Letter to the Editor

Crowned dens syndrome detected by positron emission tomography-computed tomography (PET-CT): a case description

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Introduction

Crowned dens syndrome (CDS) was first reported in 1985 by Bouvet *et al.* (1). This phrase describes the relevant radiographic terminology: it refers to the appearance of various sizes of high-density, irregular calcifications around or above the dens. Since these calcifications resemble a "crown" on the dens in radiographic images, they are termed "crowned dens syndrome" (2,3). The primary etiology of CDS is crystal deposition, with calcium pyrophosphate dihydrate crystal deposition (CPPD) being the most common (4,5). The clinical features of this disease mainly include sudden neck pain accompanied by neck stiffness, occasional fever, and elevated erythrocyte sedimentation rate (ESR) or elevated C-reactive protein (CRP). Some patients may even show signs of cervical spinal cord compression. Radiographically, there are irregular high-density shadows of varying sizes around and above the dens (4). A computed tomography (CT) scan is the gold standard for diagnosing CDS (6-8). Owing to its low incidence, clinical cases of this condition are often prone to a misdiagnosis or underdiagnosis. This article presents the case of a patient admitted with neck pain due to infective endocarditis.

Case presentation

The patient was admitted to the hospital after experiencing recurrent fever for 3 months. The patient had a history of rheumatic heart disease and underwent mitral and aortic valve replacement surgery before admission. Blood culture analysis upon admission revealed a positive result for Enterococcus. The echocardiogram revealed mitral valve vegetation, raising suspicion of infective endocarditis. In order to further clarify the cause of the fever, the patient underwent positron emission tomography-CT (PET-CT), the results of which suggested hypermetabolic foci at the cardiac valves, which, in combination with the results of blood cultures and echocardiograms, established the diagnosis of infective endocarditis. Besides, PET-CT indicated a C1–C2 hypermetabolic lesion.

The patient developed persistent neck pain after admission, without pain, numbness, an unsteady gait, or the sensation of walking on cotton in the upper limbs. The patient had no history of rheumatoid disease, no history of trauma, no oral and pharyngeal inflammation, and no history of tuberculosis. Further laboratory investigations and examinations upon admission revealed a body temperature of 37 ℃, clear consciousness, neck stiffness, and positive neck tenderness. The brachial plexus traction tests were negative. The muscle strength, muscle tone, and tendon reflexes were normal in all limbs. Pathological signs such as Hoffman's sign, Babinski's sign, ankle clonus, Kernig's sign, and Brudzinski's sign were negative. His physiological reflexes were normal, and there were no abnormalities in the superficial sensations of the limbs and trunk. The visual analog scale (VAS) was used to score the patient's neck pain at 7 points. The results of additional laboratory results were as follows: white blood cells (WBC), 7.93×10^9/L; CRP, 34.1 mg/L; ESR, 44 mm/h; procalcitonin (PCT), 0.081 ng/mL; and ferritin, 473 ng/mL.

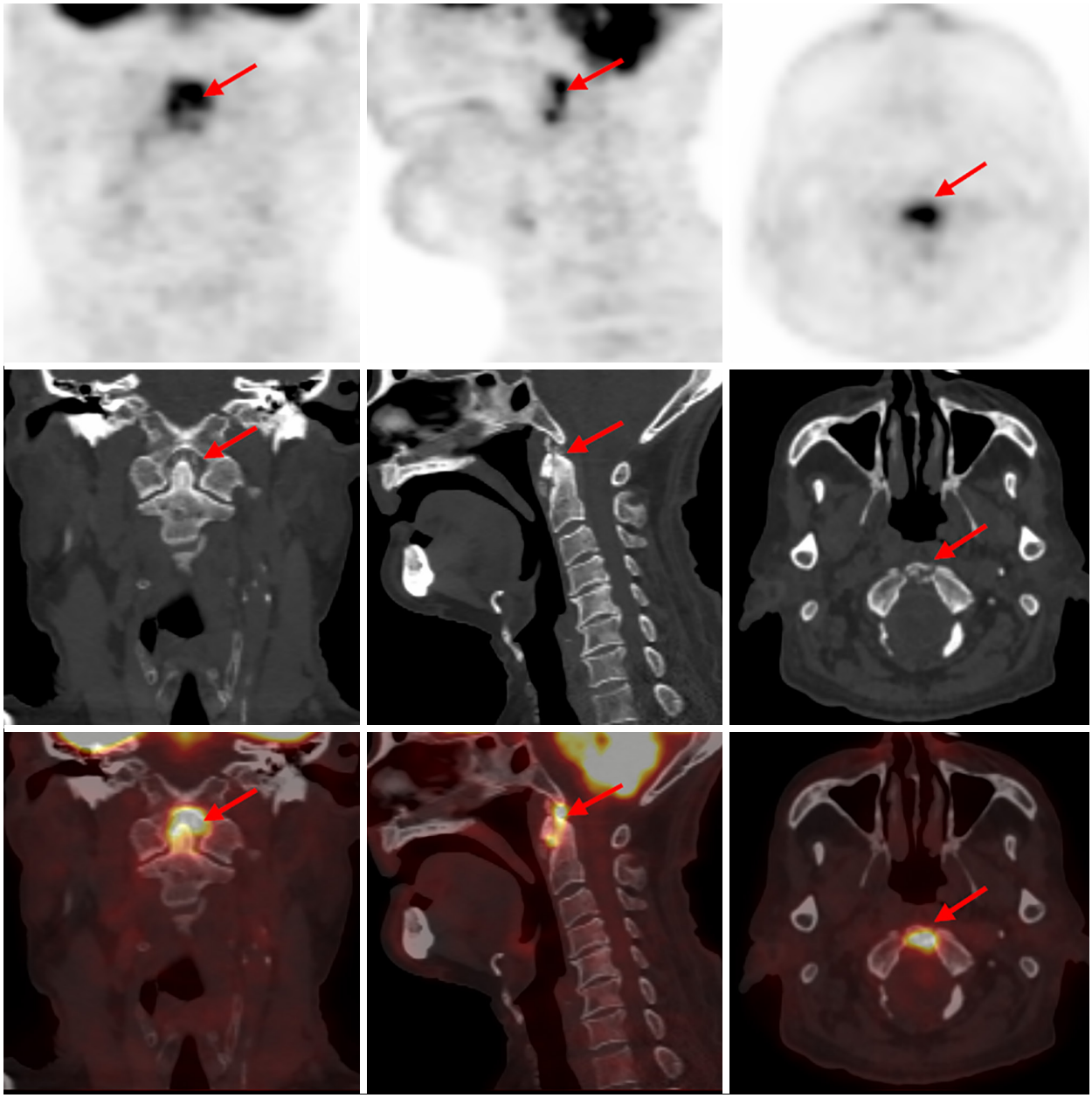

Figure 1 High-density and high metabolic lesions (arrows) visible around the odontoid process on PET-CT cross-sections. PET-CT, positron emission tomography-computed tomography.

Further imaging revealed the following: (I) PET + CT scan showed calcifications around the odontoid process. There was no dislocation of the atlantoaxial joint, and the odontoid process was intact and symmetrical with normal structure, as shown in *Figure 1*. (II) The overall PET-CT scan indicated increased metabolic activity around the aortic valve and atlantoaxial joint (*Figure 2*).

Considering the patient's symptoms, imaging findings, and medical history ruling out tumors and trauma, a diagnosis of CDS was established. During the patient's hospitalization, vancomycin was administered for the treatment of infective endocarditis. The patient had a tolerable pain threshold and was advised to take celecoxib orally at a dose of 0.2 g qd to mitigate the pain. The

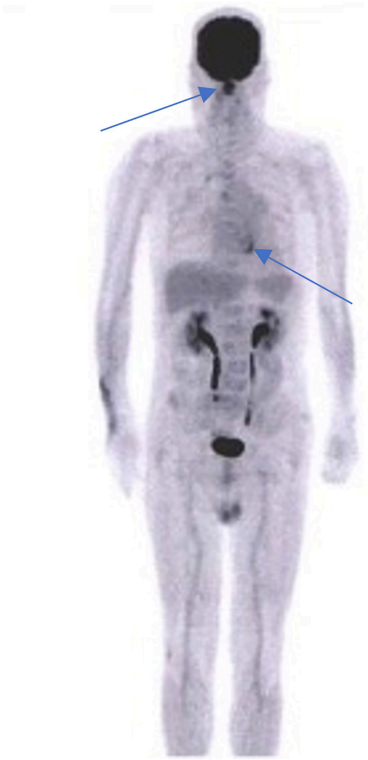

Figure 2 PET-CT indicated increased metabolic activity in the C2 odontoid dens region and heart valve (arrows). PET-CT, positron emission tomography-computed tomography.

patient experienced a significant reduction in the pain after medication. Hoffman's sign, Babinski's sign, ankle clonus, Kernig's sign, and Brudzinski's sign remained negative. After undergoing vancomycin-related anti-infection treatment, the patient's clinical symptoms improved, and his body temperature returned to normal.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was provided by the patient for publication of this article and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

CDS is currently believed to arise from the deposition of calcium salt crystals in the soft tissue surrounding the odontoid process of the axis vertebra, and these depositions manifest similarly to the ossification of the posterior longitudinal ligament in the cervical spine (5,9). Calcifications surrounding the odontoid process can compress the cervical cord, leading to neurological symptoms of limb weakness. Recurrent episodes can easily be misdiagnosed as cervicogenic pain or occipital neuralgia. Another characteristic feature of CDS is restricted neck movement. It's typical clinical presentation is reminiscent of the triad seen in meningitis: acute head and neck pain, stiffness, and fever (10-13). Meningitis typically presents with neck stiffness, a high fever, headache, vomiting, and a positive Kernig's sign, which can easily be confused with CDS. In this patient, there were no signs of increased intracranial pressure, no high fever above 39 ℃, the pathological signs on examination are negative, and the test results for leukocytes and PCT were normal, so a diagnosis of meningitis was not considered. If a patient presents with fever and limited neck movement in the emergency clinic, careful questioning of the patient's symptoms and detailed examination should be the first step. Besides neck stiffness and fever, meningitis also presents with special manifestations such as increased intracranial pressure and positive pathological signs. Moreover, blood counts and CT scans are also effective in differentiating CDS from meningitis, which may show signs such as hydrocephalus and parenchymal changes. In contrast, CDS usually features normal intracranial tissue, but foci of calcification are seen around the dentate process. However, clinical distinction between CDS and meningitis is not easy. Theoretically, the headache associated with meningitis and the neck pain resulting from CDS may present distinct characteristics. CDS is notably marked by a significant limitation in cervical rotation. Nonetheless, in the case of early-stage or atypical symptomatic meningitis, prematurely dismissing the possibility of meningitis as a diagnosis could result in delayed treatment, potentially leading to more severe outcomes, which requires lumbar puncture to rule out meningitis (14).

The current diagnostic criteria (8,15) include the following: (I) acute severe cervical pain; (II) significant restriction in cervical movement, especially in rotation; (III) alterations in inflammatory markers, such as elevated levels of CRP; (IV) CT imaging revealing calcium deposition around the odontoid process; (V) absence of trauma history, exclusion of other inflammatory diseases and tumors.

In this case, the patient presented with infective endocarditis accompanied by CDS. The presence of infective endocarditis may complicate the diagnosis of CDS. The patient completed a comprehensive examination,

including routine blood tests, CRP, PCT, ESR and PET-CT. The results revealed that the WBC and PCT levels were within the normal range. The ESR and CRP level were elevated, and PET-CT revealed high metabolic lesions at the heart valves and neck. PCT, discovered in 1992, is the precursor of human calcitonin, a protein secreted by thyroid C cells that contains 116 amino acids. It is not influenced by hormonal levels and exhibits good stability (16). The PCT levels in the serum of healthy individuals are very low and significantly increase during systemic reactions caused by bacterial infections, and the degree of increase is positively correlated with the severity of the infection (17). As an acute-phase protein, CRP can also increase due to factors such as acute trauma or surgery, in addition to bacterial infections, making it nonspecific for infection. The ESR is closely related to the serum environment and plasma protein levels and lacks relative specificity for infection. The patient had already undergone vancomycin treatment before the manifestation of neck pain. Her WBC, PCT, and temperature returned to normal, which indicated that the bacteremia related to infective endocarditis had been controlled. The elevation of nonspecific inflammatory markers, ESR and CRP, at this time is mainly attributed to the presence of CDS. This finding aligns with the characteristics of CDS as non-infectious disease, with no bacterial or viral infection factors, which explains the absence of an increase in PCT. Fludeoxyglucose (FDG) is a radiopharmaceutical used in PET-CT. It is a glucose analog that is taken up by cells, particularly those with high metabolic rates, such as cancer cells. However, it can also accumulate in areas of inflammation. When FDG accumulates around crowned dens calcifications, it might indicate an active inflammatory process rather than mature ossification. This can be particularly useful in differentiating between inflammatory and non-inflammatory causes of neck pain or other related symptoms. Monet reported similar FDG uptake around the odontoid process accompanied by polymyalgia rheumatica (18). Although it lacks specific inflammatory markers, the presence of rheumatic myalgia can lead to a modest elevation in non-specific indicators in patients. In such cases, PET-CT can serve as an alternative diagnostic tool for indicating localized inflammatory responses.

The patient had no history of rheumatoid disease, no history of trauma, no oral and pharyngeal inflammation, and no history of tuberculosis. There are no risk factors for infectious diseases or previous non-infectious diseases. The patient's CT scan results showed that the patient's atlantoaxial spine was not dislocated, the atlantoaxial anatomy was normal, and the odontoid process was intact and symmetrical. Infectious diseases of the cervical spine or osteoarthritis of the C1/C2 odontoid process were not considered. Where a tumor has been excluded, the uptake lesion may reveal abnormal metabolic activity, typically resulting from localized inflammation or other pathological processes. In patients with neck pain and restricted movement, this hotspot could indicate an area of inflammation or stress, aiding in further diagnosis and treatment planning. Since CDS is mainly characterized by calcification-related features, CT is more significant compared to MRI in the diagnosis of CDS when infection or neurological emergencies are excluded (19). However, given the high cost of PET-CT and the need for radiopharmaceuticals and medical equipment, its role in diagnosing CDS in the emergency setting limited.

Diphosphonate bone scintigraphy provides another way of studying the metabolic activity of the CDS. Similar to PET-CT, it is used for diagnosis by detecting high uptake of radioactive materials. Geeter reported the use of Tc-99m oxidronate bone scintigraphy to diagnose CDS (20).

The pharmacotherapy for CDS includes the following: (I) nonsteroidal anti-inflammatory drugs (NSAIDs): currently, NSAIDs are the most effective medication for treating CDS. Symptoms often significantly improve after medication. NSAID inhibition of the production of inflammatory factors can alleviate the course of the disease, which leads to the relief of the symptoms. However, in this case NSAID medication alone cannot reduce the metabolic activity of the bacteria. Relevant literature has shown that the sole oral administration of NSAIDs is sufficient to alleviate symptoms. (II) Corticosteroids: these drugs are primarily used in conjunction with NSAIDs to alleviate acute pain caused by CDS. However, prolonged and excessive use of colchicine can lead to severe complications. (III) For patients who do not respond well to either NSAIDs or corticosteroids alone or in combination or for those with refractory CDS, the use of colchicine can be considered (8,21).

Patients have experienced rapid symptom relief after taking NSAIDs orally. For those patients who have a refractory response to NSIADs or present with severe symptoms, the concurrent use of corticosteroids may be considered. In this case, due to the presence of infective endocarditis, the patient was also treated with vancomycin. Her neck pain symptoms were not particularly severe, and combined use of corticosteroids might have exacerbated the

spread of the infection; hence, corticosteroids were not co-administered.

A notable aspect of this article is that the patient underwent a PET-CT scan to confirm the site of infection, and the PET-CT revealed a hypermetabolic area at the odontoid process level. Previous studies have typically reported CT imaging alone for diagnosis (9,22,23). Only Monet has reported PET-CT images of CDS accompanied by polymyalgia rheumatica (18). This case study serves as a valuable complement to the diagnostic utility of PET-CT in identifying CDS. Considering the absence of neck pain symptoms in the patient prior to admission, we can attribute the acute onset of CDS to the time following admission. The high-density, hypermetabolic material deposited around the odontoid process aligns with the findings of elevated inflammatory marker levels, as reported in previous literature.

Conclusions

Due to the low incidence of CDS, CDS cases are prone to be dismissed or misdiagnosed, thus leading to inappropriate treatment. For patients with acute neck cancer, elevated inflammatory markers, and negative pathological signs, the diagnosis of CDS cannot be neglected.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1828/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was provided by the patient for publication of this article and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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