of exercise programs. The workplace-based program appeared superior in terms of the proportion of workers who returned to work. However, this program included additional interventions such as training on shoulder biomechanics and work ergonomics. In addition, a counsellor served as the liaison with the employer and adapted the work tasks. Recent scientific evidence also suggests that it is beneficial to maintain an employment relationship. Workers appear able to resume their regular tasks faster if they return to the workplace early and if their work tasks are adapted to their condition.[274] One of the studies included in this knowledge review supports this hypothesis by concluding that there is a relationship between the wait time for the worker to perform light or adapted tasks and the wait time for the RTW to the pre-injury job and tasks.[271] In addition, the use of a counsellor to liaise between the worker and the workplace regarding questions related to the work tasks appeared to promote the RTW; a significantly higher proportion of workers who did the workplace-based program returned to work than workers in the other group.[147]

Effectiveness of ergonomic or work organization modifications

The studies that assessed ergonomic or work organization modifications obtained contradictory results. Three studies reported a treatment effect in favour of the group benefiting from ergonomic modifications (use of a specialized mouse or adjustment of the workstation) or work organization modifications (more frequent rest breaks).[267,269,271] Another study revealed a positive, medium-term treatment effect (eight weeks) in a group whose workstations had undergone ergonomic modifications, but this effect was not maintained over time.[268] No conclusion can be reached on the basis of these studies, given their diverging results as to the

effectiveness of ergonomic modifications alone or in combination with other therapeutic modalities. More higher-quality studies are needed to determine the real effectiveness of these interventions. Studies comparing a control group to a group benefiting from ergonomic recommendations and to a group benefiting from rehabilitation interventions should be conducted to clearly differentiate between the effectiveness of these types of intervention.

In the past, painful shoulder disorders in workers were treated using a medical approach, often with a pathophysiological orientation. Certain factors having a positive or negative impact on the fast and sustainable return to work have been the focus of studies in recent years. In fact, one study including Québec workers on sick leave for a variety of musculoskeletal disorders concluded that the level of psychological distress they experienced was higher than that of the general population.[275] In light of these results, the study recommended an intensive multidisciplinary RTW program aimed at treating these risk factors as well and at preventing chronicity and prolonged sick leave. Other studies have revealed that taking into account the work situation as a whole, including the worker, employer, physical installations and tasks to be performed, shows promise in terms of promoting a sustainable RTW.[276] The fact of repeating regular work tasks in therapy sessions also appears to be beneficial for the participant's RTW. Moreover, an intensive program based on a functional approach combined with a biopsychosocial approach including psychological or rehabilitation-professional consultations has shown itself to be more effective than regular, non-intensive, non-multidisciplinary program in a population suffering from low back pain.[277] However, these aspects were not formally evaluated in our knowledge review for workers suffering from a RC problem or shoulder pain.

While we have included a majority of studies involving populations with shoulder pain, one of the limitations of this review is its inclusion of studies involving workers whose symptoms may include the neck and all the upper extremities. However, only studies for which the shoulder results could be singled out were included here, allowing us to evaluate specifically the effect of the interventions on shoulder symptoms as opposed to general effects on upper extremity symptoms as has been done in several previously published reviews.

Recommendations:

- Moderate-level scientific evidence suggests that a workplace-based exercise program is effective in reducing pain in various worker populations.
- No formal conclusion can be reached about the additional benefits of a multimodal workplace-based approach versus those of the usual clinical approach, although some low-level evidence may support a multimodal approach that includes counselling, exercises, workstation modifications and the adaptation of work tasks.
- In terms of improving function, there is diverging evidence, and no conclusion can be reached regarding this variable or the absenteeism, RTW, or presenteeism variables.
- Regarding the ergonomic modification of workstations and work organization, contradictory data have been published and further studies are needed.
- More studies of high methodological quality and involving different groups of workers with shoulder pathologies are needed to reach any formal conclusion about the effectiveness of workplace-based interventions for this population.

Table 21 – Synthesis of studies on interventions involving workers with shoulder pain

Name of study	Type of study	Participants	Participants' diagnosis Follow-up	Interventions	Outcome measures	Results	Methodological score
Pereira et al., 2012[270]	RCT	Garment workers Gender: unspecified Mean age: 28.5 years	Healthy subjects 12 weeks	Exercise program (stretching, massage, exercises, 10 min, 2x/day, 5x/week for a total of 120 sessions) (Ex) N = 44 Control group (no intervention) (Co) N = 17	Mean score shoulder pain pre-tx and at 12 wk (0-10)	Ex: 7.1 ± 2.2 and 4.9 ± 0.5 Pre-/post-comparison: p =0.04 Co: 5.0 ± 0 and 5.8 ± 1.1 Pre-/post-comparison: p= 0.92 Intergroup comparison: p=0.92	50%
Zebis et al., 2011[273]	RCT	Laboratory technicians Gender: Male: 52 Female: 455 Mean age: 42 years	Healthy subjects 20 weeks	Therapeutic exercise program (20 min, 3x/week) (Ex) N = 282 Control group (Advised to remain active, 1x/week) (Co) N = 255	Difference in mean change between groups shoulder pain (0-9) Odds ratio for decrease in shoulder pain intensity (≥3/9 to <3/9)	-0.2 (95% CI: -0.5 to 0.1), p=0.07 3.9 (95% CI: 1.7 to 9.4) in favour of Ex	77%
Blangsted et al., 2007[264]	RCT	Office workers Gender: Male: 195 Female: 354 Mean age: 44.9 years	Healthy subjects 12 months	Shoulder- and neck-specific exercise program (20 min, 3x/week) (Ex) N = 180 General physical exercises (advised to remain active in leisure activities) (Ge) N = 187 Control group (information meeting) (Co) N = 182	Change in pain intensity Change in pain duration Change in work disability – Work Ability Index (0-42) Number of sick leave days during the past 3 months	Ex and Ge vs Co: p= 0.0318 Ex vs Ge: p=0.5327 Ex and Ge vs Co: p=0.0565 Ex vs Ge: p=0.4016 Ex and Ge vs Co: p=0.3073 Ex vs Ge: p=0.4220 Intergroup comparison: p=0.45	81.3%
Cheng et al., 2007[147]	RCT	Workers performing moderately demanding tasks Gender: Male: 72 Female: 22 Mean age: 32.3 years	Work-related tendinopathy >90 days 4 weeks	Clinic-based exercise program with work task simulations (3x/week) (Cl) N = 48 Workplace-based exercise program (3x/week) (Wo) N = 46	Mean change in SPADI score Active shoulder ranges of motion	Cl: 13.8 ± 20.3 Wo: 20.6 ± 11.06 Intergroup comparison: p=0.034 Flexion: p=0.015 The other movements were not statistically significant (p ≥ 0.05)	62.5%
Cook et al.,	RCT	Call centre workers	Healthy	Personalized adjustment of	Proportion (%) of workers	1. Ad: 18, Sa: 18	68.8%

Name of study	Type of study	Participants	Participants' diagnosis Follow-up	Interventions	Outcome measures	Results	Methodological score
2004[266]		Average computer use = 29h/wk Mean age: unspecified Gender: unspecified	subjects 12 weeks	workstation (position of keyboard, desk and chair) (Ad) N = 30 Adjustment of workstation according to Australian Standards (Sa) N = 29	reporting shoulder discomfort: 1. Pre-intervention 2. 6 weeks 3. 12 weeks	2. Ad: 19, Sa: 24, p=0.36 3. Ad: 18, Sa: 8, p=0.15 p = 0.36	
Ketola et al., 2002[268]	RCT	Workers < 61 years using a workstation with a video display unit Gender: Male: 46 Female: 63 Mean age: 47.9 years	Symptoms related to neck or shoulders 10 months	Intensive intervention group: organization and workstation adjustments suggested by physiotherapists (In) N = 37 Instruction on ergonomics (Er) N = 33 Control group that received a pamphlet on musculoskeletal health (Co) N = 32	Level of musculoskeletal discomfort (1 to 5)* at: 1. 2 months 2. 10 months	Right shoulder: 1.In: 2.2 ± 0.2 p=0.022 vs Co Er:2.4 ± 0.1 p = 0.12 vs Co Co: 2.8 ± 0.2 2. In: 2.6 ± 0.2 p=0.53 vs Co Er: 2.5 ± 0.2 p=0.36 vs Co Co: 2.7 ± 0.2 Left shoulder: 1.In: 1.9 ± 0.1 p=0.025 vs Co Er: 2.1 ± 0.1 p=0.15 vs Co Co: 2.4 ± 0.2 2. In: 2.2 ± 0.2 p=0.61 vs Co Er: 2.4 ± 0.2 p=0.86 vs Co Co: 2.3 ± 0.2	72.9%
Veirsted et al., 2008[272]	RCT	Hairdressers Gender: Female: 38 Mean age: 29.5 years	Healthy subjects Follow-up: 1 to 2 months	Recommendations in form of pamphlet on subject of ergonomics and personalized follow-up through a demonstration and explanations given by ergonomics students (In) N = 20 Recommendations on subject of ergonomics in form of pamphlet (Pa) N = 18	Change in prevalence of shoulder pain	In: 21% à 11% Pa: 28% à 24% p ≥ 0.05	70.8%
King et al., 2011[269]	RCT	Office workers (computer work > 4h/day)	Healthy subjects 25 weeks	Use of vibrating mouse (Vm) N = 11 Standard mouse (Sm) N = 11	Shoulder pain (0-10): 1. Pre-intervention 2. At 5 weeks 2. At 25 weeks	1. Vm: 2.1 ± 2.18, Sm: 1.4 ± 2.3 2. Vm: 0.76 ± 1.1, Sm: 1.1 ± 1.7 3. Vm: 0.79 ± 1.2, Sm: 1.6 ± 2.9 Intergroup comparison: p < 0.05	79.2%
Galinsky et al., 2000[267]	RCT	Data-entry workers Gender: Male: 11	Incident cases 16 weeks	Supplementary rest breaks (5 min/hr in addition to 15 min, 2x/shift) (Sr)	Change in discomfort level (1-5) before and after intervention in: 1. Right shoulder	1. p < 0.01 2. p = 0.009	50%

Name of study	Type of study	Participants	Participants' diagnosis Follow-up	Interventions	Outcome measures	Results	Methodological score
		Female: 31 Mean age: 30 years		N = 23 Regular rest breaks (15 min, 2x/shift) (Rr) N = 19	2. Left shoulder		
Shaw et al., 2008[271]	Retro-spective	Workers in the manufacturing sector, ages 18 to 45 years, with no history of light work related to a shoulder disorder Gender: unspecified Mean age: unspecified	RC disorder 4 months	Ergonomic adjustments to workstation and adaptation of work tasks and schedule as needed N = 184 Co-worker support available if worker needed instruction on new work techniques	Proportion of workers who returned to their regular tasks (cumulative %) after: 1. 1 month 2. 3 months 3. 4 months Proportion of workers who returned to work after the program Proportion of workers who, once modified tasks implemented, returned to their regular tasks after: 1. 7 days 2. 14 days 3. 30 days 4. 59 days 5. 91 days	1. 41.7% 2. 75.0% 3. 84.3% 87.8% 1. 23.1% 2. 34.5% 3. 56.0% 4. 73.2% 5. 83.3% Correlation between number of days between sick leave and return to modified tasks, and return to regular tasks $r = 0.917$, $p < 0.001$	37.5%
Camargo et al., 2009[265]	Quasi-experi-mental	Assembly-line workers Gender: Male: 14 Female: 0 Mean age: 31.9 years	RC tendinopathy 8 weeks	Standardized interventions (cryotherapy, stretching, and strengthening exercises, 2x/week for 8 weeks) N = 14	Pain rating index (0-68) pre- and post-intervention Mean change in DASH score (%) Mean change in DASH score – work module (%)	24.9 ± 6.7 and 12.5 ± 11.6 $p < 0.05$ 12.7 ± 17.6 (95% CI: 2.5 to 22.8) 12.9 ± 18.9 (95% IC: 2.0 to 23.9)	56.3%

*A high score represents greater discomfort. RCT: Randomized clinical trial. Tx: treatment. 95% CI: Confidence interval at 95%. SPADI: Shoulder Pain and Disability Index.

4.2 Prognostic factors of absenteeism and return to work

In the care continuum, the return-to-work (RTW) decision is particularly sensitive. It involves determining the best time for a RTW that is safe and as free as possible of the risk of relapse. What are the signs indicating that a worker is ready to RTW and for what types of tasks? A number of medical, but also psychosocial, factors must be taken into account when making a RTW decision. This second part of the chapter presents a systematic review of the determinants or predictive factors of absenteeism and of a good RTW prognosis for individuals with a RC disorder. Moreover, to provide an overview of the other determinants of RTW and absenteeism, the research was broadened to include workers with musculoskeletal disorders (other than the shoulder). A summary of these other determinants will be presented in the last part of the chapter.

4.2.1 Research methodology

A search was conducted of three databases – Medline (through PubMed), Embase and CINAHL (period from the database creation date to January 2014) – to identify the literature on the prognostic factors of absenteeism and RTW in patients with a RC disorder. A manual search was also performed to identify additional articles.

Study inclusion criteria
For inclusion in this knowledge review, the articles had to meet the following criteria: **(1)** all or some of the participants had to be workers suffering from shoulder pain; **(2)** the articles had to be written in French or English; **(3)** the articles had to investigate determinants or predictive factors of absenteeism or RTW. Prospective and retrospective studies were included. Studies were excluded if the study participants presented a pain diagnosis not specific to the neck or shoulder or a diagnosis of cervical radiculopathy, or if only workers with shoulder pain of traumatic origin were involved. All definitions of absenteeism and RTW were accepted for this review.

Data extraction
Data extraction was performed using a previously designed data extraction form. The following information was extracted: study context and research design, number and characteristics of participants (diagnosis, age, gender, treatment and surgery, type and characteristics of jobs), follow-up duration, definition of absenteeism and RTW, prognostic factors, outcome measures, statistical analyses and adjustments, and results. A first reader performed the extraction, which a second reader then corroborated or completed if information was missing.

Assessment of risk of bias of included studies
Two readers independently assessed the methodological quality of each of the included studies, using the Methodology Checklist for Prognostic Studies tool.[278] This tool covers six domains that pose risks of bias in prognostic studies: sampling technique, participant withdrawal rate, prognostic factors assessed, outcomes measured, confounders and statistical analysis.[278] For each item, the study was assessed to determine whether it met the criteria for avoiding bias (“yes”) or not (“no), or whether there was insufficient information to make such a determination (“uncertain”). It was agreed beforehand, based on the recommendations made in another systematic review,[279] that studies obtaining four or more “yeses” on the total of six items, would

be regarded as having a low risk of bias, while those not obtaining this score would be regarded as having a high risk of bias. Following the independent assessment of each article by the two readers, they met to compare their findings and reach a consensus.

Data synthesis
Given the heterogeneity of the included studies, a qualitative synthesis of the results was performed.

4.2.2 Results – Prognostic factors

A total of 859 articles were identified on the basis of the bibliographic search. Following identification of the titles and abstracts of these articles, 712 were excluded. A reading of the remaining 147 articles revealed that 140 did not meet the exclusion criteria and were excluded. Eight studies (table 22) were therefore taken into account for this knowledge review.[280-287]

Characteristics of included studies
Of these eight studies,[280-287] four were prospective and four were retrospective. The total number of participants was 3,310 workers. Three of the studies focused on the prognostic factors of absenteeism,[284-286] while the other five studied the prognostic factors of RTW.[280-283,287] Ranging from 20 to 73 years of age, the participants comprised 39% men and 61% women. Their mean age was 47 years. Three studies included participants with a full-thickness RC tear.[280,282,287] The sample populations in the other studies were composed of participants with a RC tendinopathy[283] or a musculoskeletal disorder of the upper extremities (18% of the shoulder, 49% of the upper extremities including the shoulder),[281] participants suffering from neck and shoulder pain,[284] new maintenance employees in schools in one district in the United States (participants did not necessarily have shoulder pain at the time of inclusion),[285] and participants presenting with a new episode of shoulder pain.[286] The follow-up periods ranged from one to seven years.

Table 22 – Characteristics of included studies

Study	Research design	Participant				Follow-up period	Outcome measure
		Diagnosis	Treatment or surgery	Characteristic of workers' job	Number of workers (N), mean age (SD) and gender (% women)		
Bhatia et al., 2010	Cohort study	Full-thickness tears	Arthroscopic repair of RC	Compensated workers. Classification of work level.	N = 78 (start of the study) N = 55 (at final follow-up) Age: 54.9 (8.2) Gender: 21.8% F	33.6 +/- 13.9 months	Return to a job with an effort level equivalent to pre-surgical situation (yes or no)
Descatha et al., 2009	Case-control study	Symptoms or disorders of upper extremities (Shoulder: 74, elbow: 21, hand or wrist: 119, multiple disorders of upper extremities: 207)	Surgery (n = 23), physiotherapy (n = 64), corticosteroid injections (n = 32)	Repetitive work (material handlers in different types of industries: automobile, electricity, garment and footwear, food, supermarket)	N = 549 (start of the study) N = 464 (at follow-up) Age: 38.5 (range: 20-59) Gender: 73.1% F	3 years	Presence or not of upper extremity disorders in workers exposed to repetitive work (measurement tools: Nordic questionnaire, self-report questionnaire, clinical examination)

Study	Research design	Participant				Follow-up period	Outcome measure
		Diagnosis	Treatment or surgery	Characteristic of workers' job	Number of workers (N), mean age (SD) and gender (% women)		
Didden et al., 2010	Retrospective cohort study	Full-thickness tears	Open (n = 34) or arthroscopic (n = 39) repair of RC	Workers (between 18 and 55 years of age) Classification by indemnities (high or low) and work level	N = 93 (start of study), N = 73 (at follow-up) Age: 49 (range: 36–55)	Not reported	Time to return to work to same work tasks as pre-surgery (measurement tools: questionnaires: work level classification)
Engebretsen et al., 2010	Cohort study	RC disorder	Supervised exercises Extracorporeal shock wave treatment (ESWT)	Workers with different employment situations (working, not working, retired)	N =104 (start of study) N = 94 (follow-ups: SPADI) N = 91 (employment situation) Age: 48 (10.7) Gender: 50% F	1 year	SPADI, Employment situation
Grooten et al., 2007	Cohort study	Neck/shoulder pain	None	Blue collar workers, white collar workers, other workers (employers, self-employed workers, workers participating in a labour market program)	N = 2,859 (start of study) (neck, shoulder or back pain) N = 1,471 (at follow-up) (neck or shoulder pain) N = 1,459 (chronic pain) N = 1,429 (sought medical care) Age: 42 (10) Gender: 66% F	5–6 years	Symptoms and clinical signs of pain in neck/shoulder (measurement tools: Nordic Pain Questionnaire); Sought medical care or not; Compensated sick leaves (yes or no, sick leave duration of more than 14 days or 28 days)

Study	Research design	Participant				Follow-up period	Outcome measure
		Diagnosis	Treatment or surgery	Characteristic of workers' job	Number of workers (N), mean age (SD) and gender (% women)		
Harbin et al., 2011	Cohort study	Incident involving shoulder pain	Physical capacity test prior to employment	Janitorial employees: showed physical capacity to perform heavy work. Retrospective control group: did not do physical capacity test	N = 248 (intervention gr N = 497 (control gr) Intervention gr: Age: 34 (11.9) Gender: 8% F Control gr: Age: 43 (17.2), 35 at time of hiring Gender: 15.3% F	Two consecutive 3-year periods	Incidence of workers with a work-related injury
Kujipers et al., 2006	Cohort study	New episode of shoulder pain	Acetaminophen or nonsteroidal anti-inflammatory drugs (n = 253) Corticosteroid injections (n = 35) Physiotherapy (n = 41) Other therapies (n = 17)	Workers (all sectors) experiencing a new episode of shoulder pain	N = 350 (start of study) N = 298 (at follow-up) Age: 45 (11) Gender: 45% F	6 weeks, 3 and 6 months	Sick leave of at least one day (yes or no), shoulder disability (SDQ 0-100 questionnaire), pain (numerical rating scale), severity of complaint (numerical rating scale, 0–10)

Study	Research design	Participant				Follow-up period	Outcome measure
		Diagnosis	Treatment or surgery	Characteristic of workers' job	Number of workers (N), mean age (SD) and gender (% women)		
Nove-Josserand et al., 2011	Cohort study	RC tear in patients injured at work (67%) or occupational disease (33%)	Open (n = 185), semi-open (n = 24), or arthroscopic (n = 53) RC repair	Employees in private or public sector, self-employed workers, government employees, non-manual and manual employees	N = 290 (start of the study) N = 254 (at follow-up) At time of surgery: Age: 50.5 (6.4) Gender: 25% F At time of return to work: Age: 48.1 (0.8) Gender: 25% F	2 to 7 years	Return to work (yes, no, modified tasks)

The prognostic factors measured differed, depending on the study, but can be categorized as follows: sociodemographic variables (gender, age, education); characteristics of the disorder (nature of the disorder, disorder of the dominant side, recurrence, triggering event [traumatic or overuse], pain duration and intensity, functional level, range of motion, muscle strength, treatments, medication, presence of comorbidities, general health status); and work-related measures (working status, physical workload, indemnities, psychosocial work environment, employment status, type of employment). The definition of RTW varied from one study to the other; in some cases, it was the worker's complete recovery that was taken into account (level of efforts equal to those in pre-operative situation),[280] while in other studies the authors considered it to mean only that the worker was back at work performing the same tasks.[287] And some studies did not define RTW. The definition of absenteeism also varied from one study to the other, with some seeking to determine whether absenteeism existed or not (absence of at least one day, long absences), absences due to an occupational injury or the situation regarding employment (participant working, not working or retired).

Results of risk-of-bias assessment of the studies

Following assessment of the articles using the Methodology Checklist for Prognostic Studies and attainment of a consensus between the two readers, four studies were rated as having a low risk of bias[283-286] and four others as having a high risk of bias.[280-282,287] The items most frequently rated as being at high risk of bias were those related to participant withdrawal before follow-up and to inadequate statistical analyses. Five studies were rated at high risk of bias for both these items (participant withdrawal,[280-283,286] inadequate statistical analyses[280-282,285,287]).

Description of prognostic factors identified in included studies (table 23)

The retrospective study by Bhatia et al.[280] (high risk of bias) sought to identify the factors associated with the RTW following the arthroscopic repair of a full-thickness RC tear. All the participants (n = 78) received financial compensation. RTW was defined as a return to a job involving a level of effort equal to that required pre-surgery. The analyses showed that only one pre-operative case of alcohol consumption (more than six drinks per week) was associated with an inability to return to a job involving a level of effort equal to that required pre-surgery ($p = 0.011$). The other personal, clinical or surgical factors were not significantly associated with the RTW ($p \geq 0.05$).

In one prospective study (high risk of bias), Descatha et al.[281] recruited workers (n = 549) exposed to repetitive work and suffering from musculoskeletal disorders of the upper extremities (74 participants had a shoulder problem exclusively). Over a three-year period, the recovery rate of the workers with a shoulder disorder was low, with only 17 participants out of 74 (23%) recovering. This rate was even lower for workers with more than one disorder of the upper extremities (12%). Pain intensity and duration were strongly associated with multiple disorders of the upper extremities ($p < 0.001$). Moreover, older age and pain intensity were associated with a lower recovery rate: only nine participants over 45 years of age at the start of the study were symptom-free at the three-year follow-up, compared to 21 participants under 30 years of age ($p < 0.001$). No significant difference in the incidence of participant recovery was observed between workers whose job tasks were modified during the three years of the study and those who retained the same tasks ($p \geq 0.05$). Likewise, job satisfaction was not significantly associated with recovery.

In their retrospective study (high risk of bias), Didden et al.[282] examined the correlation between the level of compensation received by workers who had undergone RC repair (n = 73) and their time to RTW. The results showed that the time to RTW for the individuals receiving high compensation was longer (mean of 7.2 months) than that of workers receiving lower compensation (mean of 4.2 months) ($p < 0.05$). In addition, using Iannotti's classification of physical work demands (four levels of demands related to the weights of the loads to be lifted and to the frequency of tasks requiring arm lifting above shoulder height), the Didden et al. study also revealed a much longer time to RTW for participants whose tasks involved a very high level of physical demand ($p < 0.05$).

In the prospective study by Engebretsen et al.[283] (low risk of bias), the authors examined, over a one-year period, the determinants of work status in individuals suffering from a RC tendinopathy (n = 104). This study consisted of a secondary analysis of data from a randomized clinical trial (RCT) that compared the effectiveness of an exercise program to that of extracorporeal shock wave therapy (ESWT). At the start of the study, 41 participants (40%) were not working. One year later, 25 (24%) participants were still off work. A set of sociodemographic and clinical determinants, such as pain, initial level of disability, symptom duration, education, psychological distress, prior treatments, medications taken and range of shoulder motion, was taken into consideration in a multivariate analysis. A low level of education (fewer than 12 years of schooling) and worker-reported poor general health were found to be significantly associated with a sick leave at follow-up (odds ratio: 4.3 [95% CI: 1.3 to 14.9] for a low level of education; odds ratio: 1.06 [95% CI: 1.0 to 1.1] for worker-reported poor health status). Statistical adjustment for potential confounders, such as age, gender and treatments received during the study, did not change the results.

The prospective study by Grooten et al.[284] (low risk of bias) followed a cohort of 1,471 workers over a six-year period. At the start of the study, 124 participants confirmed that they suffered from shoulder pain and 38 reported having been on sick leave during that time. The presence of shoulder pain initially was not significantly associated with sick leave during the study follow-up period (relative risk, RR: 0.91 [95% CI: 0.64 to 1.23). The conclusions of a multivariate analysis that combined participants suffering from shoulder and/or neck pain indicated that a history of sick leave during the year of participant enrolment was associated with a sick leave during the study period (RR: 2.58, 95% CI: 2.01 to 3.19). Workers who had sought medical care for their shoulder and/or neck pain prior to the study presented a lower risk of going on sick leave during the study period (RR: 0.67, 95% CI: 0.56 to 0.80). In addition, a traumatic cause of the disorder was associated with a decreased risk of being on sick leave (RR: 0.71, 95% CI: 0.59 to 0.86).

The retrospective study by Harbin et al.[285] (low risk of bias) sought to determine whether the introduction of a pre-hiring physical examination had an effect on the proportion of workers with shoulder pain and work absenteeism among janitorial workers in schools (n = 745). The purpose of the test, which was obligatory for potential employees, was to assess whether the latter had the capacities and muscle strength needed to perform the job-related tasks. If the potential employee was deemed unfit to perform the job-related tasks, he or she was not hired. During the three years prior to the introduction of this physical examination, 19 shoulder injuries had been reported and the incidence of these injuries was 0.22 per 100 hours worked. Following

introduction of the test, no shoulder incident was reported during the three years of the study, a reduction considered to be statistically significant ($p < 0.05$).

In another retrospective study, Nové-Josserand et al.[287] (high risk of bias) investigated factors that could influence the RTW following a RC repair. A total of 290 workers completed a questionnaire less than two years post-surgery to evaluate the surgical outcome. No definition of RTW was given. Sixty percent (60%) of the participants returned to work following surgery. For the 40% who did not return to work, it was the shoulder disorder that delayed the RTW. Age ($p < 0.0001$), the diagnosis of a traumatic accident at work versus an occupational disease arising from overuse ($p < 0.0001$, against occupational disease), employee status ($p = 0.015$, against private sector versus self-employed or public sector workers) and surgical technique ($p = 0.004$, in favour of open surgery over arthroscopy) were the various factors significantly associated with the RTW. The type of work and nature of the disorder were not significantly associated with the RTW; however, the nature of the disorder was related to the duration of sick leave ($p = 0.04$, sick leave was longer if two or three tendons were affected). The only other factor associated with duration of sick leave was the type of job ($p = 0.05$, directly related to manual work).

The prospective study by Kujipers et al.[286] (low risk of bias) attempted to develop a clinical prediction rule for assessing the risk of work absenteeism following a shoulder disorder. The study involved a sample of 350 workers suffering from a new episode of shoulder pain. At the six-month follow-up ($n = 298$), sick leave was defined as at least one day off work within the previous six months due to the shoulder disorder. Thirty percent (30%) of the workers reported at least one day of sick leave due to their shoulder pain, while 16% reported having been absent for at least ten days. A longer sick leave prior to the study (more than one week: RC = 2.2 [95% CI: 1.0 to 4.7]), overuse of the shoulder as the result of routine activities (RC: 1.9 [95% CI: 1.1 to 3.5]) and the presence of a psychological disorder (RC: 4.0 [95% CI: 1.5 to 10.8]) were all factors significantly associated with a sick leave.

Table 23 – Prognostic factors identified in included studies

Category/Prognostic factor	Study	Result
Sociodemographic factor		
Education	Engebretsen et al.	A higher level of education is associated with a higher rate of presence at work after one year in patients with a RC disorder (odds ratio [OR] = 4.3 [95% CI: 1.3 to 14.9]). The chances (ODDS) of working are 4.3 times higher for individuals with more than 12 years of education.
Age	Nové-Josserand et al.	An older age is associated with a lower rate of return to work (RTW) (RTW: 82.8% of workers age 50 or under, 64% of those between ages 50 and 55 and 21% of those age 55 or over) and a lower rate of return to the same job (different job: 20.7% of the workers age 50 or under, 5.3% of the workers between the ages of 50 and 55 and 0% of those age 55 or over) following a RC repair ($p < 0.0001$).
	Descatha et al.	An older age is associated with a lower recovery rate ($p < 0.001$).
Alcohol consumption	Bhatia et al.	The fact of consuming more than six alcoholic drinks per week is associated with an inability to return to work following an arthroscopic RC repair.
Characteristic of the disorder		
Injury history	Grooten et al.	A traumatic origin appears to be associated with a lower risk of absenteeism in workers suffering from chronic shoulder or neck pain.
	Nové-Josserand et al.	The diagnosis of an occupational disease related to overuse (compared to that of a traumatic work-related injury) is associated with a lower RTW rate ($p = 0.0005$, returned to work: 63.7% of the workers injured at work and 43.6% of those with an occupational disease) and a lower rate of return to the same position ($p < 0.0001$, return to the same job: 52% of the workers injured at work and 28% of those with an occupational disease), following a RC repair.
	Kujipers et al.	A history of shoulder overuse as a result of routine activities is associated with a sick leave after six months (odds ratio [OR]: 1.9 [95% CI: 1.1 to 3.5]).
Pain	Grooten et al.	The presence of pain for more than three months is associated with a lower risk of absenteeism in workers with chronic neck and/or shoulder pain (relative risk [RR] = 0.65 [95% CI: 0.51 to 0.82]).

Category/Prognostic factor	Study	Result
	Descatha et al.	Greater pain intensity is associated with a lower recovery rate.
Health status	Engebretsen et al.	Better health status (self-reported) is associated with a higher presence at work after one year in workers with a RC disorder (odds ratio [OR]: 1.06 [95% CI: 1.0 to 1.1]). A score of one point higher on the Euro-Qol-VAS increases the probability of a return to work by 6%.
	Grooten et al.	The fact of seeking health care for neck and/or shoulder pain is associated with a lower risk of absenteeism (RR = 0.67 [95% CI: 0.56 to 0.80]).
Surgical technique	Nové-Josserand et al.	Open surgery to repair the RC is associated with a higher proportion of workers returning to work (returned to work: 66% open surgery, 41.6% semi-open surgery and 45.3% arthroscopic repair).
Psychosocial factor	Kujipers et al.	The presence of a psychological disorder is associated with a sick leave after six months odds ratio [OR]: 4.0 [95% CI: 1.5 to 10.8]).
Job-related factors		
Indemnities	Didden et al.	Higher indemnities are associated with longer times to RTW ($p < 0.05$) following RC repair (mean time of seven months to return to work in workers with a full-thickness tear caused by a work accident, of four months for compensated workers and of two months for self-employed workers).
Physical demands	Didden et al.	Physically demanding work is associated with longer times to RTW ($p < 0.05$) following RC repair (mean time of less than one month to RTW for sedentary workers [grade I, Iannotti classification], of three months with lighter tasks [grade II], four months for intermediate tasks [grade III] and six months for heavy tasks [physically demanding, grade IV]).
	Harbin et al.	A pre-hiring physical examination reduces the proportion of workers that develop shoulder pain and work absenteeism ($p < 0.05$).
Absenteeism	Grooten et al.	Sick leave during the year of participant enrolment is associated with increased absenteeism during the study period in workers with chronic neck and/or back pain (RR = 2.58 [95% CI: 2.01 to 3.19]).

Category/Prognostic factor	Study	Result
	Kujipers et al.	Sick leave of longer than one week prior to the study is associated with sick leave after six months (odds ratio [OR]: 2.2 [95% CI: 1.0 to 4.7])
Type of work	Nové-Josserand et al.	Working in the private sector is associated with a lower RTW rate (p = 0.0015, returned to work: 53% of private sector workers, 78.8% of self-employed workers, 80.6% of government employees) and lower rate of return to same position (p = 0.0004, returned to work: 39% of private sector workers, 70% of self-employed workers and 68% of government workers) following a RC repair.

4.2.3 Discussion

This section presents the determinants or predictors of sick leave and RTW in patients with shoulder pain. Eight studies were retained, including four with a low risk of bias. Overall, the results are insufficient to determine with any accuracy the factors associated with absenteeism or RTW in workers who have undergone shoulder surgery or who have a shoulder disorder.

A number of clinical, sociodemographic or work-related factors were identified in the studies, but very few of these factors were documented in more than one study. In fact, only three factors were identified in more than one study, namely, the origin of the disorder (traumatic or non-traumatic), the severity of the disorder and the frequency of sick leaves prior to initial assessment. According to the results of three studies,[284,286,287] a disorder of non-traumatic origin, also described as overuse or cumulative trauma, is significantly associated with a higher risk of sick leave and longer time to RTW. The strength of the association obtained in the three studies is similar, corresponding to a relative risk ranging from 1.4 to 1.9. Other authors have also asserted that the non-traumatic origin of an upper extremity disorder related to overuse is associated with a higher frequency of sick leaves and the "chronicization" of the disorders.[288]

Two of the studies identified pain severity and general health status (measured using the Euro-Qol-5D questionnaire) as factors in RTW or absenteeism.[283,284] These findings concur with those of several studies on other musculoskeletal disorders (upper extremity disorders and low back pain), which also associated pain severity with a higher risk of sick leave and a longer time to RTW, if not the impossibility of a RTW.[15,289] Surprisingly, in the Grooten et al. study, the authors found that pain lasting longer than three months was associated with a lower risk of sick leave.[284] According to them, these results may be explained by the fact that the workers with increased, persistent pain may have developed adaptive strategies for keeping their jobs. However, another study included in this knowledge review found no significant association between the presence of persistent shoulder pain and the failure of the RTW.[283] Given these contradictory results, it would be risky to assert that pain severity positively or negatively influences the RTW or the frequency of sick leaves. The contradictory results mentioned here could be explained by the fact that the independent variables related to the severity of the disorder did not all measure the same construct. However, it is more likely that they were due to methodological problems in the study designs or to differences in the characteristics of the workers in the various studies.

In two other studies, the authors found an association between sick leave (prior to the study), long sick leaves, and a higher risk of failed RTW or of new episodes of sick leave.[284,286] Although these factors were also identified in other studies of populations with low back or cervical pain,[290] one systematic review of prognostic factors of a good recovery following a shoulder disorder points out that there is insufficient evidence to confirm this association.[291]

Only one study[283] identified sociodemographic factors as determinants of presence at work following a RC disorder in workers. In that study, however, the authors did not take into account certain potential confounders. The workers with 12 or more years of education appeared to have a 4.3 times greater chance of being back at work one year post-operatively. This study also showed a significant association between a higher level of education and less severe pain and

fewer disabilities related to the shoulder (measured using the SPADI questionnaire) at the one-year follow-up. Other studies have concluded that a correlation exists between a higher level of education and a lower frequency of sick leaves following an orthopedic trauma.[14]

According to the authors of one study, the concurrent presence of psychological disorders, such as psychological distress, depression or anxiety, is associated with more frequent sick leaves.[286] However, another study that explored the same variables reached opposite conclusions.[283] These contradictory results are surprising, given the growing amount of data showing that psychosocial factors play a major role in RTW and in the incidence of upper extremity disorders and their chronicization.[14,15]

Three of the included studies focused specifically on the factors influencing the RTW of workers who had undergone a RC repair.[280,282,287] Older workers were less likely to return to work following a RC repair; only 21% of those ages 55 and over went back to work versus 82.8% of those ages 50 and under. Numerous prognostic studies have identified older age as a factor that is unfavourable to the recovery of tendons, function, and quality of life in people having undergone a RC repair.[14,15] The authors of another study associated alcohol consumption with an inability to return to work. However, these conclusions were based on a univariate analysis that did not take into account other factors that may have influenced these results. They must therefore be interpreted with great caution. The only clinical factor promoting RTW that was identified in this review was open surgery as opposed to arthroscopic surgery.[287] On the other hand, another study examining the same factor reached the opposite conclusion.[282] The work-related determinants were explored in two studies of workers who had undergone a RC repair procedure.[282,287] Of the significant factors identified in these two studies, physically demanding work was associated with longer sick leaves. In both studies, a mean difference of five months was observed between the RTW of workers with physically demanding jobs and that of workers with sedentary jobs. The results of another study indicated that higher indemnities were associated with a longer sick leave, and that the RTW was longer for private sector employees than for public sector or self-employed workers.[285] These factors were also associated with a longer time to RTW or with a failed RTW in workers with upper extremity disorders.[14,15]

Although several factors were identified in this knowledge review, it is difficult to advance any firm conclusions regarding their impact on absenteeism and the RTW of workers with shoulder pain. All the factors identified were reported as being significantly associated with the RTW, clinical improvement or absenteeism in numerous studies on other musculoskeletal disorders, especially involving the upper extremities.[14,15] However, the number of studies included in this review is too small to conclude that these factors are also significant for RTW and absenteeism in workers with shoulder pain. Moreover, as several authors have pointed out, a RTW and sick leave can have many causes,[292] thus complicating our understanding of the role played by the aforementioned factors . Additional methodologically valid studies are needed before an opinion can be expressed. In fact, for the most part, the methodological quality of the included studies was low. Attrition biases were frequent and few multivariate analyses (including potential confounders) were performed. Only one study used a predictive model. Another priority need is for future studies to provide clear definitions of RTW and absenteeism. While investigations into RTW and absenteeism are pertinent, presenteeism and work disability warrant examination as well since these two problems are also very important for both workers and employers.

Other factors influencing the return to work

A review of the determinants and predictive factors of RTW or absenteeism has been presented here, specifically for individuals with shoulder pain. As little literature currently exists on this subject, other determinants and predictive factors that may promote the RTW of individuals with a musculoskeletal problem, regardless of the joint involved, were examined.

The RTW problem has many different facets,[293-295] of which the biomedical aspect is only one. Moreover, studies have shown that biomedical interventions alone are not enough to ensure the RTW.[295] It is therefore vital that the obstacles to and facilitators of a prompt and sustainable RTW be identified. This would allow for a reorientation of worker management if needed, depending on the obstacles identified. Several other factors of a psychological nature, as well as workplace involvement and the employer's role, also influence sick leave duration, the RTW and the sustainability of this return.[296-298]

Psychosocial factors in the return to work

A worker's motivation can play a key role in his or her RTW. In the case of low back and cervical pain, the worker's willingness to return to work is an important factor.[294] In fact, several studies involving workers suffering from low back pain have shown that the RTW depends more on psychological factors than clinical factors. Depression, anxiety and insomnia, for example, appear to be major impediments to the RTW and are associated with chronicity.[294] It has also been shown that the stress experienced at work is associated with absenteeism, whereas a job in which the worker bears greater responsibility and feels supported by the employer reduces the risk of absenteeism.[294]

The relationship that a worker on sick leave has with health professionals also plays an important role in the RTW. In fact, meetings that are seen by workers as positive or respectful,[299] or that make them feel they have been heard and believed, appear to promote the RTW. Similarly, the feeling of being supported by the attending physician, and the physician's confidence that the patient can or will be able to return to work helps the patient return faster. Conversely, negatively perceived meetings with the attending personnel lead to feelings of shame and hinder the RTW.[256,300] This feeling of shame is experienced, among other times, when the attending personnel's attitude toward the worker is perceived as distant or indifferent. The feeling of being discredited, of not being in an egalitarian relationship with the attending professional, also appears to create a feeling of shame that hinders the RTW.[256] It is important to stress here that these psychosocial aspects are potentially modifiable, but that their importance must be taken into account in the RTW plan in order to facilitate the return.

Collaboration and communication

What emerges from a reading of several literature reviews on factors facilitating the RTW is the importance of collaboration and communication among the various stakeholders (employer, employees and health professionals).[293-295] Judging from the scientific evidence, we can affirm that the duration of an injured worker's disability and sick leave decreases significantly if the employer, worker and attending personnel communicate effectively.[293,295] Albeit potentially demanding, collaboration is not only beneficial but necessary for an efficient RTW.[295] Studies also suggest that if the employer contacts the worker on sick leave during the four weeks following his or her departure, this promotes a RTW. A collaborative multidisciplinary approach

may also be appropriate.[293,295] This type of approach makes it possible, for example, to tackle the many facets of the RTW and to smoothly coordinate interventions among the various RTW stakeholders. A manager with recognized skills in this area could coordinate such a collaborative initiative and promote communication between employer and worker to improve the RTW process.[295]

Role of the employer

The scientific evidence emerging from the literature suggests that the employer's involvement can have a major impact on the RTW. Studies show that a trusting relationship, as well as the worker's perception that the employer wants to facilitate his or her RTW, promote the return.[293] According to several studies, the employer should also maintain contact with the attending personnel and the employee, as well as come to an agreement with the latter regarding a specific intervention and RTW plan.[301,302] According to the studies, the employer should be directly involved in the RTW and foresee any potential obstacles.[301,302] For example, the adaptation of work tasks and the frictions this can potentially create with coworkers must be taken into consideration by the employer.[293] In summary, in order to promote the sustainable return to work of a worker with a musculoskeletal disorder, the employer must become an active participant in the action plan and work collaboratively with the other stakeholders (psychosocial and medical) while also maintaining contact with the employee.

5. CONCLUSION

The aim of this knowledge review was to provide an updated overview of the scientific evidence on the various aspects of follow-up of patients with a RC disorder, particularly that of workers. Three major themes were developed in this review: (1) the effectiveness of the clinical and diagnostic evaluation tools; (2) the effectiveness of the currently used treatments; and (3) the issue of absenteeism and its risk factors, as well as RTW-related interventions. Systematic reviews or meta-analyses were performed on each of these themes.

First, this knowledge review defined the role of clinical tests for diagnosing a RC disorder. The diagnostic values documented do not allow any particular clinical test to be recommended for diagnosing a RC disorder since none of them is both sensitive and specific. However, combinations of clinical tests and variables suggest that they offer superior diagnostic capacities to those of clinical tests alone. Other studies are therefore needed to confirm the diagnostic value of combining clinical tests and variables. This would allow us to ascertain the diagnostic effectiveness of a process that is closer to a clinical process. Medical imaging can be used as a complement to clinical tests to confirm more specifically the RC disorders involved. Ultrasound, MRI and MRA are in fact highly sensitive and specific. The use of ultrasound, which has a diagnostic accuracy similar to that of MRI and MRA but is less costly, is recommended for diagnosing RC disorders. In cases where ultrasound does not provide a specific diagnosis, MRI and MRA may offer interesting alternatives. However, in most circumstances, we recommend first a combination of different clinical evaluation tests that are non-invasive and less costly, prior to using medical imaging, as these medical imaging systems are primarily appropriate for confirming certain disorders.

Next, the clinical measurement tools used on a regular basis to assess the strength of the muscles acting on the shoulder, range of motion, and scapular position and movement, generally have good reliability. However, the validity and responsiveness to change of most of these tools has yet to be determined. In addition, their use should be combined with that of other tools such as self-report questionnaires for evaluating symptoms and functional limitations, which have shown their responsiveness to change in individuals with a RC disorder. Self-report questionnaires in fact show excellent measurement properties for the clinical evaluation of patients with a RC disorder. Some of them, including the popular DASH, *Quick*DASH and WORC, are available free of charge in French. Mixed tools combining questionnaires and performance tests also appear valid for clinical use. However, data are lacking on their responsiveness to change.

Regarding the treatment of RC disorders, certain interventions can be recommended for managing tendinopathy or full-thickness RC tears. Taking non-steroidal anti-inflammatory drugs (NSAIDs) for a short period of time is effective in alleviating pain associated with RC tendinopathies. The positive effects of an exercise program have also been demonstrated in adult and worker populations, as has the similar effectiveness of an exercise program combined with acromioplastic surgery for treating RC tendinopathy. Conservative treatment is therefore initially recommended in adults with a RC tendinopathy. When conservative treatment fails, surgery may be contemplated. A comparison between the different types of surgery revealed similar effectiveness for the arthroscopic and open-surgery approaches. For full-thickness RC tears, all RC repair surgeries, whether open or arthroscopic, have proven effective. Likewise, single-row

and double-row suture repairs have shown similar effectiveness, while the addition of acromioplasty to a RC repair does not appear to offer additional benefits and is therefore not recommended.

Regarding workplace-based interventions, no formal conclusions can yet be drawn about the possible additional benefits of a multimodal approach to work versus those of the conventional clinical approach, although some data appear to support a multimodal approach that includes counselling, exercises, and work task modifications and adaptations. With respect to ergonomic adjustments to work stations and work organization, contradictory data have been published and further studies involving the population of interest here are needed.

The predictive factors of absenteeism and RTW in workers have also been explored. This knowledge review confirms the ambiguity surrounding the factors related to both these phenomena in workers with RC disorders. Several factors in fact emerge from the included studies, but their results do not represent consensus. Therefore, determinants studied in previous review for other joints than the shoulder have also been explored. Psychosocial or environmental factors, as well as the role of the employer, appear to be key elements in the success of the RTW.

Lastly, this knowledge review has certain limitations. Given the variety of tests and interventions available, we opted to study only those most frequently used and those for which there was sufficient evidence to make recommendations. Some of the more recent interventions, such as platelet-rich plasma or transdermal nitroglycerin injections, were not included in this review even though such interventions may be effective.

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