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Crowned Dens Syndrome associated with rheumatoid arthritis: A case report of two patients with a systematic literature review

Abstract

Background: This study reported two cases of crowned dens syndrome (CDS) occurring in rheumatoid arthritis (RA) patients, along with a systematic literature review of similar cases, aiming to explore the association between RA and CDS within the context of calcium pyrophosphate deposition disease (CPPD disease).

Methods: A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We performed an online systematic literature search using the PICO (Patient, Intervention, Comparison, Outcome) strategy, to identify articles reporting the association between RA and CDS. A total of five studies were included in the systematic review.

Results: Most cases involved older adults aged between 60 and 80 years old. A marked predominance of female cases was observed in most cases. Clinical presentation typically included chronic or acute neck pain, stiffness, and headache. In all the studied cases, no neurological complications were reported. Standard radiographs identified atlanto-axial instability in two cases. CT imaging included calcifications of the transverse, alar, and apical ligaments encircling the odontoid process, as seen in most cases. CT might also reveal erosions, pseudotumors, or structural abnormalities. Management strategies combined colchicine, nonsteroidal anti-inflammatory drugs (NSAIDs) and glucocorticoids, resulting in significant clinical and biological improvement.

Conclusion: CDS is an uncommon condition that should be more frequently considered in patients with RA presenting with neck pain, headache, and fever. Further research studies are required to elucidate potential shared pathophysiological features between RA and CDS and to explore common treatment options.

Keywords: Calcium pyrophosphate deposition disease, Crowned dens syndrome, Rheumatoid arthritis.

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Chondrocalcinosis is a metabolic condition that is particularly prevalent in the later stages of life and is caused by calcium pyrophosphate deposition (CPPD) (1). The diagnosis of CPPD can be challenging, in the absence of a decisive diagnostic test. Aspiration of synovial fluid followed by crystal analysis using compensated polarized light microscopy remains the definitive diagnostic method (2). While it may initially be asymptomatic, various forms of joint disease can emerge as the condition progresses and may resemble other rheumatic diseases such as rheumatoid arthritis (RA) (3). Crowned Dens Syndrome (CDS) represents a rare but clinically significant manifestation of CPPD, characterized by crown-shaped calcifications surrounding the odontoid process of the cervical spine (4). Although CPPD disease traditionally involves peripheral joints, the axial skeleton, particularly the cervical spine, can also be affected, resulting in a triad of acute headache, neck stiffness, and fever (4).



RA, a systemic autoimmune disease that frequently involves the cervical spine, particularly the atlantoaxial and atlantooccipital joints, shares overlapping epidemiological and clinical features with CPPD disease. An increasing number of studies suggest that RA is a risk factor for CPPD disease (5-7). The coexistence of RA and CDS presents unique diagnostic and therapeutic challenges, particularly in distinguishing inflammatory flares of RA from acute calcification-related symptoms in CDS. Moreover, the chronic inflammation in RA may predispose to CPPD, compounding disease severity. In this study, we reported two cases of CDS occurring in RA patients, and we performed a systematic literature review of similar cases, aiming to explore the association between RA and CDS within the context of CPPD disease, emphasizing diagnostic challenges and management strategies.

Methods

Search strategy: A systematic review was conducted according to the Preferred Reporting Items for Systematic

Reviews and Meta-Analyses (PRISMA) guidelines (8). IRB approval and informed consent were not required for this study because it is a retrospective case report and systematic review of previously published data. The study was registered on PROSPERO under the reference CRD420251027725. Since this study included anonymized retrospective case reports and a systematic review of publicly available data, ethics committee approval was not required, in accordance with institutional and international guidelines. Two authors (BS, RE) independently performed a systematic literature search using the PICO (Patient, Intervention, Comparison, Outcome) strategy, to identify articles reporting the association between RA and CDS. The following online databases (PubMed, Scopus, Web of Science, and Embase) were searched for potentially eligible studies published up to October 2024. The following search terms were used: ("Calcium pyrophosphate deposition" OR "CPPD disease" OR "calcification") AND ("Crowned dens syndrome" OR "Rheumatoid arthritis"). The two authors (BS, RE) also performed a supplementary hand search to gather additional articles.

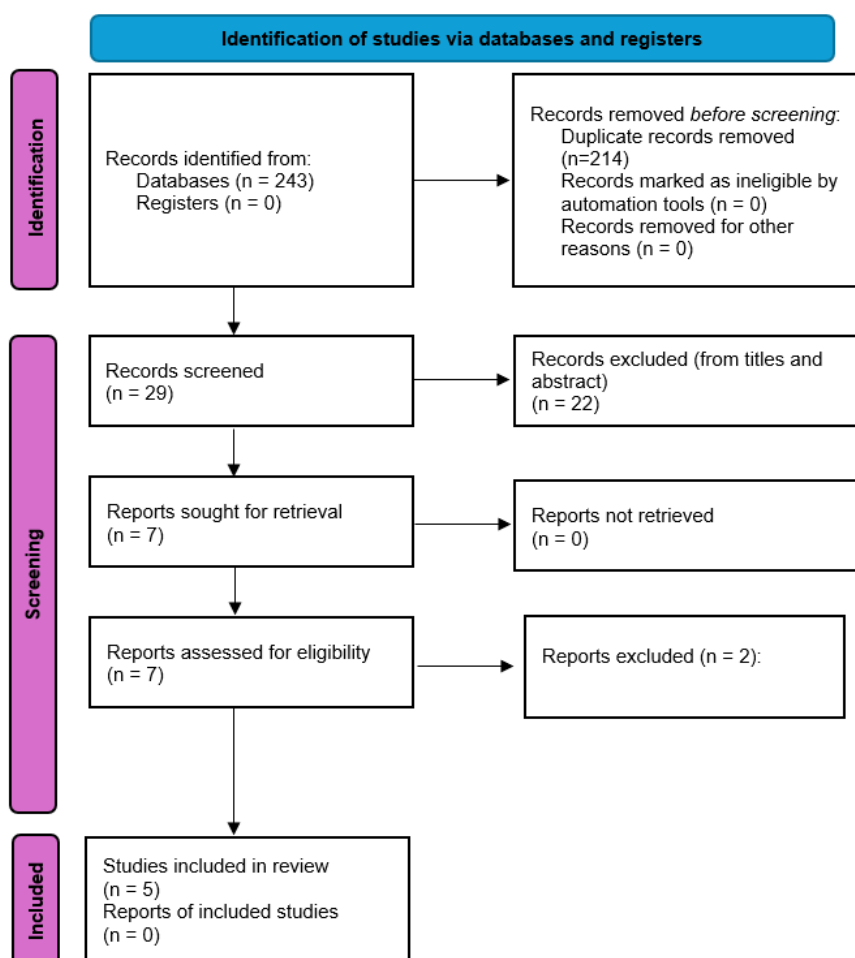


Figure 1. PRISMA 2020 flowchart

Study selection:The two authors (BS, RE) independently reviewed all the generated articles for relevance. The selected languages were English and French. Off-topic articles, duplicate publications, letters, editorials, comments, systematic literature reviews, and meta-analyses were excluded. Subsequent screening was performed in successive stages by title, abstract, and full text to determine final eligibility. Discrepancies in the selection process were resolved through discussion and consensus. All authors approved the final selection of the included studies.

Study quality assessment:The methodological quality of the included case series was assessed using the NIH Quality Assessment Tool for Case Series Studies, developed by the National Institutes of Health (NIH) (9). This tool consists of nine criteria that evaluate key aspects such as the clarity of the study question, the description of the study population, the reliability of outcome measures, and the appropriateness of statistical analyses. Each study was rated as “Good,” “Fair,” or “Poor” based on the cumulative score across these criteria. Two reviewers (BS, RE) independently conducted the assessment, and discrepancies were resolved through discussion and consensus. A total of five studies were included in the systematic review (10-14). The flowchart is shown in figure 1.

Results

Case 1 (AH): A 61-year-old woman with a 24-year history of seropositive RA, presented with a relapse of acute pain and swelling in the wrists and hand joints, associated with a two-week history of cervical spine pain. The Visual analog scale (VAS) score was 6/10 for cervical spine pain. Physical examination revealed tenderness on C7 palpation, without stiffness. She had a fever of 38.5°. Neurological

examination was normal. The anterior atlanto-dental interval (AADI) measurement in the cervical spine x-ray showed a diastasis of 4mm, and the posterior atlanto-dental interval (PADI) was 12mm. Computed tomography (CT) scan images ruled out C1-C2 dislocation but revealed calcifications of the transverse ligament and alar ligaments (figure 2). Her RA treatment with Methotrexate (10 mg per week, intramuscularly) was continued, along with 10 mg per day of prednisone, resulting in a moderate reduction in pain.

Case 2 (HS): A 56-year-old woman treated with a combination of conventional synthetic disease-modifying antirheumatic drug (csDMARD) and a biologic DMARD for seropositive RA and secondary Sjogren’s syndrome, was admitted with an acute inflammatory neck pain. The patient had active disease with arthritis in several small joints of the hands and the elbow. The cervical spine examination showed a limited and painful range of motion, with a normal neurological assessment. Inflammatory markers were elevated, with C-reactive protein (CRP) at 24 mg/L. A CT scan of the cervical spine was performed despite the absence of abnormalities in the radiographic images, which revealed C1-C2 narrowing, erosion of the odontoid process, and joint space narrowing with geodes (cyst-like lesions) in the left C0-C1 and C1-C2 joints. Calcification of the transverse ligament was also noted, suggestive of articular chondrocalcinosis (figure 3). Knee radiographs were performed to support the diagnosis and revealed large osteophytes bilaterally, cartilage thinning, and external meniscal calcification on the right, as well as calcification in the hyaline cartilage of the left knee. The patient was started on colchicine 1mg per day, with a marked improvement after three days of treatment: VAS pain went from 5/10 to 1/10.

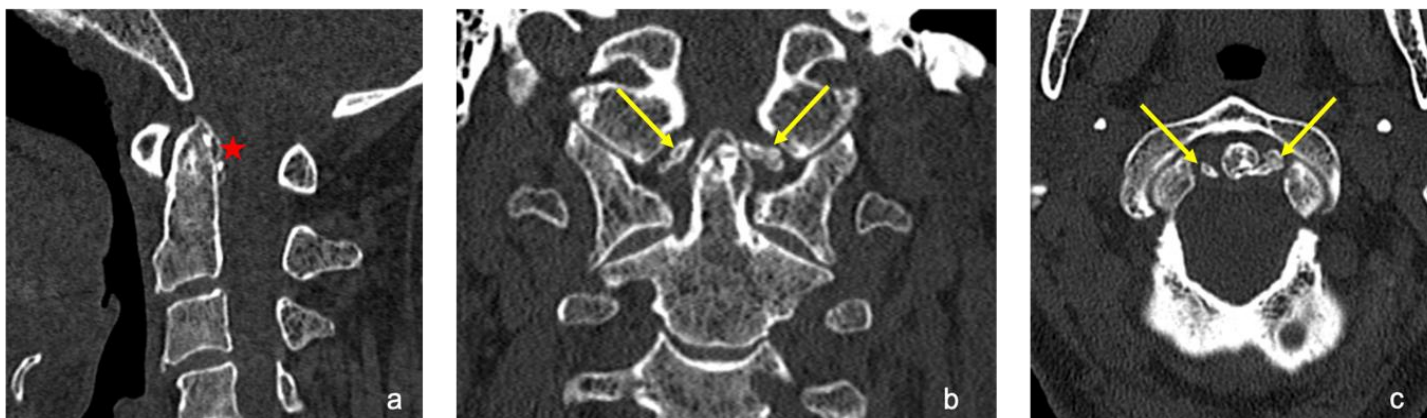


Figure 2. CT scan images in the bone window show: (a) calcification of the transverse ligament (red star) on the sagittal view, and calcification of the alar ligaments (yellow arrow) on (b) the coronal and (c) transverse views.

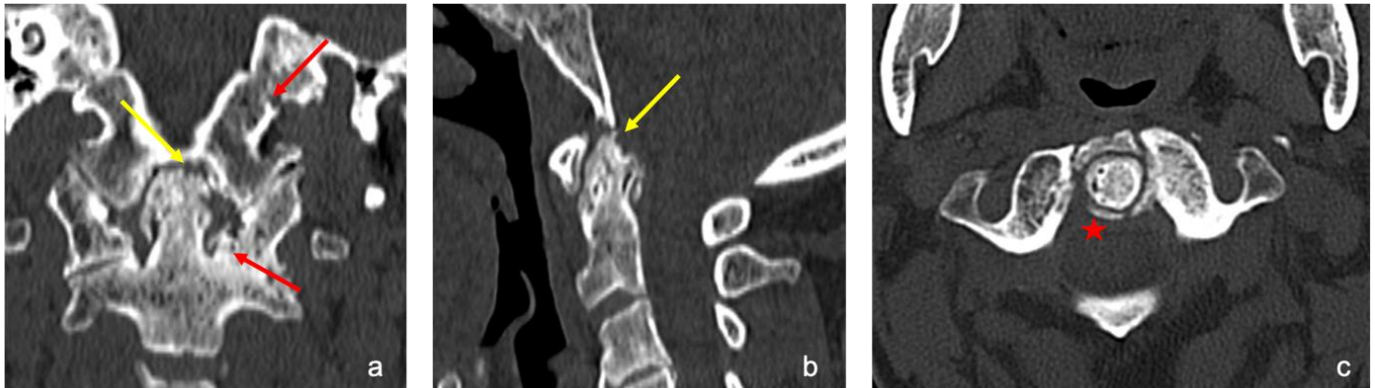


Figure 3. CT scan revealed C1-C2 joint space narrowing with geodes (cyst-like lesions) in the C0-C1 and C1-C2 joints on (a) the coronal view (red arrows), erosion of the odontoid process on (a) coronal and (b) sagittal views (yellow arrow), and calcification of the transverse ligament on (c) the transverse view (red star).

Discussion

In this review, we tried to provide a comprehensive overview of epidemiological features, different clinical and radiological manifestations of CDS in RA, and common treatment options. As presented in table 1, most cases involved older adults aged between 60 and 80 years old (10-14). A marked predominance of female patients was observed, apart from Scutellari et al. who reported only one male patient in their study (11). Clinical presentation typically included chronic or acute neck pain, stiffness, and headache. In all the studied cases, no neurological complications were reported. Radiological features demonstrated distinctive imaging findings across x-ray, CT scan, and MRI, which are instrumental in diagnosing conditions like CDS associated with RA and CPPD. Standard radiographs identified atlanto-axial instability in case 1 and also in the study of Soubai et al. (10).

Management strategies in the cases reviewed combined colchicine, nonsteroidal anti-inflammatory drugs (NSAIDs) and glucocorticoids, demonstrating significant improvement. RA affects approximately 1% of the population, with a female-to-male prevalence ratio of 3:1. It is the most frequently encountered inflammatory condition involving the cervical spine, with cervical spine involvement observed in up to 86% of individuals with RA (15). The atlantooccipital and atlantoaxial joints are most commonly affected, as these are the only segments of the vertebral column lacking intervertebral discs. They comprise exclusively synovial joints (15, 16).

Cervical pain in RA can arise from various etiologies. Atlanto-axial lesions are a common manifestation, including subluxations, erosions, pannus formation, and instability at the C1-C2 level due to chronic inflammation and ligamentous damage (17). Despite their efficacy, biologic treatments carry a small but notable risk of serious head and neck infections as a potential adverse effect (18). Also, degenerative changes in the cervical spine can coexist with RA, further complicating symptomatology in addition to possible serious neurological consequences (19). CPPD is a common condition that is usually strongly linked to aging and osteoarthritis. Other well-established risk factors for CPPD include hyperparathyroidism, hemochromatosis, hypomagnesemia, and hypophosphatasia (20).

The association between CPPD disease and RA is increasingly recognized, particularly in older populations. CPPD disease in RA is underdiagnosed due to overlapping clinical features. According to the 2023 ACR/EULAR classification criteria for CPPD disease, the presence of CDS or calcium pyrophosphate crystals in synovial fluid is sufficient to classify a patient as having CPPD disease (21). However, these classification criteria also specify that if the symptoms are better explained by an alternative condition, such as RA, the diagnosis of CPPD disease should be excluded (21).

This stipulation makes it challenging to confirm the coexistence of CPPD disease and RA. Yet, this association does not appear to be uncommon. One hand joint synovial fluid study demonstrated that 19% of RA fluids contained CPP crystals (6). Approximately 8% of RA patients had

CPP crystals in their synovial fluid samples as shown by a similar study of 2,370 synovial fluids (22). However, little is known about possible shared risk factors between the two diseases. What is suggested in the literature is that long-

standing inflammation in RA may predispose patients to CPPD by promoting crystal deposition and structural damage (7).

Table 1. Summary of published cases of association between CDS and RA including our two cases

Follow up	management	MRI	Other locations of CPPD	CT scan	X-ray	biology	Examination	Clinical presentation	Disease evolution (years)	Gender	Age (years)	Number of cases	References
Moderate decrease of pain	Methotrexate, prednisone 10mg/day	-	-	Absence of C1-C2 dislocation. Calcification of the transverse ligament	AADI=4mm PAADI=12mm	CRP was normal	Painful palpation of C7, without stiffness. Fever at 38.5°. Neurological examination was normal	Recent cervical spine pain (2 weeks) and pain and swelling relapse of RA	24	Female	61	1	case 1: AH
Spectacular improvement after 3 days of treatment	Colchicine 1mg/day	-	Knees	C1-C2 narrowing, erosion of the odontoid process, narrowing of the joint space with geodes (cyst-like lesions) in the left C0-C1 and C1-C2 joints and calcification of the transverse ligament	Normal	CRP=24mg/L	Limited and painful mobilization of cervical spine with a normal neurological assessment	Acute inflammatory neck pain	16	Female	56	1	case 2: HS
The nuchal pain decreased gradually	A cervical splint with NSAIDs	-	-	Calcifications of transverse and alar ligaments, surrounding the odontoid process. The spinal canal appeared normal. No dislocation of C1-C2.	atlido-axial diastasis of 4 mm.	-	A painful palpation of C1 and C2, without stiff neck. Neurologic examination was normal	Chronic nuchal pain	9	Female	34	1	Soubai et al. 2012 (10)
-	-	-	-	-Man: calcification of the transverse ligament, -Women: varying distribution of calcifications in all soft tissues surrounding the dens (transverse ligament of the atlas in four cases; alar ligaments in two cases).	-	-	-	Neck pain	-	10 females 1 male.	-The man: 69 -Women between 35 and 79	11 cases of RA out of 38	Scutellari et al. 2007 (11)

	Follow up	management	MRI	Other locations of CPPD	CT scan	X-ray	biology	Examination	Clinical presentation	Disease evolution (years)	Gender	Age (years)	Number of cases	References
	dramatic improvement in both clinical (head/neck pain alleviated and cervical spinal mobility regained) and laboratory measures.	glucocorticoids as 0.5 mg/kg prednisone plus colchicine	-	-	-	-	-	-	Acute onset pain in the upper neck and/or occiput accompanied with neck stiffness	-	-	-	2/24	Awisat et al. 2019 (12)
	After 24h she was better with no fever, and she improved the cervical and wrists pain. At the latest follow-up, she had a cervical VAS pain of 3-4/10, no swollen wrists, and a CRP of 5.9mg/L	colchicine 2mg on day 1, and 1mg/day thereafter.	-	Knee radiographic confirmation	Deep erosion of the dens. Erosions of the atlantoepistrophe joint. Calcium crystal deposition in the transverse atlas and in the alar and apical ligaments, surrounding the odontoid process	-	Blood cultures and procalcitonin were negativ. Uric acid was normal. No RF, no ACPA, no ANA	severe cervical pain. Rotation was almost impossible and flexion was limited.	Acute pain relapse in wrists and cervical spine	5	Female	75	1	Ferraccioli et al. 2023 (13)
	Six months after no further radiographic progression appeared, but pannus formation remained stable	Was on methotrexate, adalimumab, and baricitinib. Started on colchicine 0.5 mg/day	-	-	cyst-like osseous destruction of the odontoid process and calcifications within the retro-odontoid pseudotumor representing CPPD. Color-coded dual-energy CT image: cervical CPPD, confirmative for crowned dens syndrome	-	-	-	Chronic neck pain	-	Female	72	1	Haller et al. 2020 (14)

CT: computed tomography; CPPD: calcium pyrophosphate deposition; CRP: C-reactive protein; AADI: anterior atlanto-dental interval; PADI: posterior atlanto-dental interval; NSAIDs: nonsteroidal anti-inflammatory drugs; RA: rheumatoid arthritis; RF: rheumatoid factor; ACPA: anti-citrullinated protein antibody; ANA: anti-nuclear antibody.

CDS is underdiagnosed and should be considered in patients with CPPD disease and presenting with neck pain and stiffness. In 2020, Haikal A et al. found that about 60%

of patients who had CPPD disease showed cervical CT scan images consistent with CDS (23). Interestingly, in a retrospective study conducted by Andrew Joyce et al.,

atlantoaxial pannus formation was found not only in patients with RA but also in patients with CDS (24). Other studies have suggested distinct mechanisms: in RA, inflammation within the joint synovium triggers pannus development, mirroring the destructive processes observed in peripheral joints (25). Similarly in CDS, the inflammatory response caused by calcium pyrophosphate crystal deposition contributes to pannus formation (26). Cervical CT is the gold standard for diagnosing CDS, as it can identify linear calcifications surrounding the dens in a characteristic “Halo” distribution. These characteristic calcifications are typically observed in the transverse ligament of the atlas, which has a fibrocartilaginous matrix prone to CPPD (27). A cervical CT scan performed on 40 patients in a case study revealed that the majority (90%) had symmetrical calcific peri odontoid deposits (28). However, several radiological differential diagnoses must be considered when evaluating calcifications around the odontoid process, such as osteoarthritis, which typically lacks the crown-like calcifications around the dens; longus colli tendinitis, with anterior prevertebral calcifications; and ankylosing spondylitis, which shows syndesmophytes and sacroiliac involvement rather than peri-odontoid calcifications. Infectious spondylodiscitis or meningitis should also be considered, especially in febrile patients, but are ruled out by imaging and lack of neurological signs.

Although MRI is less effective in detecting calcified structures, it has been reported that features such as bone erosions, bone marrow or soft tissue edema, and gadolinium contrast enhancement can help distinguish between symptomatic and asymptomatic calcifications. In 2019, Scheldeman et al. showed that the presence of contrast enhancement and T2 hyperintensity in the odontoid process on MRI suggested that these calcifications were not incidental or asymptomatic but were indeed associated with the clinical symptoms of CDS (29). Bone marrow edema and gadolinium contrast enhancement in the odontoid process may result from a mechanism similar to that observed in RA, further complicating diagnosis (30). Additionally, MRI is valuable for ruling out critical conditions such as spondylodiscitis or neoplasms (31).

The goal in treatment for chronic calcium pyrophosphate arthritis is the suppression of acute flares. Our review highlights the possibility of controlling acute symptoms by using NSAIDs that are effective on RA-specific peripheral symptoms. One of our patients was treated with 1mg of colchicine daily, with rapid and substantial pain relief. Important doses of corticosteroids were also administered and gradually tapered, in some cases with positive

outcomes. Combined therapy using glucocorticosteroids and colchicine was reported as well. The review of S.Y. Kim et al. suggested that methotrexate and hydroxychloroquine were possible options that could be considered in case of resistance to the drugs used for acute flare treatment (1). No cases of surgery were reported in our review, while in the systematic review of Ben Tekaya et al. concerning the lumbar spine involvement in CPPD disease, 13 cases of surgery among 62 patients were performed, allowing to establish the histological diagnosis (32).

Beyond clinical management, it is also important to better understand the nature of the relationship between CDS and RA, particularly in elderly patients presenting with cervical pain. Although CDS may coexist with RA, it is important to emphasize that RA is not the underlying etiology of this syndrome. CDS results from CPPD, a process typically linked to aging, metabolic conditions, or mechanical factors. The association between RA and CDS is therefore generally considered coincidental rather than causal. However, because RA frequently causes cervical spine symptoms, CPPD disease may be overlooked in elderly patients presenting with neck pain and systemic features. This overlap may delay accurate diagnosis and management. Moreover, CPPD-related CDS can also occur in association with other autoimmune diseases, such as seronegative spondyloarthropathies (20). In both elderly individuals and younger patients with known risk factors for CPPD (such as hemochromatosis or hypomagnesemia), CDS should be considered when neck pain and suggestive imaging findings are present (20). This study presents both clinical and systematic insights into a rare condition CDS in patients with RA by combining original case reports with a structured literature review. A key strength of our work lies in its integrative approach, which offers a broader understanding of clinical presentation, radiological features, and therapeutic strategies in this underdiagnosed intersection of RA and CPPD disease.

However, several limitations must be acknowledged. First, in our two cases, there was no synovial fluid analysis with compensated polarized light microscopy to confirm the presence of CPP crystals, which remains the gold standard for the diagnosis of CPPD disease. In our two cases, the diagnosis of CDS was based on a combination of clinical features and characteristic imaging findings. While these findings are highly suggestive of CPPD disease according to the 2023 ACR/EULAR classification criteria, the lack of direct crystal confirmation limits the diagnostic certainty. Second, the number of included cases was small, and the rarity of the condition may have introduced

reporting bias in the literature review. Third, as a descriptive study, the lack of a control group limits our ability to draw causal inferences about the association between RA and CDS. Finally, variability in imaging protocols and treatment strategies across reports may limit generalizability.

CDS is an uncommon condition that should be more frequently considered in patients with RA and presenting with neck pain, headache, and fever, particularly when bacterial meningitis has been ruled out and there is a history of CPPD arthropathy. Neck CT plays a critical role in confirming the diagnosis, typically revealing a characteristic calcified “crown” around the odontoid process. While no large-scale clinical studies have defined optimal treatment targeting both RA and CPPD disease at the same time, probably due to the distinct nature of these conditions, recent case reports suggest that NSAIDs and oral corticosteroids conventional treatments in RA along with colchicine often lead to symptom relief and favorable outcomes, as demonstrated in our cases. Further research studies are required to elucidate eventual common pathophysiological features or risk factors between RA and CDS, and to explore other treatment options.

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Ethics approval: IRB approval and informed consent were not required for this study because it is a retrospective case report and systematic review of previously published data. All patient data were anonymized, and no identifiable information was included.

Conflict of interest: All authors have no conflicts of interest to disclose.

Author contribution: Selma Bouden: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. Emna Razgallah: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. Rym Makhoul: Methodology, Validation. Leila Rouached: Formal analysis, Methodology. Aicha Ben Tekaya: Formal analysis, Methodology. Siwar Ben Dhia: Writing – original draft. Ines Mahmoud: Writing – review & editing. Rawdha Tekaya: Conceptualization, Visualization. Olfa Saidane: Validation. Leila Abdelmoula: Validation.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

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