

Clinical features in rotator cuff calcific tendinopathy: A scoping review

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Abstract

Introduction: The main goal of this scoping review is to highlight the clinical features of subjects with rotator cuff calcific tendinopathy (RCCT), in order to identify and map this condition clinical criteria, and thus to be able to hypothesize such pathology before imaging investigations.

Methods: Four databases were consulted up to January 2023. The obtained results were reported following the PRISMA-ScR and the Joanna Briggs Institute reviewer's manual was used as guideline for conducting the review. No time and geographical restrictions were applied.

Results: A total of 851 records have been identified, with 50 studies meeting the inclusion criteria. Subjects with RCCT mostly reported nightly, acute and severe pain with spontaneous onset. Symptoms were mostly unilateral. Subjects were mostly women aged between 30 and 60. Deficit in active and passive range of motion was reported, mainly during abduction and forward flexion. Endocrine and metabolic disorders were described as comorbidity, in particular diabetes and thyroid disorders.

Conclusion: In this scoping review, the most relevant RCCT clinical features were detected. These clinical criteria, predictive for shoulder RCCT, can be crucial to help all clinicians suspect this musculoskeletal disease early and with certainty, thus allowing for an appropriate and prompt diagnosis path.

Level of evidence: III.

Keywords

calcific tendinopathy, clinical features, scoping review, shoulder

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Highlights

- Subjects with rotator cuff calcific tendinopathy often reported nightly, acute, unilateral and severe pain with spontaneous onset
- Subjects complaining rotator cuff calcific tendinopathy were often female aged between 30 and 60
- Subjects often reported deficit in active and passive range of motion, mainly in abduction and flexion
- Endocrine and metabolic disorders were often described as comorbidity

Background

Rotator cuff calcific tendinopathy (RCCT) is a clinical condition characterized by the presence of calcific deposits in the rotator cuff tendons,¹ which led to shoulder pain and functional limitations.^{2,3} The calcium deposits are most

commonly located at the level of the supraspinatus tendon^{1,2,4–8} and in about 10% of individuals the deposits are found bilaterally.^{1,4,5,7} Notably, in 20% of cases, the subjects are asymptomatic.^{1,7,8}

According to the literature, RCCT etiology remains unclear; probably, endocrine disorders play an important role in its development, but the effect of this process is still unknown.^{3,9} As far as its pathogenesis is concerned, various theories have been described in the literature; the

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most accredited one is the reactive calcification theory proposed by Uthoff in 1997,¹⁰ which consists in a three-stages process: pre-calcific, calcific, and post-calcific stage. During the pre-calcific stage, tenocytes undergo a metaplastic transformation into chondrocytes^{1,4,10} within the site where the calcium deposits will subsequently form. The calcific stage is further divided into three different phases: the formative phase, in which calcium deposits increase in size,^{4,10} the resting phase, characterized by the presence of calcium deposits in the rotator cuff,⁸ and finally, the resorptive phase, during which the calcium deposits are gradually eliminated through macrophages phagocytosis.^{8,10} During the last post-calcific phase, the tendon seems to undergo a remodeling process and it gradually returns to its prior physiological conditions.^{4,10} This theory emphasizes the fact that calcium deposits are characterized by spontaneous formation and remission and therefore RCCT should not be considered a degenerative process.¹

As for RCCT diagnosis, the majority of the studies focused on imaging screening investigations,^{1,4,5,11} rather than on the subjects' clinical presentation. X-ray, ultrasonography^{1,4,5,11} and, optionally, computed tomography^{6,12} and magnetic resonance imaging being described as the main diagnostic tools used to identify where calcium deposits are located and to inspect their morphology, dimension and evolution.^{7,12,13}

To date there is a lack of knowledge of relevant clinical criteria for hypothesizing RCCT in subjects with painful shoulder, therefore a scoping review would seem to be the most appropriate study for investigating these aspects.

The aim of this scoping review is to highlight the clinical features of RCCT in subjects affected by shoulder pain, in order to identify, map and summarize useful and relevant clinical criteria, which could led clinicians to an early RCCT diagnostic hypothesis, before imaging testing.

Review question

The review question is the following: what clinically relevant features are useful to hypothesize the clinical entity of RCCT.

Materials and methods

In this scoping review, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR checklist)¹⁴ was used for reporting and the Joanna Briggs Institute reviewer's manual was used as guideline for conducting the review.¹⁵

Inclusion and exclusion criteria

As far as the eligibility of the studies to be included in the study is concerned, the population, concept and context (PCC) criteria appeared to be the most appropriate.¹⁶

Therefore, in order to be included, articles had to meet the following criteria:

- *Population:* Symptomatic subjects diagnosed with RCCT
- *Concepts:* Any study reporting the RCCT clinical presentation
- *Context:* Any context.

In this scoping review, no restrictions regarding study design, publication type and time and geographical restriction have been applied. Therefore, studies which do not meet all the inclusion criteria included in PCC were excluded.

Search strategies

The search process to identify the studies to be included in this scoping review began on 28 July 2022, and the following databases were searched: PubMed, PEDro, and Cochrane Library. The articles obtained were subsequently screened for title and abstract, after the duplicates removal (28 records). Google Scholar has been consulted in order to identify any additional study and eventual grey literature. The full search strategy for PubMed and Google Scholar are available in Appendix 1. In January 2023, the search strategy was updated in order to include all articles published in 2022 as well.

Studies selection

The studies analysis was conducted by two independent authors (FG, ADS), who are physiotherapists specialized in shoulder musculoskeletal disorders. The studies selection was conducted using the Rayyan QCRI web application¹⁷; during this process both (a) a title and abstract and (b) a full-text screening was performed. A third independent author (DV) contributed to solve any disagreement. The PRISMA-ScR flow-chart shows the studies selection process (Figure 1); a detailed list of excluded studies, with their reason for exclusion, is provided in Appendix 2.

Data charting process

For data extraction we used a standard Excel file which follows the PCC. Two authors (FG and DV) filled the Excel, with mutual check. Disagreements were solved by a third author (FB). In this file, the following items have been included: title of the study, first author, year of publication, study type, and clinical presentation. In the "Clinical presentation" section, the subjects' most relevant features were reported—such as age, sex, pain characteristics, functional limitation, and possible comorbidities.

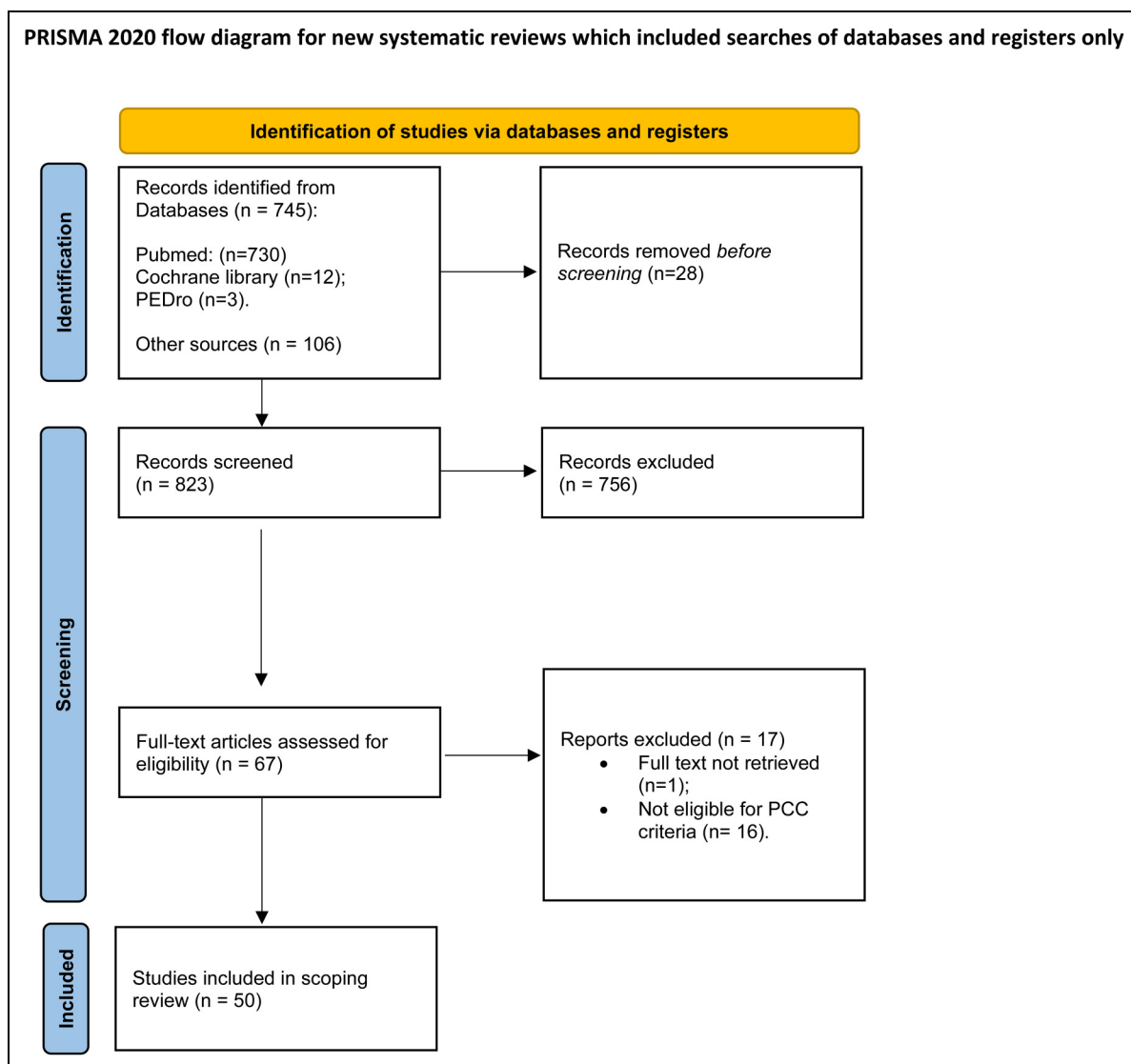


Figure 1. PRISMA 2020 flow diagram.

Data synthesis

As a scoping review, it was not necessary to perform a quality assessment of the included studies.¹⁸ The results have been presented quantitatively and thematically:

1. The quantitative results have been represented through a histogram (Figure 2), showing all the clinical features found in the analyzed studies. This quantitative representation provides a mapping of the clinical criteria that were found in subjects affected by RCCT: age, sex, pain characteristics (acute, chronic, onset type, intensity), functional limitation, signs (tenderness, erythema, increased temperature skin, etc.), comorbidities, lifestyle, and occupation type (manual workers, sedentary jobs, etc.) with the number of studies reporting such features.

2. Thematic analysis was performed to discuss and summarize the existing literature on the clinical characteristics of RCCT subjects, based on the quantitative results reported in this scoping review.

Results

Characteristics of the included studies

The search on the aforementioned databases was conducted at the end of January 2023 and led to the collection of 851 articles. Firstly, all duplicates were removed ($n=28$). Subsequently, the selection by title and abstract of each of the 823 remaining studies was conducted, leading to 756 articles being deleted at the end of this analysis. An article was not retrieved for full text evaluation. The full text analysis was conducted on the 66 remaining articles

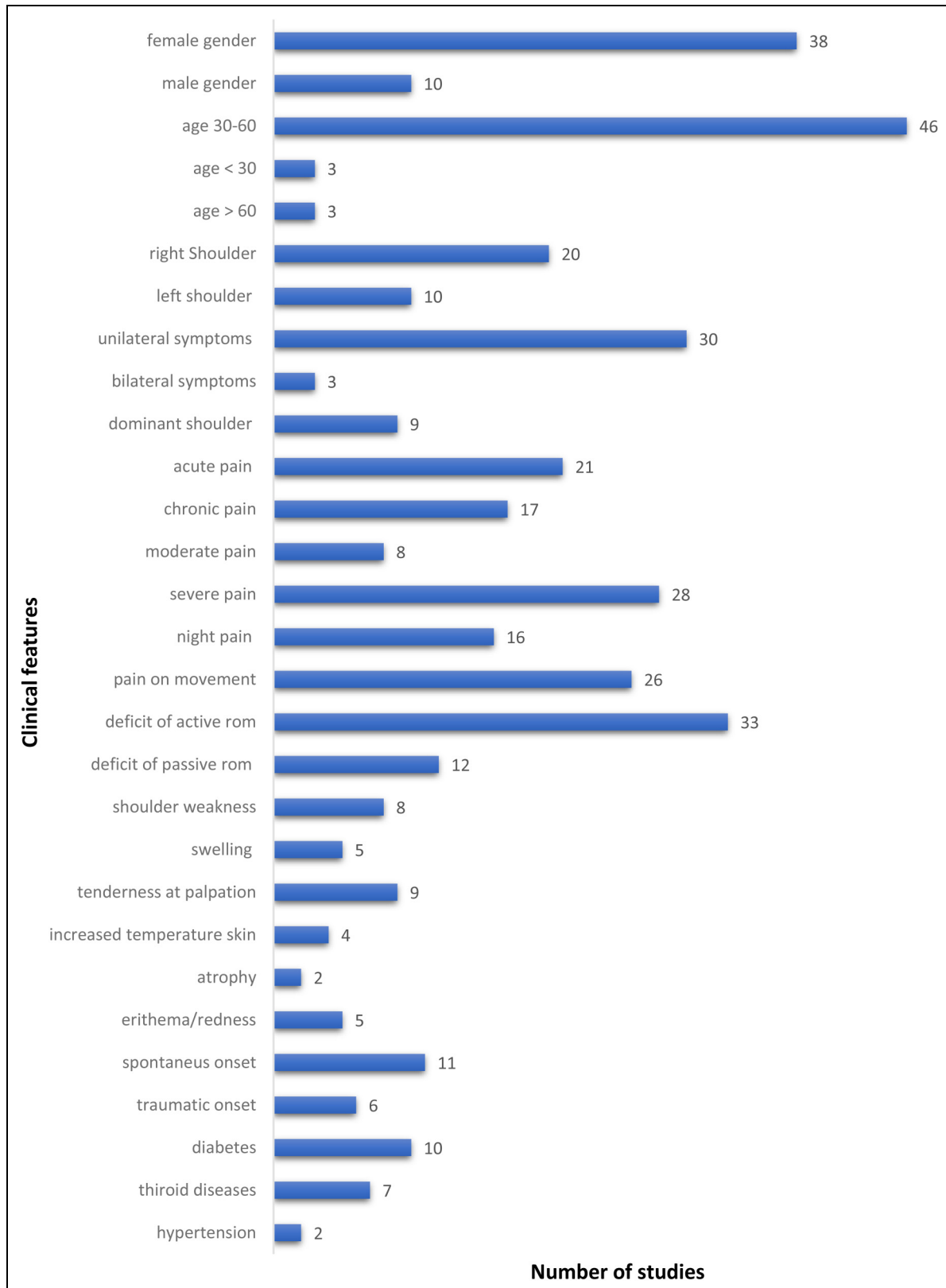


Figure 2. Clinical findings of rotator cuff calcific tendinopathy.

and 16 articles were excluded (the reasons for exclusion are detailed in Appendix 2). Therefore, at the end of the study selection, 50 articles were finally included (Figure 1). The report of included studies can be found in Appendix 3.

The 50 included studies were: case reports (n = 14),^{19–32} narrative reviews (n = 11),^{1–3,6–8,33–37} randomized clinical trials (n = 4),^{38–41} clinical trials (n = 4),^{42–45} retrospective studies (n = 5),^{9,46–49} case series (n = 3),^{50–52} prospective studies (n = 2),^{53,54} concise reviews (n = 2),^{4,55} cross sectional study (n = 1),⁵⁶ comparative study (n = 1),⁵⁷ prognostic study (n = 1),⁵⁸ diagnostic clinical study (n = 1),⁵⁹ clinical commentary (n = 1).⁶⁰ Three articles were declared as case reports; however, Gimblett et al.⁵⁰ reported two clinical cases in his study, Takahashi et al.⁵¹ described four clinical cases in his article, and Lehmer et al.⁵² reported three RCCT case reports. Indeed, 14 case reports and 3 case series were included, together with 23 RCCT single reports.

Most of the included studies were conducted after 2010 (32/50), 10 studies were conducted between 2000 and 2010 and 8 before 2000. Moreover, 24 of the included studies were European, while the others came from USA (13/50), Japan (3/50), Republic of China (2/50) Australia (1/50), Canada (2/50), Nepal (1/50), Egypt (1/50), Korea (1/50), Pakistan (1/50), and only in one study (1/50) the (geographical) origin of the data was not specified.

Clinical findings

As previously pointed out, the study included 50 articles and each article was fully reviewed in order to bring out all relevant clinic data. A mapping of the data is provided by the histogram in Figure 2.

In the majority of the articles included, female subjects were the most affected (>75%)^{1,2,4,6–9,19,21,23,25,28–30,32,33,36–39,42–56,58,59} and the subjects' age was reported between 30 and 60 years of age (>85%).^{1–4,6–9,19–22,27–30,33,34,36–40,42–56,58,59} Only in six studies, the individuals' age fell outside this range, with two children,^{23,24} three subjects who were over sixty^{28,30,32} and one 29-year-old individual.³¹

In 30 studies, the reported symptoms were unilateral (20 right shoulders)^{7,19–22,24,26,31,32,39,44,46,49–53,56} and 10 left shoulders,^{23,25,27–30,44,49,50,52} and in three studies the symptoms were present bilaterally.^{34,36,44} Nine of them specified that the subjects' dominant shoulder was affected.^{8,20,22,26,31,42,46,47}

Pain was mostly defined as acute, recent, severe,^{2,4,6,8,19,23,24,26,28,29,31,33,35–37,42,43,49,51–53,55} with a spontaneous and sudden onset^{20–23,27–32,50,51} and which occurred during the night.^{1,2,4,20,22,26,31,32,35,42,44,48,51} However, in some articles, the subjects' pain was described as chronic^{4,22,30,32,33,36,39–44,46,48,50,51,55} and moderate^{1,36,38,43,51}.

Another RCCT important clinical sign seems to be linked to the subject's limited range of motion (ROM). Indeed, in

thirty-three studies^{1,2,4,6–8,19–21,23–36,38,40,48–51,55} an active ROM deficit was reported, and in twelve studies^{2,19,20,24,26,28,30,36,40,44,50,51} a passive ROM deficit was reported; this suggested that RCCT may indeed frequently cause a functional movement restriction in affected subjects. Specifically, the restricted glenohumeral movements were reported in case of: forward flexion (17 studies),^{4,19,20,23,26,27,29,31,48,50,51} abduction (15 studies),^{8,19,20,23,26,29–31,33,50,51} internal rotation (11 studies),^{19,20,27,28,33,50,51} external rotation (8 studies),^{19,20,27–29,33,51} adduction (5 studies)^{19,51} and extension (5 studies).^{19,31,51}

Others clinical features reported by subjects affected by RCCT were tenderness upon palpation of greater tuberosity,^{2,6,29,50} deltoid,^{24,50} bicipital groove,⁵⁰ acromial process area²⁰ and coracoid process.³² Moreover, local erythema or redness,^{2,4,23,34,37} swelling,^{21,23,32,37,60} muscle atrophy^{20,33}; increased skin temperature^{4,20,34,51} were reported. Shoulder weakness was reported in 4 studies,^{20,22,33,48} specifically, strength deficit during abduction (3 studies),^{20,22,33} external rotation (3 studies)^{20,22,33} and internal rotation (2 studies)^{20,33} were described; pain upon movement was reported in 14 studies^{2,20,22–24,26,29,30,33,37,44,48,50,51} and in particular glenohumeral movements contributed to exacerbate the subject's pain: abduction (7 studies),^{23,29,30,33,37,50} forward flexion (6 studies),^{2,20,23,29,48,50} internal rotation (3 studies),^{29,33,50} overhead activity (3 studies),^{22,26,37} external rotation (2 studies)^{29,33} and extension (1 study).²⁰ Furthermore, two studies^{24,51} reported that all shoulder movements worsened the subject's pain, in one study²² running was also described as a painful activity for the RCCT subject.

As far as comorbidities are concerned, endocrine and metabolic disorders have been reported. In particular, ten studies reported diabetes^{2–4,9,29,33,36,37,46,49} and seven studies reported thyroid disorders.^{2,3,9,33,36,37,49} Hypertension was also reported as comorbidity in subjects with RCCT in two studies.^{3,29}

Discussion

In the present study, the main RCCT clinical findings were the following: predominantly female-related condition, subjects aged between thirty and sixty, sudden onset of severe pain, night pain, active and passive ROM deficit, pain upon movement and presence of metabolic or endocrine comorbidities.

The aim of this scoping review is to highlight the RCCT clinical features reported in literature, in order to profile the clinical diagnostic criteria of this musculoskeletal condition. The scoping review study typology was chosen since no other reviews have been conducted on this topic. In fact, most of the RCCT diagnostic studies which can be found in the literature were based on imaging^{1,4,5,11} and little consideration was given to RCCT clinical features or to functional impairments. Detecting RCCT clinical

features would be crucial and beneficial for both the scientific literature and the subjects, since it would imply that clinicians could hypothesize RCCT cases earlier; consequently, they could offer their subjects a targeted therapeutic treatment immediately, in order to intervene promptly; moreover, this would help cutting costs for the subjects, who would resort less to imaging investigations and would perform only those strictly necessary for their own clinical condition.

The present study showed that the most common RCCT symptom is unilateral pain, mostly acute, severe and occurring at night, which has a sudden onset and strongly impairs the subject's movements.^{2,20,22–24,26,29,30,33,37,44,48,50,51} It is likely that subjects with a sudden onset of these severe clinical features are in their resorptive RCCT stage^{2,3,10,37} – which is generally described as the most painful and disabling stage^{1,4,7,10,33,37} – whereas subjects who are experiencing a chronic moderate pain are more likely to be in their RCCT formative stage.^{2,10,33,37}

Our review revealed an active and passive ROM deficit; in particular, forward flexion and abduction were the most restricted movements. This can be due to calcium deposits occurring more often in the supraspinatus tendon insertion, near the greater tuberosity.^{2,4} Indeed, Kim et al.⁴ reported that 63% of calcification occurs in the supraspinatus tendon, 20% in both supraspinatus and subscapularis tendons, 7% in both the infraspinatus tendons and subacromial bursa and 3% in the subscapularis tendon. Notably, all of these muscles play a predominant role in the active abduction of the shoulder^{61–64} and during the elevation on the scapular and sagittal plane.⁶⁵ Furthermore, the distance between the acromion and the humeral greater tuberosity during abduction and flexion on the scapular plane is minimal between 36 and 72 degrees of movement⁶⁶; therefore, the presence of calcium deposits at the supraspinatus insertion site could furtherly contribute to narrowing this space, resulting in pain upon movement, since the supraspinatus tendon and the calcified mass end up caught between the acromion and humeral head.³⁷

However, RCCT shows some clinical features that could be found in other shoulder pathologies as well and the present study could not rigorously delineate and isolate the clinical diagnostic criteria for symptomatic RCCT. For example, passive and active ROM deficit on different planes of movement, associated with night pain, is typically found in subjects with frozen shoulder,⁶⁷ therefore they cannot be considered discriminating RCCT criteria.

However, the sudden onset of severe pain found in RCCT subjects deserves to be assessed more in-depth. Generally, subjects affected by frozen shoulder or rotator cuff tendinopathies report a gradual onset of their symptoms, which tend to worsen over time.⁶⁸ Furthermore, in most cases, acute shoulder pain due to a rotator cuff tear is associated with a traumatic event⁶⁹ and their onset is generally spontaneous and sudden. In this review, the majority

of the included studies reported pain characterized by a sudden onset, which could compromise all active and passive shoulder movements. For example, Takahashi et al.⁵¹ described two case reports in which symptoms began at midnight and, subsequently, all active and passive shoulder movements were impossible due to the subject's pain; Spivey et al.²⁹ described the case of a 37-year-old woman, who reported pain lasting for 5 days, without notion of trauma; in this case, both internal and external rotation were impossible due to the pain. Fong et al.²⁴ described a case report of a 7-year-old boy with acute RCCT mimicking humeral great tuberosity fracture for the intensity of his pain and the severity of his functional impairment. These studies highlight both RCCT symptoms severity and its rapid flair up, which would indeed represent RCCT clinical peculiarities. Therefore, clinicians should consider these features during their first subject's assessment, in case of acute and severe shoulder pain, especially when subjects report a sudden onset of their symptoms, associated to other signs, such as tenderness upon shoulder palpation,^{2,6,20,24,29,32,34,50} swelling^{21,23,32,37,60} and erythema^{2,4,23,34,37}

Another important aspect which clinicians should take into consideration is the presence of endocrine conditions in the subjects' medical history. Indeed, Robinson et al.² reported that the typical RCCT subject profile is that of a female subject, aged between forty and sixty; moreover, RCCT suspicion should increase in case of factors such as diabetes or thyroid diseases.^{2,3} Harvie et al.⁹ showed a high prevalence of endocrine and metabolic diseases in their cohort and described a female predisposition for RCCT, with a peak prevalence during the fifth decade. Moreover, Bechay et al.³³ reported that hormonal disorders, such as diabetes and hypothyroidism, and metabolic disorders have to be considered as risk factors for RCCT. Greis et al.³ reported ischemic heart disease, hypertension, diabetes and thyroid conditions as clinical findings potentially linked to the development of RCCT. Considering all the data discussed above, it is indeed very likely that endocrine and hormonal disorders could actually play a key role in calcium deposits formation in RCCT subjects, however, this mechanism is not yet fully understood.^{3,9}

Implications for clinical practice

This scoping review was conducted in order to highlight the main clinical characteristics of subjects affected by RCCT, since beforehand the only diagnostic criteria were mainly based on imaging investigations.

Therefore, in order to be able to suspect (and subsequently detect) RCCT during an early stage of their clinical evaluation, clinicians must remember that subjects affected by RCCT frequently report a sudden onset of their symptoms, which are characterized by severe and disabling pain; in case of RCCT, the subjects' symptomatology

may led to the restriction of all their glenohumeral movements; furthermore, it should be remembered that RCCT predominantly affects women aged between thirty and sixty.

Lastly, it would be important to ask the subject if they have ever suffered from endocrine or metabolic disorders, as these could represent further risk factors of RCCT.^{2,3,33}

Early suspicion of RCCT could be beneficial for the affected subject that should be referred for a prompt and definitive diagnosis by imaging, cutting costs for health services and saving from ineffective pharmacotherapy and/or physiotherapy.

Implications for research

This scoping review has provided a summary of RCCT clinical findings, since no other review has been ever conducted on this topic. Indeed, no systematic reviews about this specific area has emerged during our study selection, and this implies that the literature would certainly profit from more in-depth studies regarding RCCT clinical criteria.

Strengths and limitations

This scoping review followed the PRISMA-ScR checklist for the correct reporting of the study. The methods have been reported and the search strategy has been specified in Appendix 1. No time, language and geographical areas restrictions have been applied.

However, as a scoping review, no methodological quality assessment of the included studies was performed. Moreover, our search strings, even if as comprehensive as possible, could still have missed some paper of interest. Nevertheless, being a scoping review, the present study carries its methodological limitations and, therefore, it aims to provide useful information in order to allow for the development of subsequent better-quality research.

Conclusion

The most relevant RCCT clinical findings detected in this scoping review were predominantly female-related condition, subjects aged between 30 and 60, sudden onset of severe pain, night pain, active and passive ROM deficit, specifically during forward flexion and abduction, pain upon movement, and presence of metabolic or endocrine comorbidities. These clinical criteria, predictive for shoulder RCCT, can be crucial to help all clinicians to confidently suspect this musculoskeletal disease early, thus allowing for an appropriate and prompt diagnosis path. In this way, clinicians could refer the subjects to perform the most appropriate imaging examination for RCCT (x-ray) and, subsequently, start the proper therapeutic treatment.

Abbreviations

RCCT	rotator cuff calcific tendinopathy
PCC	population, concept, and context
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews

Contributorship

Concept/Idea: DV and FB. Research Design: DV, FB, and FG. Writing: FG, DV, and FB. Data Collection: FG and ADS. Data Analysis: FG, ADS, and GG. Project Management: FB and DV. Consultation (including review of manuscript before submitting): FG, DV, ADS, GG, and FB. Final approval of the Manuscript: FG, DV, ADS, GG, and FB.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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