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Clinical and CT Imaging Features of Brucellar Spondylitis and Differential Diagnosis

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Abstract: This study aims to explore the clinical and CT imaging features of brucellosis spondylitis (BS) and to strengthen the clinical cognition to reduce misdiagnosis and mistreatment. In this study, clinical and CT imaging data of 106 patients with BS diagnosed in the Second Hospital of Hohhot and the Third Hospital of Baotou were collected from March 2023 to September 2024 and retrospectively analyzed by clinical manifestations, CT imaging, and disease regression. In 106 patients, 58.5% had fever, 98.1% had malaise, 96.2% had excessive sweating, 81.1% had lumbosacral pain, 79.3% had limitation of limb movement, 76.4% had constipation, and 6.6% had urinary retention. For imaging manifestations, the involvement of lumbar, thoracic and cervical vertebrae were 80.2%, 16.9% and 1.9%, respectively. Lesions < 1.0 cm, 1.0–2.0 cm, 2.0–3.0 cm, and > 3.0 cm were found in 49.4%, 29.6%, 19.4%, and 1.6%, respectively. In 106 patients, CT showed round, irregular or worm-like areas of bone destruction, with coexisting osteophytes in 61.5% and no signs of dead bone or pedicle destruction. Interdiscal destruction, spinal canal abscess, ligament injury, and signs of lumbar major muscle compression were rare, accounting for 11.7%, 6.6%, 4.7%, and 3.8%, respectively. Regarding regression, 106 patients with BS treated with antimicrobial therapy or antimicrobial + surgery had a good prognosis. In conclusion, BS has its own characteristics in clinical and imaging aspects and it is easy to distinguish from other common causes of spondylitis bone damage.

Keywords: Brucellosis; Spondylitis; Clinical; CT; Imaging; Differential

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1. Introduction

Brucellosis is a zoonotic disease caused by *Borrelia burgdorferi* infection with a global distribution and is a common and frequent disease in animal husbandry areas [1,2]. The clinic is characterized by fever, malaise,

excessive sweating, bone and joint destruction, and easy chronicity [1,3]. As brucellosis is a systemic allergic disease caused by *Brucella* infection, it can involve multiple systems and tissues of the body, and the clinical manifestations are extensive and complex, which is very likely to lead to misdiagnosis and mistreatment [4]. Osteoarticular damage is the most common clinical manifestation of chronic brucellosis, with an incidence of 20% to 53%, of which Brucellar spondylitis (BS) accounts for more than half of the overall brucellar osteoarthropathy [3]. Due to the low clinical awareness of BS, it is easy to cause misdiagnosis and mistreatment, and even lead to repeated surgical treatment of patients due to misdiagnosis [4]. In this study, we analyzed the clinical and CT images of 106 patients with BS diagnosed in the Second Hospital of Hohhot and the Third Hospital of Baotou, aiming to reduce clinical misdiagnosis and mistreatment by recognizing the clinical and imaging features of BS.

2. Methodology

2.1. Study data

A total of 106 BS patients admitted to the Second Hospital of Hohhot and the Third Hospital of Baotou between March 2023 and September 2024 were selected for this study. The inclusion criteria were as follows: (1) Diagnosis of BS met the national health department's criteria for brucellosis [5]; (2) Positive *Brucella* culture and/or positive results in the *Brucella* agglutination test (BAT) or the tiger red plate test (TRPT); (3) Presence of bone damage signs on CT imaging; (4) Availability of complete clinical and imaging data with clear referral information; and (5) Exclusion of patients with spondylitis caused by tuberculosis, septicemia, or spinal tumors.

2.2. Methods of study

A retrospective study was conducted to summarize and analyze the clinical features, CT imaging findings, and disease progression in 106 patients with BS.

2.3. CT examination

All 106 patients underwent CT examination using an Activion16 TSX-031A 64-row spiral CT machine manufactured by Toshiba Corporation, Japan. The scanning parameters were as follows: tube voltage 120 kV, tube current 250–450 mA, layer thickness 5 mm, pitch 0.984:1, rotation speed 39.37 mm/week, rotation time 0.8 s, field of view (FOV) 350 mm, matrix 512×512, and reconstruction interval 1.2 mm.

2.4. Imaging analysis

All imaging data were independently analyzed by two imaging professionals with the title of deputy chief physician or higher. In cases of discrepancies in imaging analysis results, a chief physician was consulted to reach a final determination. Imaging terminology was based on the nomenclature established by the Fleischner Society Nomenclature Committee in 2008 [6].

3. Results

3.1. General information

Among the 572 brucellosis cases admitted during the study period, 106 patients (18.5%, 106/572) were

diagnosed with BS. The cohort included 81 males and 25 females, with a male-to-female ratio of 3.2:1. The patients ranged in age from 21 to 74 years, with an average age of 47.2 ± 4.7 years. The duration of illness varied from 2 to 20 months, averaging 5.3 ± 3.8 months. Regarding occupation, 82 patients (77.4%) were farmers and herders, 14 (13.2%) were self-employed, 8 (7.5%) were workers, and 2 (1.9%) were domestic workers. In terms of exposure history, 85 patients (80.2%) had direct contact with sheep, 5 (4.7%) had contact with cattle, while 16 (15.1%) had no clear history of animal contact. All 106 patients (100%) tested positive for the *Brucella* agglutination test (BAT) and the tiger red plate test (TRPT), while 11 patients (10.4%) were positive for *Borrelia burgdorferi* culture.

3.2. Clinical manifestations

Among the 106 patients in this study, the most common clinical symptoms included fatigue in 104 cases (98.1%) and excessive sweating in 102 cases (96.2%). Fever was reported in 62 cases (58.5%), while lumbosacral pain was present in 86 cases (81.1%), and sciatica in 75 cases (70.8%). Additionally, 84 patients (79.3%) experienced limb movement limitations, 81 (76.4%) had constipation, and 7 (6.6%) had urinary retention. Less common symptoms included upper back pain in 18 cases (16.9%) and neck pain in 2 cases (1.9%).

3.3. CT imaging

3.3.1. Lesion site

Among the 106 patients in this study, all cases exhibited adjacent bone damage, accounting for 100.0%. A total of 247 vertebrae were affected, with the number of involved vertebrae ranging from 1 to 3 per patient, averaging (2.1 ± 0.6). The most commonly affected site was the lumbar spine, observed in 85 cases (80.2%), involving 192 vertebrae (77.7%). The thoracic spine was affected in 18 cases (16.9%), with 51 vertebrae involved (20.6%), while the cervical spine was involved in 2 cases (1.9%), affecting 4 vertebrae (1.6%). The sacrococcygeal spine was affected in 1 case (0.9%), involving 1 vertebra (0.4%). Lesion sizes were classified as follows: less than 1.0 cm in 122 vertebrae (49.4%), 1.0 to 2.0 cm in 73 vertebrae (29.6%), 2.0 to 3.0 cm in 48 vertebrae (19.4%), and greater than 3.0 cm in 4 vertebrae (1.6%).

3.3.2. CT imaging findings

CT imaging findings in the 106 patients revealed various patterns of vertebral involvement. Bone destruction was observed in all 247 affected vertebrae, appearing as round, irregular, or worm-eaten lesions without evidence of dead bone (**Figure 1**–**Figure 4**). Osteophyte formation was common, with 152 osteophytes detected in 61.5% of the affected vertebrae, presenting as periosteal hyperplasia and hypertrophic calcification (**Figure 1**, **Figure 3**, and **Figure 4**). Disc disruption and narrowing were seen in 29 vertebrae (11.7%), characterized by isodense or hypodense shadows, sometimes accompanied by reduced intervertebral space (**Figure 2**– **Figure 4**). Vertebral abscesses were found in 7 patients, including 5 paravertebral and 2 vertebral abscesses, while 4 cases showed compression of the lumbar major muscle (**Figure 3**). Facet joint destruction affected 72 vertebrae (29.2%), leading to joint surface erosion and joint space narrowing (**Figure 4**). Notably, no cases of vertebral arch root destruction were observed across the affected vertebrae (**Figure 1**– **Figure 4**). Ligament involvement was detected in 5 cases (4.7%), with 3 cases exhibiting ligament thickening and 2 cases showing calcification.

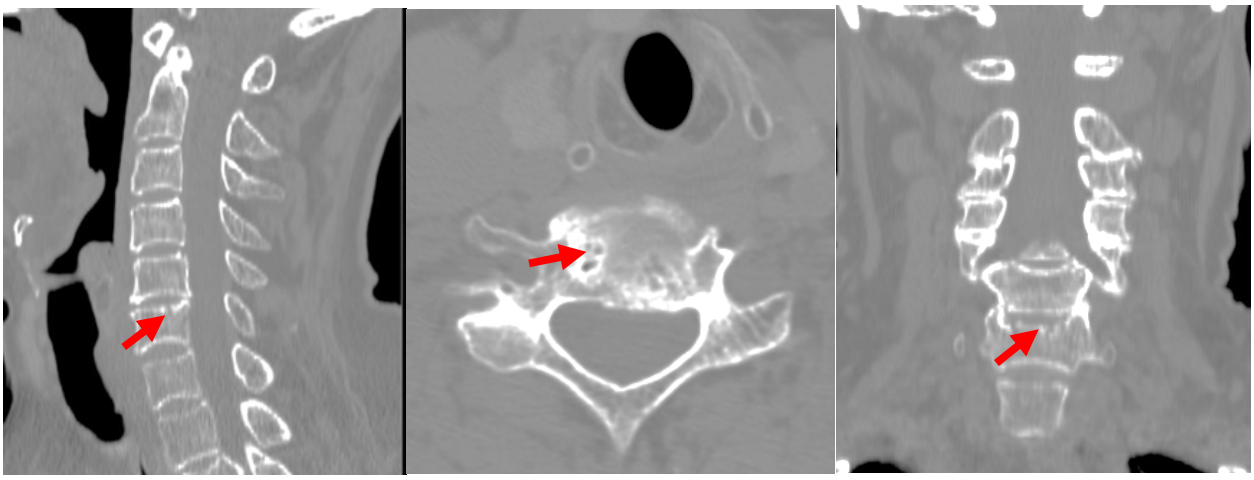

Figure 1. Female, 69 years old, history of sheep farming, weakness, excessive sweating, neck pain for 5 months, CT showed C5-6 terminal bone destruction with hyperplastic sclerosis

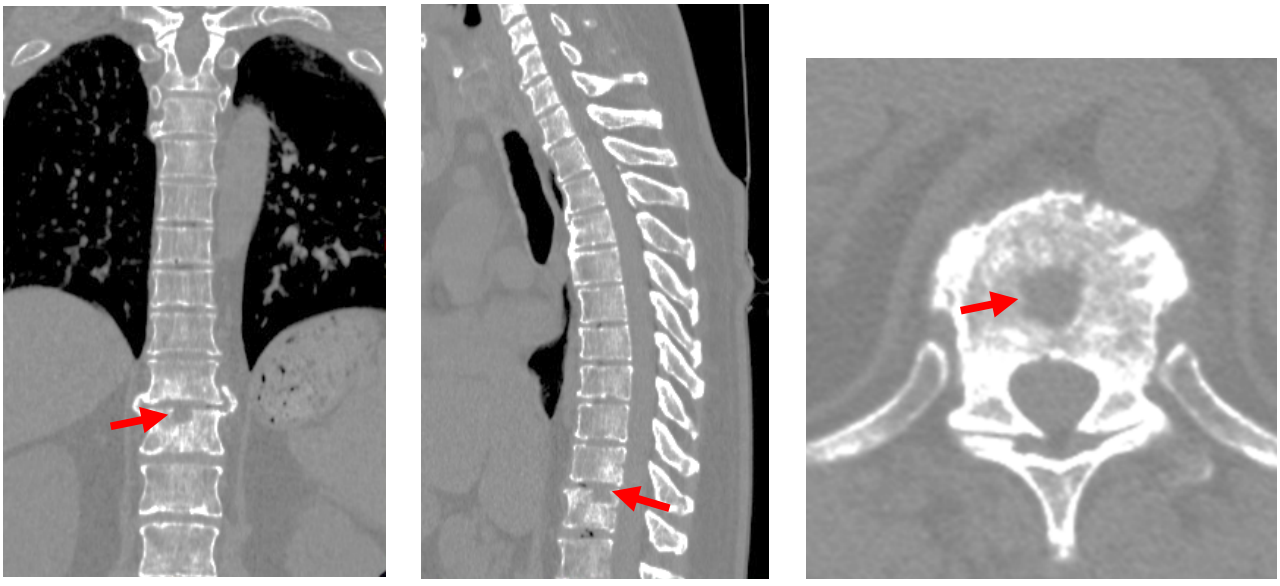

Figure 2. Patient, male, 45 years old, raising sheep at home, with weakness, excessive sweating, and posterior chest pain for 3 months, CT showed bony destruction of T10–11 endplates and subendplates, and narrowing of the intervertebral space.

Figure 3. Female, 68 years old, raising sheep at home, with low back pain and fatigue for 6 months, CT showed L3–4 endplate bone destruction with hyperplastic sclerosis, narrowing of the intervertebral space and abscess formation.

Figure 4. Male, 73 years old, no clear history of exposure, weakness and low back pain for 3 months, CT showed bone destruction under the L2–3 endplate with hyperplastic sclerosis, small joint arthritis, and narrowing of the intervertebral space.

3.4. Clinical regression

Among the 106 patients with BS, 87 cases (82.1%) received combined antimicrobial therapy, while 19 cases (17.9%) underwent surgery alongside antimicrobial treatment. Following a 6–12 month follow-up, all patients showed a good prognosis, with no reported cases of death or limb paralysis.

4. Discussion

First described by Kulowski and Vinke in 1932, BS is one of the most important clinical manifestations of brucellosis, which seriously affects patients' daily life and organic health [7]. BS has become increasingly prominent in recent years as the incidence of brucellosis has risen. Literature reports indicate that fever, malaise, excessive sweating, and arthralgia are the most common clinical manifestations of brucellosis. In our study, malaise and excessive sweating were observed in 98.1% and 96.2% of cases, respectively, whereas fever was present in only 58.5% of patients [8]. This lower fever incidence may be associated with the prolonged course of brucellosis, leading to its chronicity. Regarding the site of injury, lesions in this study primarily affected the lumbar spine (80.2%), thoracic spine (16.9%), and cervical spine (1.9%). These findings closely aligned with the patients' clinical symptoms, including lumbosacral pain (81.1%), posterior thoracic pain (16.9%), and cervical pain (1.9%). This correlation suggests that the clinical manifestations of BS can serve as a predictive indicator for identifying the site of injury. Meanwhile, constipation and urinary retention were also important clinical manifestations of BS, accounting for 76.4% and 6.6%, respectively. Analysis of the reasons for this was related to lumbosacral pain, limitation of movement, and/or compression of the cauda equina nerve by the focal abscess, suggesting that attention should be paid to both bowel movements in the clinic to avoid the occurrence of adverse events.

CT is an important means of examining bone damage in BS and a reliable basis for assessing the patient's condition. Data indicate that the early manifestation of BS in affected vertebrae is osteoporosis, with bone damage occurring after a few weeks. As the disease progresses, vertebral bone destruction gradually becomes evident. In the early stages, multiple small low-density lesions, typically less than 5 mm in diameter, appear in rounded, irregular, or worm-eaten-like patterns. As the disease progresses, the lesions continue to expand, leading to periosteal proliferation and hypertrophy. This results in a characteristic imaging sign where vertebral bone destruction coexists with osteophyte formation [8–10]. The data in this group showed cumulative lumbar, thoracic, and cervical vertebrae, 80.2%, 16.9%, and 1.9%, respectively, suggesting that the lumbar vertebrae are the most vulnerable site for BS bone injuries, followed by the thoracic vertebrae. Regarding lesion sites, although previous literature has reported cases of non-contact bone damage in BS, the data from this study showed that all 106 patients exhibited bone damage in adjacent vertebrae, with no cases of non-contact bone damage [11]. This finding suggests that adjacent vertebral bone damage remains the primary manifestation of bone involvement in BS, aligning with existing literature [8,10]. Regarding lesion morphology, the data in this study showed that BS primarily manifested as round, irregular, or worm-like bone destruction. Additionally, 61.5% of BS patients exhibited osteophytes, with no signs of dead bone or pedicle destruction. These findings suggest that the coexistence of bone destruction and osteophytes, along with the absence of dead bone and pedicle destruction, are important imaging characteristics of BS. In addition, the incidence of disc destruction, paravertebral/vertebral canal abscesses, and ligament involvement was low, at 11.7%, 6.6%, and 4.7%, respectively, suggesting that heavy bone destruction and light soft tissue injury is another imaging feature of BS.

In terms of differential diagnosis, common causes of vertebral destruction are tuberculous spondylitis, septic spondylitis, and spinal tumours. Data indicate that tuberculous spondylitis predominantly affects the thoracolumbar segment and presents as osteolytic bone destruction. Imaging findings typically show the coexistence of vertebral body and intervertebral disc destruction, often accompanied by dead bone formation, pedicle root destruction, and frequent paravertebral or vertebral canal abscesses. Notably, there is no coexistence of bone damage and osteophytes [12–15]. In contrast, BS is characterized by the coexistence

of bone destruction and osteophytes, the absence of dead bone and pedicle root destruction, and the rarity of paravertebral or vertebral canal abscesses. These distinct differences make BS easily distinguishable from tuberculous spondylitis when combined with pathogen culture, tuberculin testing, and T-lymphocyte assays.

Septic spondylitis, most commonly affecting young adults, is characterized by high fever, severe thoracolumbar pain, and restricted movement. It typically occurs in the thoracolumbar region and presents with distinctive imaging features such as vertebral destruction, cavity formation, and surrounding high-density "fragmented" proliferative sclerotic foci [16-19]. With an acute onset, short disease course, and severe symptoms, septic spondylitis can be readily differentiated from BS through a combination of etiological analysis, peripheral blood tests, and inflammatory markers.

Spinal tumors or spinal metastases typically have a subacute onset and present with clinical features such as weight loss, bone pain, and/or paraplegia. Imaging usually shows osteolytic bone destruction, with soft tissue masses visible in the paravertebral region and frequent involvement of the vertebral canal. CT scans reveal vertebral spongiosa, adnexal patches, and hypodense masses. In the early stages, the bone cortex may remain intact or show slight damage, whereas in advanced stages, the entire vertebral body undergoes infiltrative destruction [20-22]. In combination with history and serological tumour marker testing, it can be differentiated from BS.

In terms of clinical regression, a combination of long-term antimicrobial therapy and surgical intervention has proven to be an effective treatment approach for BS [23–25]. Our data showed that antimicrobial therapy was used in 82.1% of cases and surgery + antimicrobial therapy in 17.9%. Follow-up showed that none of the patients had serious outcomes such as death or limb paralysis, indicating that BS is a disease with a good prognosis [26]. Wu *et al.* adopted total endoscopic transforaminal debridement and decompression to treat BS and also achieved the same efficacy as the traditional procedure , which added a new therapeutic tool for the clinical treatment of BS [27].

5. Conclusion

BS is a serious complication of brucellosis and it has its own characteristics in clinical and imaging, fatigue, hyperhidrosis, spinal pain, sciatica, constipation, and urinary retention are the important clinical manifestations of BS.CT is a reliable means of diagnosing bone destruction and evaluating the condition. Additionally, BS is prone to affect the lumbar spine, and the co-existence of vertebral body bone destruction and osteophytes, the absence of dead bone, and the absence of pedicle root destruction are the specific imaging manifestations of BS. The combination of pathogenetic and laboratory tests can effectively differentiate BS from tuberculous spondylitis, septic spondylitis, and spondylitis caused by spinal tumours, thus effectively reducing clinical misdiagnosis and mistreatment.

Disclosure statement

The authors declare no conflict of interest.

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