Research Article

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Radiological evaluation of calcific tendinitis with intraosseous migration: a single-center experience

İntraosseöz migrasyonlu kalsifik tendinitin radyolojik değerlendirmesi: tek merkez deneyimi

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Abstarct

Purpose: Migration of calcific deposits into adjacent tissues, such as bones, muscles, and the subacromial-subdeltoid bursa, is a rare complication that can lead to diagnostic challenges and unnecessary procedures. This study aims to describe the uncommon intraosseous migration of rotator cuff calcific tendinitis and evaluate these cases concerning demographic characteristics, associated pathologies, and radiological findings.

Materials and methods: This retrospective study, conducted between January 2021 and September 2024, reviewed 3.755 shoulder MRI scans. Exclusions included motion artifacts, pediatric cases, trauma or surgery history, and infections. Two radiologists independently evaluated cases of calcific tendinitis and intraosseous migration, analyzing findings against demographic data and related pathologies.

Results: Out of 3.000 scans, calcific tendinitis was found in 8.17% of cases. Intraosseous complications occurred in 0.5% of the total population and 6.12% of tendinitis cases. Most calcific tendinitis patients (73.77%) were female, with 86.67% of intraosseous cases being women (p=0.211 (Fisher's Exact Test)). The supraspinatus tendon was most frequently affected (63% of cases), with effusion being the most common pathology (55%). Patients with intraosseous complications showed higher rates of supraspinatus and infraspinatus involvement (both 73%) compared to those without complications (63% and 36%, respectively), and the difference was statistically significant (Fisher's Exact Test, p=0.005 for infraspinatus).

Conclusion: Calcific tendinitis can present rare intraosseous extensions, requiring careful imaging for accurate diagnosis. MRI and CT play crucial roles in identifying these cases. Untreated cases show persistent complications, while ultrasound-guided injections provide effective treatment. Proper differential diagnosis is necessary as calcific tendinitis may mimic tumors. Early diagnosis and appropriate treatment of intraosseous complications are essential. Future studies should explore larger populations and long-term follow-up for better evaluation of prognosis and outcomes.

Keywords: Calcific tendinitis, supraspinatus tendon, intraosseous migration, MRI.

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Öz

Amaç: Kalsiyum depositlerin kemik, kaslar ve subakromiyal-subdeltoid bursa gibi komşu dokulara göçü, tanısal zorluklara ve gereksiz prosedürlere yol açabilen nadir bir komplikasyondur. Bu çalışmanın amacı, rotator manşet kalsifik tendinitinin nadir görülen intraosseöz migrasyonunu tanımlamak ve bu vakaları demografik özellikler, ilişkili patolojiler ve radyolojik bulgular açısından değerlendirmektir.

Gereç ve yöntem: Bu retrospektif çalışma, Ocak 2021 ile Eylül 2024 tarihleri arasında gerçekleştirilmiş ve 3,755 omuz MRG incelemesi gözden geçirilmiştir. Hariç tutulanlar arasında hareket artefaktı olan hastalar, pediatrik vakalar, travma veya cerrahi öyküsü olanlar ve enfeksiyon vakaları yer almıştır. İki radyolog kalsifik tendinit ve intraosseöz migrasyon vakalarını bağımsız olarak değerlendirmiş, bulgular demografik veriler ve ilişkili patolojilerle analiz edilmiştir.

Bulgular: 3,000 tarama sonucunda vakaların %8,17'sinde kalsifik tendinit tespit edilmiştir. İntraosseöz komplikasyonlar toplam popülasyonun %0,5'inde ve kalsifik tendinit vakalarının %6,12'sinde gözlenmiştir. Kalsifik tendinit hastalarının çoğunluğu (%73,77) kadın olup, intraosseöz komplikasyonların %86,67'si kadın hastalarda görülmüştür (p=0,211 (Fisher's Exact Test)).

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İntraosseöz komplikasyonu olan hastalarda supraspinatus ve infraspinatus tutulum oranları (her ikisi de %73), komplikasyonu olmayan hastalara kıyasla daha yüksekti (sırasıyla %63 ve %36) ve bu fark infraspinatus için istatistiksel olarak anlamlıydı (Fisher's Exact Test, *p*=0,005).
Sonuç: Kalsifik tendinit, nadir görülen intraosseöz uzanımlar gösterebilir ve doğru tanı için dikkatli görüntüleme gerektirir. MRG ve BT, bu vakaların tanısında kritik bir rol oynar. Tedavi edilmeyen vakalarda komplikasyonlar devam ederken, ultrason rehberliğinde yapılan enjeksiyon tedavisi etkili sonuçlar vermektedir. Kalsifik tendinit, görüntülemede tümörleri taklit edebileceğinden doğru ayırıcı tanı gereklidir. İntraosseöz komplikasyonların erken teşhisi ve uygun tedavisi esastır. Gelecekteki çalışmalar, daha geniş popülasyonlar ve uzun dönem takiplerle prognoz ve tedavi sonuçlarını daha iyi değerlendirmelidir.

Anahtar kelimeler: Kalsifik tendinit, supraspinatus tendonu, intraosseöz migrasyon, MRG.

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Introduction

Calcific tendinitis is a relatively common condition associated with the deposition of calcium hydroxyapatite crystals in tendons [1-4]. It usually affects the pre-insertional portion of rotator cuff tendons, especially the supraspinatus tendon, in middle-aged women. Although benign and self-limiting, it can be an excruciatingly painful condition by triggering inflammatory changes. In rare cases, tendinous calcifications may show intraosseous, intramuscular and adjacent soft tissue migration [1-3, 5]. Ultrasound (US) and X-ray are the initial imaging modalities performed to patients having shoulder pain. Soft tissue calcifications and tendinopathy findings can be detected by US and X-ray. Despite percutaneous arthroscopic treatments have been reported less effective, US is also the preferential imaging modality for guiding these procedures. Computed tomography (CT) may be performed to patients not remembering trauma history or for any other reasons and findings like cortical erosion and intraosseous calcifications can be best detected with CT (Figure 1). Magnetic resonance imaging (MRI) is also frequently requested by clinicians for patients having persistent and nontraumatic shoulder pain immediately after X-ray or US imaging (Figure 2, 3). Additionally, while tendinopathy, cortical erosion and intraosseous calcifications can be detected by X-ray, US and CT, MRI is superior to other imaging modalities and highly sensitive in showing bone marrow edema and reactive inflamatory changes in perilesional soft tissues. However, intraosseous migration of intratendinous calcifications can mimic a neoplastic process like osteoid osteoma, osteoblastoma, chondroblastoma and periosteal osteosarcoma or infection, especially on MRI [6-8]. Furthermore, variable MR imaging characteristics due to temporal evolution of migrated intraosseous calcific deposits and associated bone changes may also contribute to diagnostic challenge [5]. So, radiologists should be aware of imaging findings of this rare clinical entity and they can reach confident diagnosis thanks to specific imaging characteristics in order to avoid misdiagnosis and biopsy which can cause unnecessary patient anxiety, further imaging and interventional procedures.

The aim of this study is to contribute to the identification of calcific tendinitis with intraosseous extension, which is defined as a rare complication in the literature.

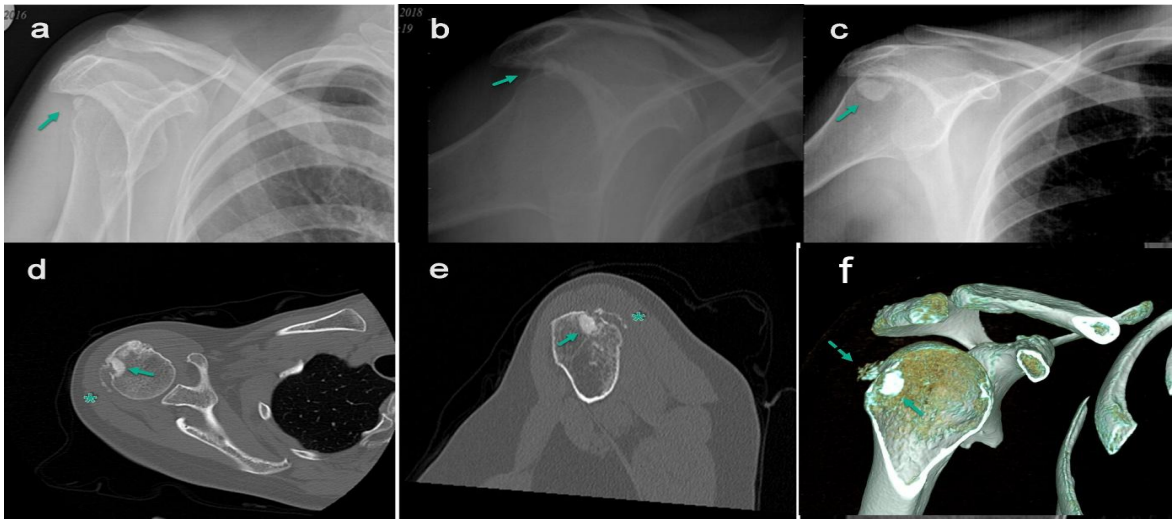

Figure 1. Radiographs of a 51-year-old female patient today (a), 2 years ago (b), and 4 years ago (c)

Migration of amorphous calcification (arrow) of musculoskeletal tendinitis. Computed tomography (CT) images—axial (d), sagittal (e), and volume-rendered (f)—reveal calcific tendinitis (* in d, e; dashed arrow in f) and its intraosseous migration (arrow in d, e, f)

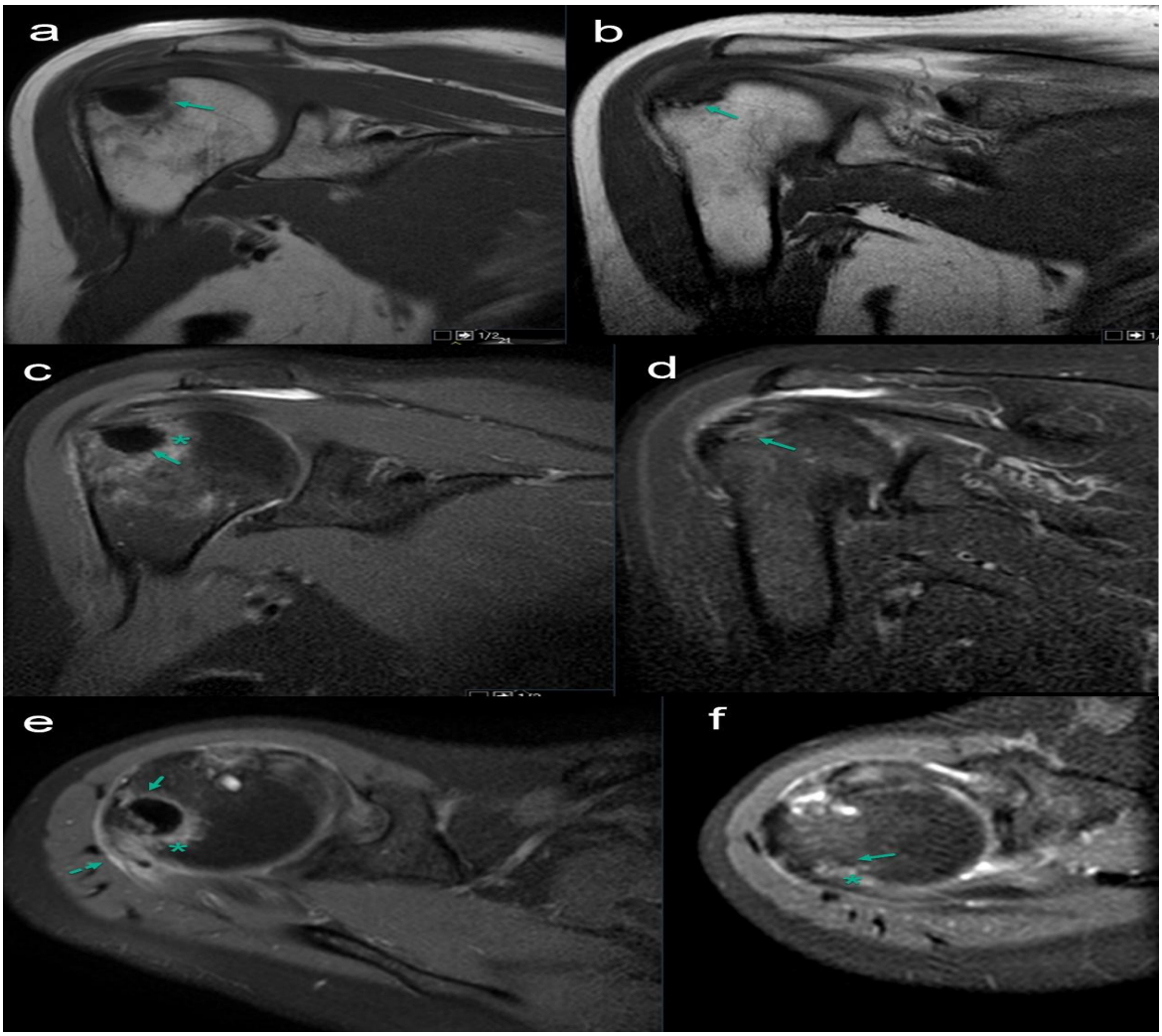

Figure 2. A 51-year-old female patient underwent MRI scans before and after treatment

Pre-treatment images—coronal T1-weighted (a), coronal proton density (PD) (c), and axial PD (e)—revealed intraosseous calcific tendinitis in the humeral head (arrow in a, c, e), accompanied by significant surrounding edema (* in c, e) and amorphous calcification foci of muscular tendinitis (dashed arrow in e). Post-treatment images—coronal T1-weighted (b), coronal PD (d), and axial PD (f)—demonstrated the resolution of calcifications (arrow in b, d, f) and a reduction in edema (* in f)

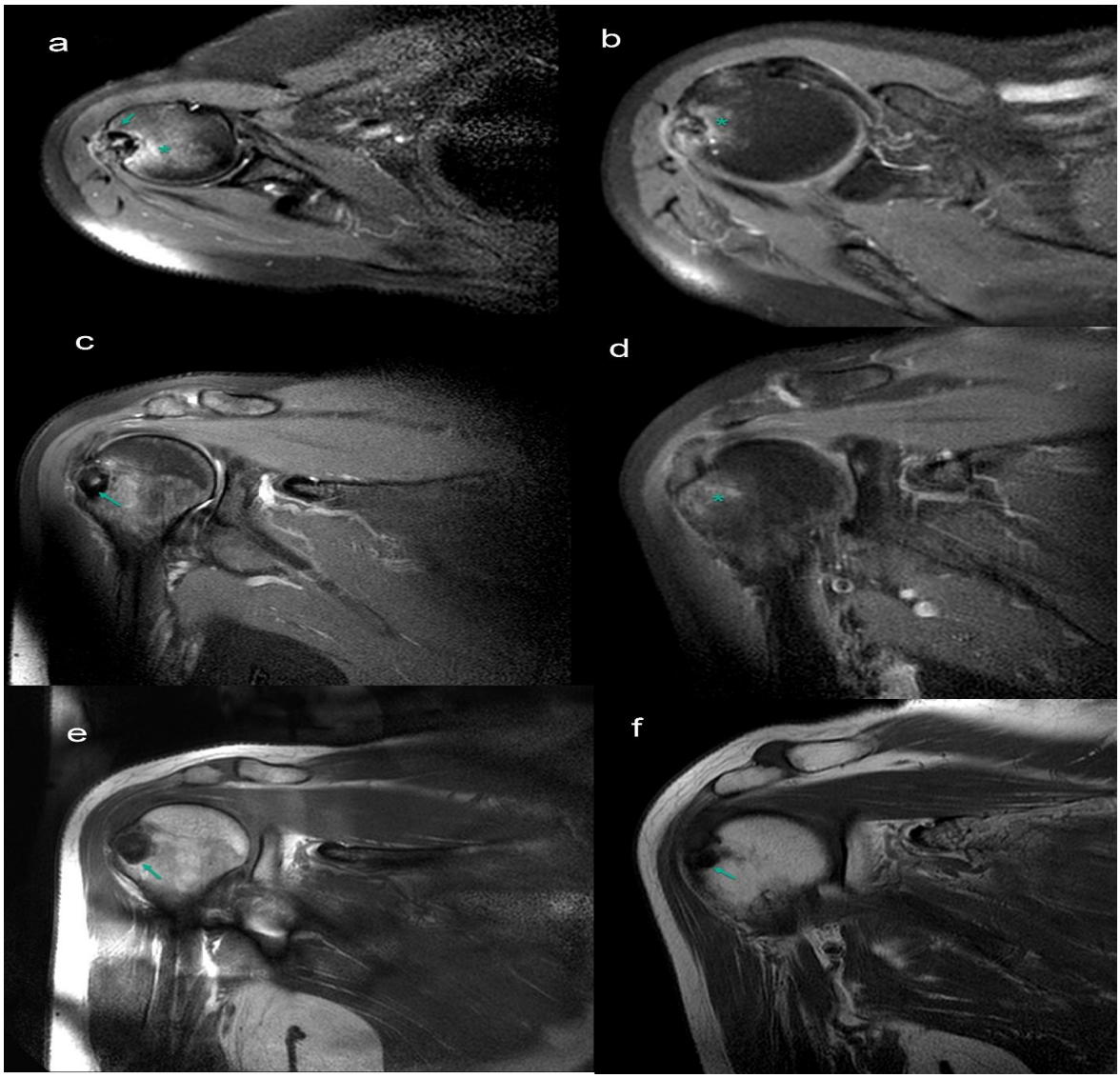

Figure 3. A 59-year-old female patient with known supraspinatus calcific tendinopathy presented with shoulder pain and limited range of motion

Initial and follow-up MRI scans, taken three months apart after the patient declined minimally invasive treatment, showed persistent intraosseous calcium in the greater tubercle (arrows in a, c, e, f) with marked surrounding bone marrow edema (* in a, b, d). The images included coronal (c, d) and axial (a, b) proton density sequences, as well as coronal T1-weighted images (e, f)

Material and methods

Ethics Committee approval from Dicle University Medical Ethics Committee (date:10.12.2020, and 60116787-020/73335) were obtained and was conducted in accordance with the principles of the Helsinki Declaration. A total of 3.755 shoulder MRI scans performed at our institution between January 2021 and September 2024 were retrospectively reviewed. Excluded from the study were scans with motion artifacts, pediatric patients, patients with a history of trauma or surgery, patients with infections or inflammatory pathologies, and those with masses detected in the shoulder region. As a result, 3.000 shoulder MRIs were independently evaluated by two experienced radiologists. The consensus method was used to ensure consistency between evaluations and validate results. In cases of discrepancies, final decisions were made through consensus.

In our study, calcific tendinitis was diagnosed based on MRI findings of hypointense signal changes on both T1- and T2-weighted images, consistent with calcium deposits within the rotator cuff tendons, and tendon thickening in muscles adjacent to the shoulder joint. Intraosseous calcific tendinitis was identified by the migration of these calcifications into the humeral head, accompanied by surrounding edema, which appeared hyperintense on T2-weighted sequences. A total of 245 cases of calcific tendinitis were identified. The MRI images were processed automatically through the picture archiving and communication system (PACS). Calcific tendinitis was classified according to the muscles involved, and the frequency of associated pathologies such as impingement, effusion, tendinopathy, rotator cuff tears, and the rare occurrence of intraosseous migration was investigated. All findings were correlated with patient demographic characteristics (age, gender, etc.).

Two patients with intraosseous complications had follow-up imaging available. One patient was treated by the interventional radiology unit, and detailed evaluations of both cases are described in the case examples section.

Magnetic resonance imaging (MRI) of the shoulder was performed using a 1.5T scanner (Magnetom Altea, Siemens Healthcare, Erlangen, Germany). The shoulder MRI protocol included two coronal oblique planes: a fluid-sensitive sequence with fat suppression (T2W FS) and a dark fluid sequence (T1W). Additionally, proton density (PD) sequences with a long TR and short TE were used for axial imaging, while bright fluid (T2W) sequences were applied for sagittal imaging (Table 1).

Table 1. Shoulder MRI sequence parameters

Sequence	Plane	TR (ms)	TE (ms)	Slice Thickness (mm)	FOV (mm)	Matrix	Time (min)
T2W FS	Coronal Oblique	4000	50	3.5	160	256x256	2:00
T1W	Coronal Oblique	600	12	3.5	160	256x256	1:40
PD (Long TR, Short TE)	Axial	3000	35	3.0	160	256x256	1:50
PD (Long TR, Short TE)	Sagittal Oblique	4000	50	3.5	160	256x256	2:10

TR= Repetition Time; TE= Echo Time; FOV= Field of View; T2W FS= T2-Weighted Fat-Saturated; T1W= T1-Weighted; PD= Proton Density

Statistical analysis

In this study, statistical analyses were performed to evaluate the differences in demographic data, muscle involvement, and associated pathologies among patients with calcific tendinitis and intraosseous complications.

Statistical analyses were conducted using the SPSS (Statistical Package for Social Sciences) for Windows version 22.0. Descriptive data were presented as n and % for categorical variables, and as mean ± standard deviation (mean ± SD) for continuous variables.

The normality of continuous variables (e.g., age) was assessed using the Kolmogorov-Smirnov test. Comparisons between two groups (e.g., age differences between patients with and without intraosseous complications) were performed using the Student's t-test when the data followed a normal distribution.

For the analysis of categorical data (e.g., gender distribution among patients with calcific tendinitis and those with intraosseous complications), Chi-square (χ^2) test or Fisher's Exact Test was used depending on the expected cell counts. Fisher's Exact Test was applied when the sample size was small.

The frequency of involvement of different muscles in calcific tendinitis cases was analyzed using Cochran's Q test, given that multiple muscles could be affected in the same patient.

Additionally, the occurrence of associated pathologies, such as effusion, tendinopathy, impingement, and tears, was evaluated using Cochran's Q test to compare their frequencies.

A *p*-value of <0.05 was considered statistically significant.

Results

A total of 3.000 shoulder MRIs were reviewed, and the prevalence of calcific tendinitis was found to be 8.17% (n:245). Intraosseous complications were observed in 0.5% (n:15) of the entire population. Among the calcific tendinitis cases, the incidence of intraosseous complications was calculated to be 6.12%. These findings suggest that intraosseous complications are rare.

In this study, the demographic data of patients with calcific tendinitis and intraosseous complications were analyzed (Table 2). Of the 245 patients, women made up 73.77% of the calcific tendinitis cases, while men accounted for 26.23% ($p=7.7\times10^{-14}$ (Chi-squared test)). Among the 15 patients with intraosseous complications, the percentage of women was even higher at 86.67% (*p*=0.211 (Fisher's Exact Test)). The average age in the general population was 51.78±12.10 years, while the average age of patients with intraosseous complications was 49.53±11.61 years (*p*=0.459) (student t test). These results indicate that calcific tendinitis and intraosseous complications are more common in women, and there is no significant age difference between the two groups (*p*=0.459) (student t test).

Table 2. Demographic data of calcific tendinitis and intraosseous complications

Feature	General Population	Intraosseous Cases
Total Cases	245	15
Female (%)	73.77%	86.67%
Male (%)	26.23%	13.33%
Age Mean ± Std Dev, Min-Max)	51.78±12.10, 20-92	49.53±11.61, 31-71

Gender distribution: Fisher's Exact Test, *p*=0.211 (not significant), age comparison: Kolmogorov-Smirnov test (D=0.047, *p*=0.20); levene's tetst (F=0.037, *p*=0.848); Student's t-test, t=-0.741, *p*=0.459 (not significant)

Muscle involvement

In calcific tendinitis cases, the most frequently affected muscle was the supraspinatus, found in 155 out of 245 patients (63%). The infraspinatus muscle was involved in 93 cases (38%), the subscapularis in 27 cases (11%), and the teres minor in 26 cases (11%). More rarely, the biceps was involved in 4 cases (2%) and the deltoid in just 1 case (<1%). The results of Cochran's Q Test (*p*=0.0001) demonstrate a statistically significant difference in the frequency of muscle involvement, with the supraspinatus and infraspinatus muscles being the most commonly affected (Table 3).

Table 3. Muscle involvement in calcific tendinitis

Muscle	Count	Percentage (%)
supraspinatus	155	63
infraspinatus	93	38
subscapulariss	27	11
teres minor	26	11
biceps	4	2
deltoid	1	0

Cochran's Q Test; Q=176.961, *p*=0.0001

In our patients with intraosseous complications, the involvement rates of the Supraspinatus and Infraspinatus muscles are respectively 73%, whereas these rates are observed as 63% and 36% in patients without complications (Figure 4). A comparison of muscle involvement rates between patients with and without intraosseous complications revealed statistically significant differences in the involvement of the infraspinatus (p=0.005) and teres minor muscles (p=0.013), based on Fisher's Exact Test.

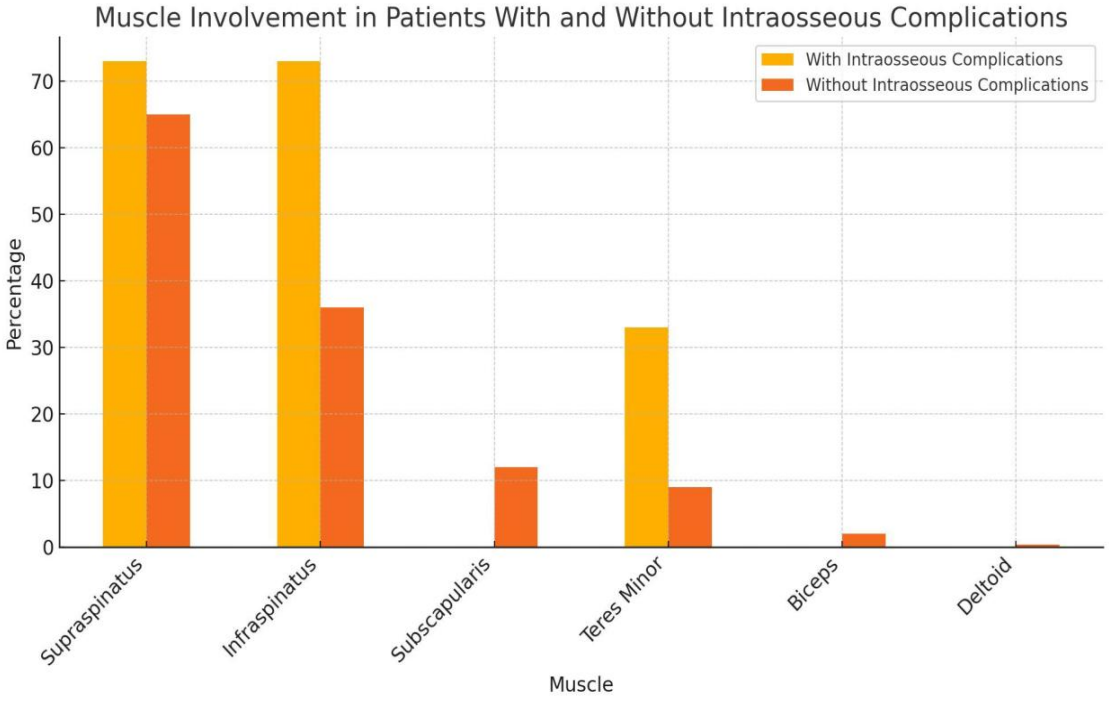

Figure 4. Comparison of muscle involvement rates in patients with and without intraosseous complications. Statistically significant differences were observed in the involvement of the infraspinatus (p=0.005) and teres minor muscles (p=0.013), based on Fisher's Exact Test

Accompanying diseases

When the associated pathologies in calcific tendinitis cases were examined, the most frequent finding was effusion, which was detected in 135 patients (55%). Tendinopathy was observed in 95 patients (39%), impingement in 60 patients (24%), and tears in 36 patients (15%). Intraosseous migration was observed in 15 patients (6%). Cochran's Q Test (p=0.0001) indicates a statistically significant difference in the distribution of associated pathologies, with effusion being the most frequently observed finding (Table 4).

In our patients with intraosseous complications, the prevalence rates of effusion, tendinosis, tears, and impingement are respectively 73%, 53%, 20%, and 33%. In patients without complications, these conditions are recorded at 54%, 38%, 14%, and 24% respectively (Figure 5). The differences were analyzed using the Chi-square test and found to be not statistically significant (χ^2=0.0059, p=0.995).

Table 4. Associated pathologies in calcific tendinitis

Pathology	Count	Percentage (%)
Impingement	60	24
Effusion	135	55
Tendinopathy	95	39
Tear	36	15
Intraosseous Migration	15	6

Cochran's Q Test; Q=225.614, *p*=0.0001

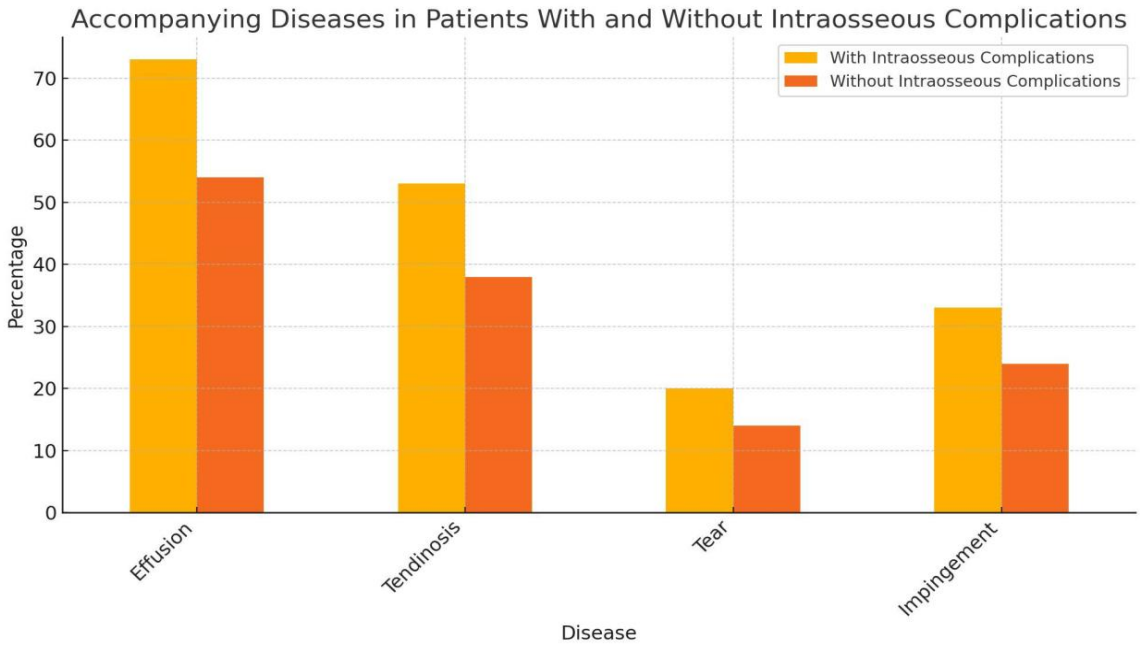

Figure 5. Comparison of accompanying diseases prevalence in patients with and without intraosseous complications. No statistically significant differences were observed (Chi-square test, χ^2=0.0059, *p*=0.995)

Discussion

The most significant finding of our study is the high involvement rates of the Supraspinatus and Infraspinatus muscles in patients with intraosseous complications of calcific tendinitis, observed at 73% each. Previous studies have shown that calcific tendinitis most commonly affects the Supraspinatus tendon. Furthermore, intraosseous migration is frequently reported in patients with calcific tendinitis involving the Supraspinatus and Infraspinatus tendons. However, there is limited data in the literature on this aspect. Case reports often describe involvement of both the Supraspinatus and Infraspinatus tendons in patients with intraosseous complications, which aligns with the findings of our study [9-14].

Calcific tendinopathy, also known as hydroxyapatite deposition disease or calcific tendinitis, accounts for approximately 3% to 7% of all cases of painful shoulder [4, 9]. Its clinical presentation ranges from asymptomatic to severe pain and symptoms do not always correlate with imaging findings [2, 3, 9, 10]. Adhesive capsulitis, rotator cuff tears, migration of calcific deposits to bones and soft tissues, humeral head osteolysis and ossifying tendinitis are the well-defined complications of calsific

tendinitis [11]. In our study, intraosseous complications were observed in 15 out of 240 cases, highlighting a notable prevalence of this specific complication.

In the literature, treatment methods involving intraosseous extension and those without it for patients with rotator cuff calcific tendinopathy (RCCT) have shown that treatments performed under ultrasound guidance yield less favorable outcomes in cases with intraosseous spread compared to those with only tendinous or peritendinous disease [12]. In our study, follow-up imaging of one treated patient with intraosseous calcific tendinitis among the 15 cases showed significant regression of findings after treatment. However, in another patient with intraosseous calcific tendinitis who did not undergo treatment but had follow-up imaging, the findings persisted.

The radiologic diagnosis of calcific tendinitis is made by the characteristic and classical imaging appearance of calcific deposits in the involved tendon, particularly pre-insertional portion of supra and infraspinatus tendons. US and X-ray imaging findings can be considered sufficient for the diagnosis in majority of cases. However, demonstration of continuity between the migration of calcific deposits to the humeral head and initial calcific tendinitis plays the crucial role in the diagnosis. Our study observed that follow-up imaging with plain X-rays was sufficient to confirm the diagnosis in some cases. However, in cases where intraosseous migration was suspected, CT imaging provided a detailed evaluation of cortical discontinuity and the precise localization of calcific deposits. These findings emphasize the importance of advanced imaging modalities in complex cases.

Furthermore, well-defined hypointens MR focus on all pulse sequences corresponding to hyperdense foci in CT images accompanying to marked bone marrow oedemia in humeral head and periarticular calcifications seem very specific to this condition. In our cohort, MRI was instrumental in diagnosing patients where bone marrow oedema and periarticular changes were prominent. This allowed for a more comprehensive assessment of disease progression and provided valuable information for clinical management.

For these reasons, additional imaging with CT and MRI should be performed in patients having calcific tendinitis diagnosis with suspected intraosseous migration for depicting classical imaging findings and continuity of disease [15]. We believe that both CT and MRI imaging should be performed due to CT is superior to detect cortical discontinuity and sites and morphology of intraosseous calcifications while bone marrow and soft tissue oedema can be best demonstrated with MRI. In our study, the use of MRI follow-up in select patients proved essential for monitoring the evolution of the disease, assessing changes in bone marrow oedema—which is closely related to pain symptoms—and excluding other pathologies such as tumors.

As Zampa et al. [8] stated in the recent study, CT and MRI images performed 3 months after first presentation and initial X-ray examination contributed much to reach correct diagnosis in our cases too. Similarly, in our cases, follow-up imaging, including both CT and MRI, clarified the temporal evolution of the disease and associated bone changes. In addition, Paruthikunnan et al. [1] struggled to define temporal evolution of disease and associated bone changes and stated that imaging findings may vary because of nature of the disease and this can lead to diagnostic difficulties. Consistent with these observations, follow-up with MRI in our study also enabled us to track the migration of calcific deposits and identify diverse imaging characteristics confidently.

In some cases which patients have nocturnal pain symptoms and CT features of an osteolytic lesion without osseous extrusion of the tendon calcification, it can be challenging to exclude tumors like osteoid osteoma, osteoblastoma or any other malign lesions [1]. Physcians may request further imaging such as nuclear bone scan in such cases however its contribution to diagnosis is limited due to inflammation around migrated calcific deposits in humeral head also shows increased bone tracer activity. In our cases, presence of cortical discontinuity in greater tuberositas, demonstration of calcific deposits migration from tendons to humeral head, absence of symptoms like nocturnal pain responding to aspirin therapy and lack of a soft tissue mass did not necessitate any further imaging.

Bone involvement in calcific tendinitis is a very rare complication and humeral head is the most affected site, but other areas of involvement such as the wrist, elbow, hip, and knee have also been reported in the literature [3]. In 76% of cases, migration of calcific deposits to humeral head originate from supraspinatus tendon while other rotator cuff muscles are less commonly affected [16]. In our cases, both the supraspinatus and infraspinatus tendons were affected, with involvement rates of 73% each. These findings indicate a broader pattern of tendon involvement in calcific tendinitis with intraosseous migration. A comparison of muscle involvement rates in patients with and without intraosseous complications revealed statistically significant differences in the involvement of the infraspinatus (p=0.005) and teres minor muscles (p=0.013), based on Fisher's Exact Test. These results emphasize the need to consider multiple tendon involvements in similar cases and highlight the diagnostic importance of advanced imaging.

This study has several limitations. First, the retrospective design of the study may lead to missing or inaccurate data, as it does not allow for direct intervention in the data collection process. Additionally, retrospective studies carry the risk of selection bias, as patients included in the study are chosen based on specific criteria, limiting the generalizability of the results. Since this study was conducted in a single center, the findings may not be applicable to different populations or centers. Moreover, the lack of long-term follow-up data restricts the ability to evaluate the long-term outcomes of calcific tendinitis.

Future studies should aim to overcome these limitations by being designed as prospective and multicenter studies involving larger patient populations. Additionally, the inclusion of long-term follow-up data would allow for a more detailed assessment of the prognosis and response to treatment of calcific tendinitis.

In conclusion, despite its rarity, it is crucial for radiologists to be familiar with the imaging findings of intraosseous extension of calcific tendinitis mentioned above in detail for avoiding misdiagnosis which may lead to further unnecessary imaging, biopsy and any other surgical interventions. Additionally, the injection treatment guided by ultrasound is practical and therapeutic.

Our findings emphasize the importance of advanced imaging modalities such as CT and MRI in confirming intraosseous migration and assessing its extent. Furthermore, routine follow-up with MRI can aid in monitoring disease progression, evaluating response to treatment, and detecting any residual or recurrent changes. A comprehensive understanding of the characteristic imaging findings will not only improve diagnostic accuracy but also help in guiding appropriate management and preventing overtreatment.

Abbreviations and acronyms: US, ultrasound; CT, computed tomography; MRI, magnetic resonance imaging; PACS, picture archiving and communication system; PD, proton density.

Consent for publication: Informed consent is routinely obtained from all patients undergoing MRI.

Availability of data and materials: The data supporting this study's findings are available on request from the corresponding author.

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Authors contributions: M.T. and K.A. have constructed the main idea and hypothesis of the study. I.A. and M.T. developed the theory and arranged/edited the material and method section. M.T., M.A.D. and K.A. have done the evaluation of the data in the results section. Discussion section of the article was written by M.T., I.A., K.A. and M.T. reviewed, corrected and approved. In addition, all authors discussed the entire study and approved the final version.

Conflict of interest: No conflict of interest was declared by the authors.

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