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SCIENTIFIC ARTICLE

Diagnostic accuracy of imaging modalities in the detection of clinically diagnosed de Quervain's syndrome: a systematic review

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Abstract

Objectives To collate and synthesise the literature to provide estimates of the diagnostic accuracy of imaging modalities, and summarise the reported imaging findings associated with de Quervain's syndrome.

Materials and methods A systematic search was performed in seven databases (MEDLINE, EMBASE, CINAHL, Cochrane Library, PROSPERO, Web of Science, and ProQuest Dissertations & Theses Global). Two reviewers independently performed screening, data extraction and quality assessment using a modified Quality Assessment of Diagnostic Accuracy Studies-2. Measures of diagnostic accuracy were summarised for different modalities and imaging findings.

Results Twenty-two studies were included, reporting ultrasound, magnetic resonance imaging, X-ray and scintigraphy findings. Reported imaging findings included sheath effusion, retinaculum thickening, subcutaneous oedema, tenosynovitis, hypervascularity, increased tendon size, bony erosion, apposition, calcific lesions and increased uptake on scintigraphy. The most commonly reported imaging findings related to the tendon sheath, with a sensitivity ranging from 0.45 to 1.00 for thickening, and 0.29 to 1.00 for effusions. The risk of bias of studies is largely unclear owing to a lack of reported detail.

Conclusions The accuracy of imaging in the diagnosis of de Quervain's syndrome is unable to be determined because of the quality of the studies included. Ultrasound is the most frequently studied imaging modality and may be the modality of choice in clinical practice. Further research involving both symptomatic and asymptomatic participants and clear definitions of abnormal findings are required to better evaluate the effectiveness of imaging in identifying de Quervain's syndrome.

Keywords De Quervain's syndrome · Diagnostic imaging · Ultrasound · Magnetic resonance imaging · Sensitivity · Specificity

Introduction

de Quervain's syndrome is a painful condition that predominantly affects women, with a prevalence of 1.3% compared with 0.5% in men [1]. The anatomy of the region is variable [2–4]; the presence or absence of a septum, varying numbers of tendon slips and differences in the site of insertion are commonly reported [3].

The pathological features of de Quervain's syndrome are described as a thickening of the extensor retinaculum that causes restriction of the extensor pollicis brevis and abductor pollicis longus tendons at the level of the first extensor compartment of the wrist [5, 6]. However, the pathogenesis and nature of the condition are poorly understood [6, 7]. Findings of histological studies are conflicting, with degenerative [8, 9] and inflammatory [10] mechanisms reported.

The diagnosis of de Quervain's syndrome is usually based on clinical findings [11, 12]. There is no consensus on the provocative tests that are most useful; however, commonly reported tests in the literature include Finkelstein's test [13, 14], Eichhoff's test [14] and Brunelli's test [15, 16]. To confirm diagnosis, medical imaging is commonly ordered.

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Ultrasound and magnetic resonance imaging (MRI) are utilised in clinically suspected de Quervain's syndrome to assist with differential diagnosis. Despite this, the diagnostic accuracy of imaging in the diagnosis of de Quervain's syndrome is unclear, with, to our knowledge, the clinical utility and effectiveness of imaging not investigated to date. The aim of this systematic review was to collate and synthesise the literature, to provide estimates of diagnostic accuracy of imaging modalities and to summarise the reported imaging findings associated with de Quervain's syndrome in adults.

Materials and methods

Search strategy and study eligibility

This systematic review follows the PRIMSA guidelines for Diagnostic Test Accuracy reviews [17], with the protocol registered on PROSPERO (CRD42017062551). The authors searched for relevant studies using MEDLINE, EMBASE, CINAHL, the Cochrane Library, Web of Science and PROSPERO. To minimise publication bias [18], grey literature was searched using Web of Science and ProQuest Dissertations & Theses Global. A search for ongoing studies was performed in the WHO International Clinical Trials Registry, the Current Controlled Trials. No time limits were placed on the search. Secondary searching was undertaken, including screening for potential studies through the reference list of any relevant studies, including reviews, identified in our search (Supplemental Fig. 1).

Inclusion/exclusion criteria

All study designs were considered for inclusion in this review, except for single case reports. Interventional and prospective studies were considered for inclusion, with baseline data extracted where possible. Only studies published in the English language were included.

Participants

Studies that involved adults (≥18 years old) who had undergone both an index test (imaging of any kind of the first extensor compartment of the wrist) and reference standard (clinical assessment to identify the presence/absence of de Quervain's syndrome) were considered for inclusion. Studies that included participants with systemic inflammatory disorders, a history of significant wrist trauma or surgery, fibromyalgia or complex regional pain syndrome were excluded. The reference standard in this review was clinical assessment for de Quervain's syndrome. This may include, but was not limited to, any combinations of the following signs: palpation over the first extensor compartment, swelling or thickening over the first extensor compartment, pain on resisted thumb extension, and positive provocative tests. There was no restriction on the type of imaging used as the index test.

Data collection and analysis

Selection of studies

Titles and abstracts of citations were screened independently for eligibility by two authors (BM, SD). If eligibility could not be determined from the title and abstract, full texts were retrieved and screened. Any discrepancies in decisions between the two authors were discussed with a third author (ER), and a consensus reached.

Data extraction and analysis

A standardised, pre-piloted form was used to extract data from the included studies for the assessment of quality and evidence synthesis. This was completed independently by two review authors (BM, SD). Discrepancies were identified and resolved through discussion with a third author (ER), where necessary. Data were extracted under the following subheadings: study characteristics, population characteristics, details of the index test and reference standard, including the time between tests.

Where sufficient data were available, sensitivity, specificity and associated 95% confidence intervals were calculated using Review Manager 5.3 software. Data were subgrouped based on imaging finding into the following categories: retinaculum or sheath changes, hypervascularity, tendon findings, bony findings and anatomical variations. Imaging findings were then further subgrouped by imaging modality. Based on variability in the terminology in the published research, the synovial sheath and retinaculum are difficult to differentiate on ultrasound. As such, the description of sheath thickening and retinaculum thickening is considered representative of the same phenomenon for the purposes of this review.

Assessment of methodological quality

The risk of bias in the studies included was assessed independently by two review authors (BM, SD) using the Quality Assessment of Diagnostic Accuracy Studies 2 (QUADAS-2) tool. Disagreements between the review authors were resolved by discussion, with involvement of a third review author (ER) where necessary. An additional question was included in the QUADAS-2 tool for this review regarding whether, in cases of bilateral symptoms, one or both wrists were included in the data analysis.

Results

The search yielded 3,409 publications. 3,341 records were excluded based on initial screening, with 68 full-text articles reviewed. Of these, 22 studies met the inclusion criteria and relevant data were extracted (Fig. 1, Supplemental Table 1).

Study characteristics

Eighteen of the studies included assessed a single type of imaging, comparing it with clinical assessment. Four studies compared two types of imaging. Ultrasound assessments were reported in 14 of the studies included [15, 19–31], MRI in 4 [24, 29, 32, 33], X-ray in 7 [15, 25, 34–38], and scintigraphy in 2 studies, which utilised TC-99m methylene diphosphonate [39] and TC-99m polyphosphonate [36] tracers.

The most commonly reported reference standard was a combination of positive provocative testing, pain and/or tenderness on palpation localised to the first extensor compartment of the wrist. The detail of reporting varied, with some studies stating participants had a clinical diagnosis of de Quervain's syndrome without further explanation.

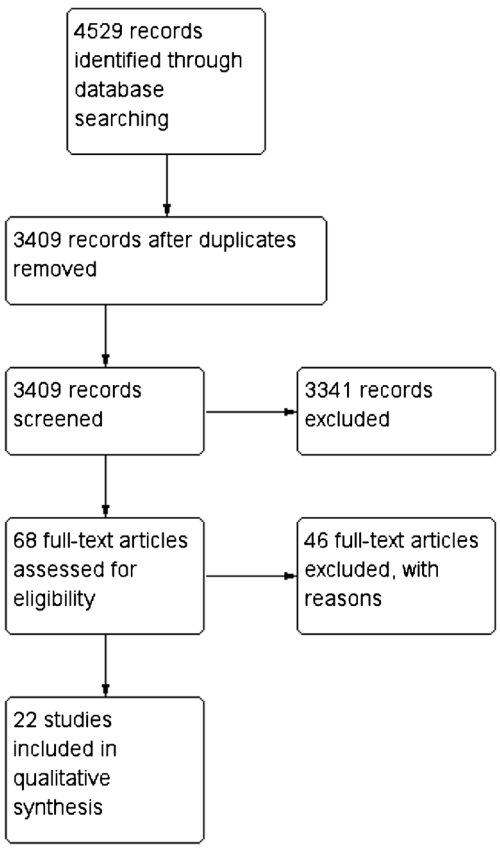

Fig. 1 Study flow diagram

Participant numbers ranged from 3 wrists to 111 wrists, and the range of reported mean participant age was 36.6–53 years. Duration of symptoms was reported by 8 studies, with means ranging from 3.6 to 19 months (Supplemental Table 1).

Structures assessed in imaging studies

Eleven studies reported findings relating to sheath or retinaculum changes, 3 studies reported hypervascularity findings, and 11 studies reported bony findings. Nine studies recorded anatomical variations (number of tendons, septum, bony crest), 2 [20, 27] of which reported no other imaging outcomes. Anatomical variations were not included in the data analysis of this review, as they were not considered a diagnostic sign. Studies investigating only anatomical variations were assessed as having a high concern for applicability to the aim of this review as the diagnostic accuracy of imaging modalities was not assessed. Five studies [15, 25, 29, 34, 38] commented about a general presence of abnormality on imaging (Supplemental Fig. 2f), 4 of which provided no further detail as to the specific abnormalities identified.

Owing to heterogeneity in index tests and reference standards, meta-analysis could not be performed. Forest plots summarising findings were constructed using Review Manager 5.3 software (Figs. 2, 3, Supplemental Fig. 2a–f).

Three studies commented on the presence of any abnormality on ultrasound, with sensitivities of 0.93 (95% CI 0.86, 0.97; $n = 100$) [15], 0.86 (95% CI 0.76, 0.92; $n = 83$) [25], and 0.75 (95% CI 0.55, 0.89; $n = 28$) [29]. None of these studies included individuals without clinical symptoms; thus, specificity could not be calculated.

Sheath or retinaculum findings

The presence of a sheath effusion was examined in seven studies, with sample sizes ranging from 3 to 41 wrists. Sensitivity of sheath effusion in the presence of clinically diagnosed de Quervain's syndrome was highly variable when assessed by ultrasound (range from 0.29 [95% CI 0.13, 0.49; $n = 28$] [29] to 1.00 [95% CI 0.29, 1.00; $n = 3$] [26]) and MRI (range from 0.00 [95% CI 0.00, 0.60; $n = 4$] [32] to 1.00 [95% CI 0.40, 1.00; $n = 5$] [33]) (Supplemental Fig. 2a). Specificity could not be calculated, as only one participant/wrist was included that tested negative to the presence of clinically diagnosed de Quervain's syndrome in the seven studies.

Seven studies, with sample sizes ranging from 4 to 120 wrists (Fig. 2), reported findings relating to retinaculum or sheath thickening or degeneration. Sensitivity ranged from 0.46 (95% CI 0.28, 0.66; $n = 28$) [29] to 1.00 (95% CI 0.93, 1.00; $n = 51$) [21] on ultrasound, and 0.45 (95% CI 0.29, 0.62; $n = 40$) [24] to 1.00 (95% CI 0.40, 1.00; $n = 4$) [32] on MRI (Fig. 2). Specificity could be calculated in one study [28], with a result of 0.93 (95% CI 0.83, 0.93; $n = 120$).

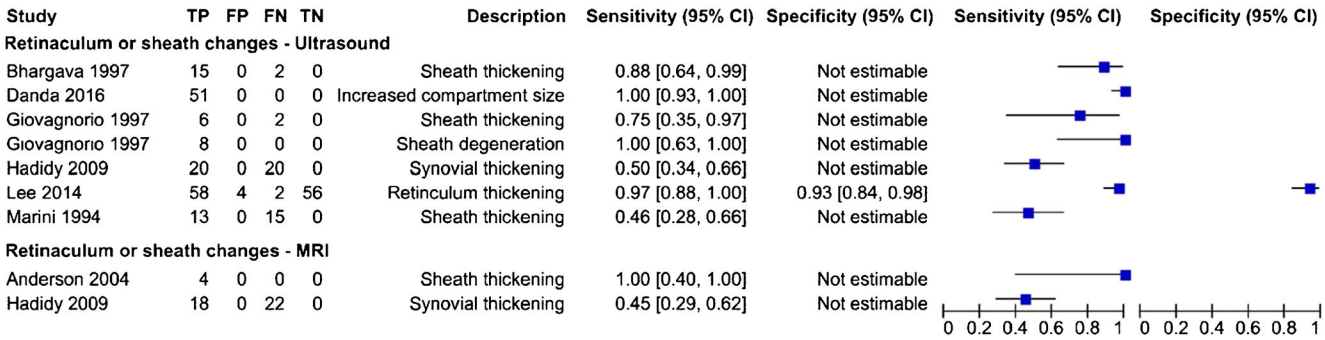

Fig. 2 Forest plot of retinaculum or sheath changes found on ultrasound and MRI. *TP* true-positive, *FP* false-positive, *FN* false-negative, *TN* true-negative

Subcutaneous oedema was reported in two studies. Hadidy et al. [24], with a sample size of 40 wrists, found a sensitivity of 0.35 (95% CI 0.21, 0.52) on ultrasound. Sensitivities calculated for MRI were 0.55 (95% CI 0.19, 0.99; $n = 40$) [24] and 0.75 (95% CI 0.38, 0.71; $n = 5$) [33], and specificity was calculated by Glajchen and Schweitzer [33] as 0.00 (95% CI 0.00, 0.97; $n = 5$). However, interpretation of the findings of Glajchen and Schweitzer [33] were difficult because of the small sample size ($n = 5$ wrists), resulting in large confidence intervals.

The umbrella terms "tenosynovitis" and "synovitis" were utilised to report findings in two studies, with De Keating-Hart et al. [22] defining it as "non-compressible hypoechoic thickening of the tendon sheath as a positive Doppler signal", and finding a sensitivity of 0.73 (95% CI 0.57, 0.86; $n = 41$) [22]. Anderson et al. [32] did not define what constituted "synovitis" and calculation of the diagnostic accuracy on MRI was limited, as a total of only 11 participants were assessed across two studies, resulting in large confidence intervals.

Hypervascularity was assessed with the use of Doppler ultrasound in three studies [22, 26, 31]. Two studies with moderate sample sizes have calculated sensitivities of 0.61 (95% CI 0.45, 0.76; $n = 41$) [22], and 0.5 (95% CI 0.39, 0.75; $n = 33$) [31]. Specificity could not be calculated owing to a lack of inclusion of participants with a negative reference standard.

Tendon findings

Tendon thickening was reported in five studies (Fig. 3) [24, 26, 29, 30, 33]. Ultrasound was utilised in four studies, with sensitivities ranging from 0.39 (95% CI 0.13, 0.49; $n = 28$) [29] to 1.00 (95% CI 0.91, 1.00; $n = 40$) [24]. Two studies reported tendon thickening on MRI. Results reported by Glajchen and Schweitzer [33] found 4 true-positives and 1 false-positive, resulting in a sensitivity of 1.00 (95% CI 0.40, 1.00; $n = 5$) and a specificity of 0.00 (95% CI 0.00, 0.97; $n = 5$). Hadidy et al. [24] reported a sensitivity of 0.95 (95% CI 0.83, 0.99; $n = 40$).

Bony findings

X-ray findings included periostitis, periosteal bone apposition, periosteal irritation, calcific lesions in the region of the tendon sheath, radiolucency or osteopenia of the radial styloid, cortical erosions, and sclerosis. Sensitivities of these findings varied between studies, and between assessors within the same study [34]. Hadidy et al. [24] reported bone marrow signal changes on MRI, which had a sensitivity of 0.23 (95% CI 0.11, 0.38; $n = 40$). Scintigraphic findings of increased uptake had sensitivities ranging from 0.71 (95% CI 0.29, 0.96; $n = 7$) to 1.00 (95% CI 0.59, 1.00; $n = 7$) [39].

Three additional studies [15, 25, 38] commented that no abnormalities were identified on X-ray for any of the participants included.

Risk of bias

Measured using the QUADAS-2, the risk of bias of included studies is largely unclear due to lack of detail in reporting (Fig. 4, Supplemental Tables 2–3). Patient selection was

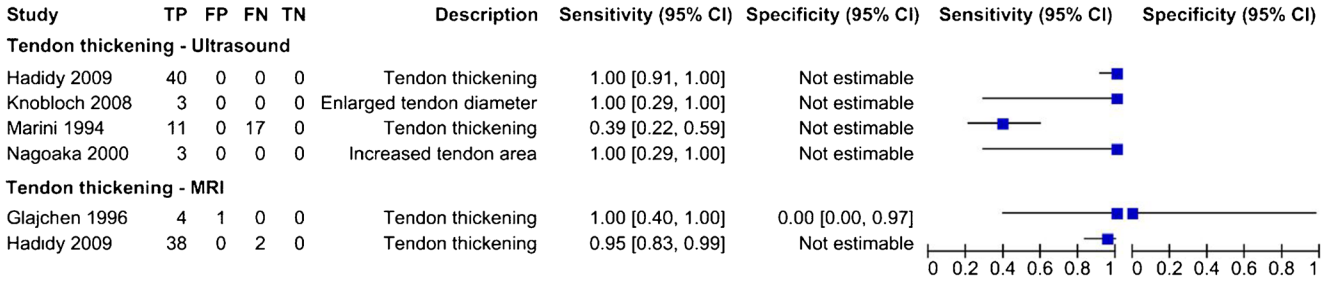

Fig. 3 Forest plot: tendon thickening on ultrasound and MRI

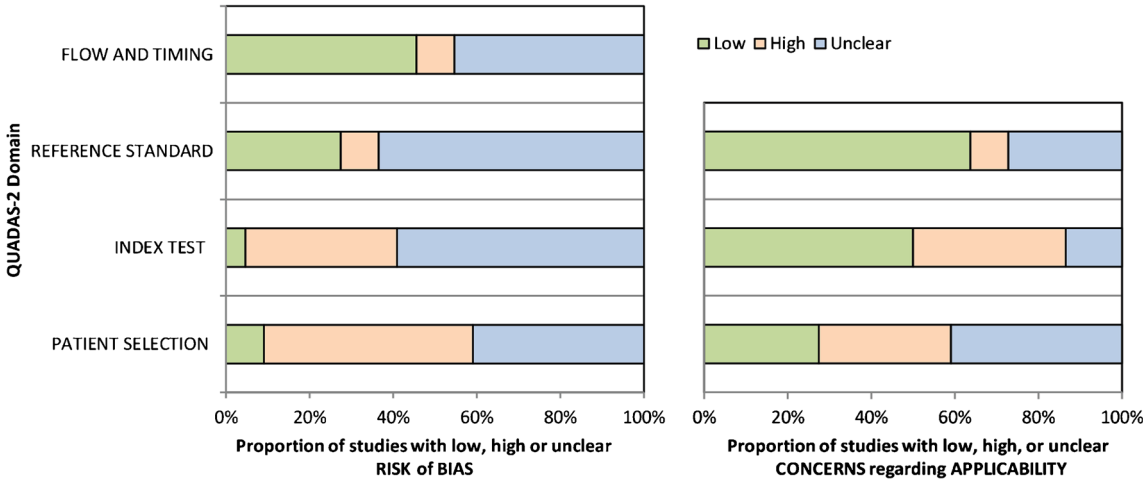

Fig. 4 QUADAS-2 risk of bias summary graphs

assessed as being a source of high risk of bias in 50% of the studies included. This related to studies not using consecutive or random sampling methods, and inclusion of data relating to both left and right wrists in participants with bilateral symptoms. Whilst a case–control design was avoided in sixteen of the included studies, only seven included a negative reference standard group at all. Two of which consisted of the contralateral asymptomatic wrist of the participants, impacting validity as the asymptomatic wrist may not be a 'true control'.

Index test (imaging) performance was found to be at a high risk of bias in 36% of studies because assessors were not blinded to the outcomes of the reference standard (clinical assessment). A judgement of unclear risk of bias was made in 59% of studies owing to a lack of reporting of blinding procedures and whether a pre-specified threshold was utilised. Only one study [34] reported clear blinding of assessors to the results of clinical test findings. Lack of blinding results increased the risk of test review bias [40], which is further enhanced by the subjective nature of imaging interpretation.

Risk of bias relating to the reference standard was assessed as unclear in 64% of the studies included owing to a lack of detail in procedural description. Concerns regarding applicability were low in 64% of studies. Flow and timing of the studies was assessed as being at a low risk of bias in 45% of studies. None of the studies included reported the time interval between test performances; however, the tests were reported to be consistent within each study.

Discussion

There is considerable uncertainty regarding development of pathological changes, correct terminology, and diagnostic criteria in de Quervain's syndrome. The condition does not appear to be isolated to a single structure; instead, it can affect the tenosynovium (sheath and retinaculum), tendons and underlying bone within the first extensor compartment. This review suggests that imaging might be able to identify various changes associated with clinically diagnosed de Quervain's syndrome, such as sheath or retinaculum thickening, increase in tendon size, presence of fluid, and hypervascularity. We are unable to draw any conclusions regarding the diagnostic accuracy of imaging, whether there is a key imaging finding associated with clinical signs, whether certain structural changes occur concurrently or in isolation, or the sequelae of structural changes. These uncertainties also exist in other sheath-related conditions, such as trigger digit [41].

Based on the data from the studies included, we are unable to determine whether one imaging modality is superior to another. Ultrasound, however, was the imaging modality most commonly studied (14 studies). This is reflective of clinical practice, and likely because of its accessibility, affordability and ability to identify soft-tissue changes.

Although the effectiveness of imaging in the diagnosis of de Quervain's syndrome cannot be determined, there is some belief that identifying anatomical variations using imaging (specifically the presence of an intra-compartmental septum) may provide an insight into treatment response [22, 42]. This hypothesis is based on the higher prevalence of an intra-compartment septum in those undergoing surgical management for de Quervain's syndrome compared with cadavers, and those responding to non-surgical treatment methods [22]. Ultrasound has been found to be reliable in identifying a septum when compared with surgical findings [20, 27, 28], with radial bony crests a potential indicator of the presence of a septum [28]. This may be relevant in intervention decision-making. However, further research into the correlation between the presence of a septum and prognosis is required.

Beyond identifying anatomical variations, exploration of the role of imaging in directing treatment or patient outcomes is limited. Establishing diagnostic accuracy is the second of six levels in the imaging model of efficacy, described by

Fryback and Thornbury [43]. Although technical and diagnostic accuracy are important in determining the utility of imaging, future research to understand its impact on treatment decision-making and patient outcomes is necessary to truly assess the value of imaging value in de Quervain's syndrome.

Terminology around imaging findings were inconsistent and often without clear guidelines. Thresholds for a positive finding on imaging were rarely explained or utilised. Only Lee et al. [28] performed receiver operator characteristic curve analysis to determine a threshold for considering the thickness of the retinaculum abnormal (0.45 mm, area under the curve 0.99), although this was not done a priori. Studies of other sheath-related conditions have specified that a small amount of fluid around a tendon is normal, with "tenosynovitis" defined as more than 2 mm of fluid circumferentially [44]. No such definitions were made in any of the studies included.

This use of subjective interpretation without thresholds is perhaps reflective of clinical practice, where the diagnosis of de Quervain's syndrome based on imaging findings is often a dichotomous one. Findings may be deemed "abnormal" or "normal", based on experienced opinion rather than on recognised criteria with consensus. Also reflective of the subjective nature of imaging interpretation, the two studies [33, 34] that compared inter-observer findings demonstrated inconsistent interpretation of results (Kappa 0.44 [34]). Given that most studies did not appear to follow systematic processes for imaging interpretation, the reliability of the findings is unknown.

The results of this review regarding the accuracy of imaging in the diagnosis of de Quervain's syndrome require careful interpretation owing to the high or unclear risk of bias in most of the studies. A lack of detail around imaging interpretation, timing and blinding impeded the ability to draw conclusions that are applicable to clinical practice. Similarly, findings were limited by a lack of reported findings of a negative reference standard group, resulting in specificity being calculated for only four outcomes. Many of the studies included had small sample sizes, with their calculated sensitivities likely to be exaggerated measures.

A further limitation of this review is the exclusion of studies that reported only means and standard deviations for the size of structures (tendon and retinaculum) owing to an inability to determine the number of participants with abnormal findings.

In conclusion, the accuracy of imaging in the diagnosis of de Quervain's syndrome cannot be determined. As such, interpretation of imaging findings in clinical practice should be undertaken with care and within the context of clinical presentation. Ultrasound is the most frequently studied imaging modality, and, given its accessibility and ability to identify changes to soft tissue, it may be the imaging modality of choice in clinical practice.

Further research involving both symptomatic and asymptomatic participants is required to better define and evaluate imaging findings in de Quervain's syndrome. Notably, clarity in the definition of abnormal findings, the reporting of standardised assessments, and a greater consistency in terminology are required. Imaging may play a further role in exploring the temporal sequence of pathological changes, and hence our understanding of the pathogenesis of de Quervain's syndrome. Imaging also has the potential to explore whether any structural changes might be associated with patients who are recalcitrant to conservative treatments, with the aim of potentially developing targeted treatment strategies.

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Compliance with ethical standards

Conflicts of interest Author, Rafal Grabinski, is a practicing radiologist, and as such receives remuneration for the delivery of radiology consultancy services. Each author certified that he or she has no other commercial association that might pose a conflict of interest in connection with the submitted article.

Ethical review committee statement As this article is a systematic review of previously published articles, ethical approval was not required.

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