

# Brucella Infection of the Sternoclavicular Joint with Innovative Localized Drug Delivery: A Case Report and Review of the Literature

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**Background:** Brucellosis is typically associated with complications involving the osteoarticular, cardiovascular, and central nervous systems. However, septic arthritis of the sternoclavicular joint (SCJ) represents an isolated and exceptionally rare clinical entity. We report a case of Brucella-induced SCJ abscess successfully managed via the localized implantation of doxycycline-loaded calcium sulfate. This targeted drug delivery system offers a robust therapeutic strategy for controlling focal infections in atypical anatomical locations.

**Case Presentation:** A 47-year-old woman presented with intermittent fever and a progressively enlarging clavicular mass. Physical examination revealed distinct, tender swelling over the right SCJ. The patient's symptoms were refractory to prior antimicrobial therapy with cefuroxime sodium. Computed tomography (CT) demonstrated localized soft tissue swelling and osteolytic destruction at the SCJ. Magnetic resonance imaging (MRI) further characterized the pathology, revealing cortical erosion, marrow edema, and abscess formation. Serological testing confirmed the diagnosis by demonstrating a Brucella antibody titer of 1:400. The patient underwent surgical intervention. Intraoperative exploration exposed significant yellowish-white purulent exudate covering the joint surface. Following extensive debridement, doxycycline-loaded calcium sulfate beads were implanted into the residual cavity, and a drainage catheter was placed. Postoperatively, she received intravenous cephalosporins for two weeks, followed by oral doxycycline and rifampin. At the three-month follow-up, inflammatory markers—including ESR, CRP, and IL-6—had normalized. Long-term monitoring confirmed complete recovery without recurrence.

**Conclusion:** Managing infections at atypical sites often necessitates the adaptation of standard therapeutic protocols. This case illustrates that novel modalities, specifically localized antibiotic delivery systems using calcium sulfate, can effectively treat complex infections where systemic therapy alone may be insufficient. By ensuring sustained local antibiotic release, this strategy expands the therapeutic armamentarium available for clinicians addressing rare, site-specific presentations of pathogens such as Brucella.

**Keywords:** brucellosis, sternoclavicular joint, abscess, surgical treatment, drug delivery system

## Introduction

Brucellosis is a zoonotic infectious disease caused by the genus *Brucella*, an intracellular bacterium capable of multiplying within phagocytes. While animals are the primary reservoirs, humans are incidental hosts.<sup>1</sup> The disease is caused by various *Brucella* species, most notably *Brucella melitensis*, *Brucella abortus*, *Brucella suis*, and *Brucella canis*.<sup>2</sup> Due to unique virulence mechanisms exhibited by species such as *Brucella abortus*—specifically their strategies for intracellular survival and evasion of the host immune system—the infection frequently evolves into a chronic state characterized by recurring symptoms, posing significant challenges for clinical treatment.<sup>3–5</sup> Over the past decade, the epidemic areas of brucellosis have expanded significantly on a global scale, increasing from 53 countries to at least 97

affected nations. Currently, Asia bears the highest global burden of human brucellosis. In China, brucellosis has emerged as a major public health problem. The incidence rate has risen precipitously from 0.0281 to 5.0553 per 100,000 population between 1993 and 2021 with over 95% of cases concentrated in the northern regions.<sup>6</sup> Recent surveillance indicates a clear upward trend; the northern part of the country continues to report a high incidence, while the western and southern regions are showing a continuing rise in cases.<sup>2</sup> The incidence of brucellosis in China demonstrates a distinct seasonal trend, with higher infection rates observed in the warmer seasons, peaking notably in May.<sup>7</sup> Furthermore, while most human infections traditionally occur among pastoralists, rapid urbanization has placed urban populations increasingly at risk.<sup>8</sup> Brucellosis is a systemic infection that affects tissues and organs throughout the body. Although it does not result in a high mortality rate, it leads to serious complications in multiple systems, including the joints, bones, heart, and central nervous system.<sup>9</sup> Acute brucellosis is associated with nonspecific flu-like symptoms, including intermittent fever, headache, malaise, back pain, and myalgia.<sup>10</sup> As the disease progresses, the pathologic manifestations may evolve into chronic conditions such as arthritis, spondylitis, endocarditis, meningitis, and chronic fatigue.<sup>11</sup> Clinically, brucellosis is difficult to distinguish from other chronic febrile illnesses; therefore, prompt and standardized treatment is essential to prevent chronic persistent infections and multi-organ damage, which are notoriously difficult to treat.

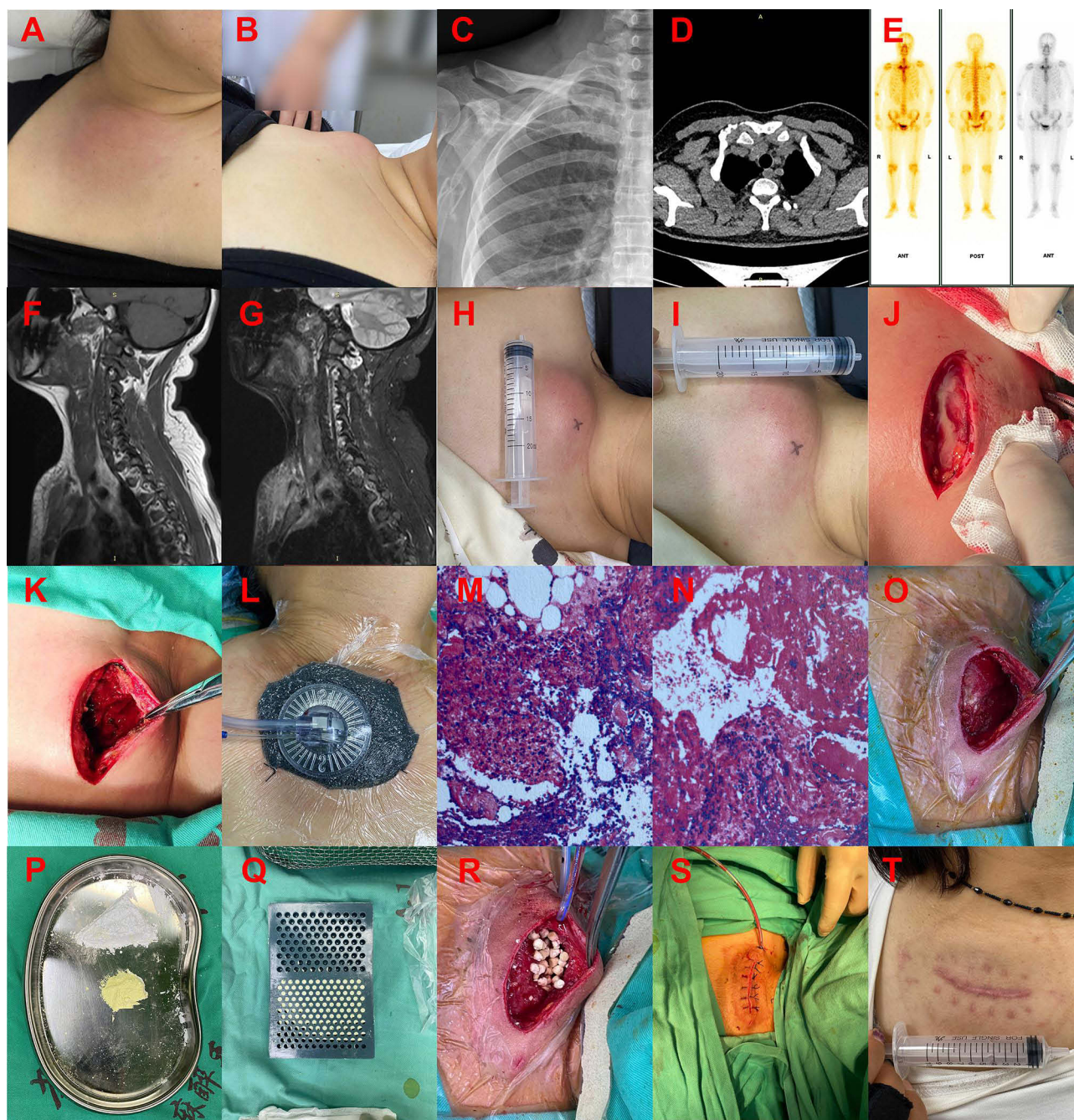
While osteoarticular involvement is common, *Brucella* infection leading to abscesses in the sternoclavicular joint (SCJ) is relatively rare. To date, fewer than 50 cases have been described in the literature, mostly appearing as isolated case reports.<sup>12</sup> In this paper, we report a novel therapeutic strategy: the use of calcium sulfate loaded with doxycycline implanted into the lesion space. This approach establishes a localized sustained-release system for the treatment of a *Brucella* sternoclavicular joint abscess and, to our knowledge, is reported here for the first time.

## Case Presentation

A 47-year-old female patient presented to our department with a chief complaint of intermittent fever persisting for over 20 days, accompanied by a maximum recorded temperature of 39°C. Although her fever could temporarily subside to baseline following the self-administration of antipyretics, it exhibited a relapsing pattern throughout the course of her illness. Ten days prior to admission, she noticed a localized swelling in the right supraclavicular region. An ultrasound examination performed at a local hospital revealed bilateral cervical lymphadenopathy and a hypo- to isoechoic mass (measuring approximately 3.2 cm × 1.7 cm) located 0.7 cm beneath the subcutaneous tissue. The mass had clear margins and exhibited minimal punctate blood flow signals on color Doppler imaging. Due to the lack of a definitive diagnosis at the local facility, she was treated symptomatically with Tramadol injections for pain relief; however, she experienced no significant improvement in symptoms, which prompted her referral to our hospital. The patient had a body weight of 50 kg and a history of good general health, with no underlying chronic conditions such as heart disease, hypertension, or diabetes. Furthermore, there was no family history of hereditary diseases among her immediate relatives.

Upon admission (Day 1), a focused physical examination revealed a localized swelling over the right sternoclavicular joint, measuring approximately 4 cm × 3 cm and elevated about 0.7 cm above the skin surface. The lesion was well demarcated, fixed, and tender on palpation, accompanied by elevated local skin temperature and erythema (Figure 1A and B). Systemic examinations were otherwise unremarkable. Laboratory investigations yielded the following results: white blood cell count (WBC)  $9.8 \times 10^9/L$ , neutrophil count (NE)  $7.4 \times 10^9/L$ , hemoglobin (Hb) 101 g/L, erythrocyte sedimentation rate (ESR) 57 mm/h, and interleukin-6 (IL-6) 42.02 pg/mL. Radiographic assessment was comprehensive: plain radiography (Figure 1C) indicated an irregular and widened right sternoclavicular joint space surrounded by flocculent high-density shadows, findings suggestive of sternoclavicular arthritis. A CT scan (Figure 1D) further characterized the lesion, revealing local soft tissue swelling and distinct bony destruction of the right sternoclavicular joint. Bone scintigraphy (Figure 1E) demonstrated increased radiotracer uptake strictly localized to the right sternoclavicular joint without other skeletal abnormalities. Additionally, MRI of the region (Figure 1F and G) revealed local tissue swelling, bony erosion, and bone marrow edema, and associated abscess formation.

Based on the cumulative clinical and imaging evidence, a diagnosis of a sternoclavicular joint abscess was strongly suspected. While common pathogens such as *Mycobacterium tuberculosis*, *Staphylococcus aureus*, or *Escherichia coli* were initially considered, other potential etiologies could not be excluded. Empirical therapy was initiated with



**Figure 1** Perioperative clinical course, radiological evaluation, and surgical management of the patient. (A and B) Clinical presentation on admission (Day 1) showing localized swelling (approximately 4 cm × 3 cm × 0.7 cm) over the right sternoclavicular joint. (C) Plain radiograph revealing irregular widening of the right sternoclavicular joint space with surrounding flocculent hyperdensities, suggestive of sternoclavicular arthritis. (D) CT scan demonstrating localized soft tissue swelling and evident osseous destruction of the right sternoclavicular joint. (E) Bone scintigraphy showing increased radiotracer uptake in the right sternoclavicular region. (F and G) MRI scans revealing soft tissue swelling, marginal bone destruction, and bone marrow edema accompanied by abscess formation. (H and I) Clinical progression on Day 3 of admission, showing exacerbated erythema and swelling (approximately 8 cm × 6 cm × 2 cm). (J) Intraoperative view showing significant yellowish-white purulent discharge following skin incision. (K) Exposure of viable tissue following radical debridement and abscess removal. (L) Placement of the vacuum sealing drainage (VSD) system. (M and N) Histopathological examination confirming a diagnosis of acute suppurative inflammation. (O) View upon VSD removal (7 days post-debridement), showing fresh granulation tissue growth around the sternoclavicular joint. (P and Q) Preparation of doxycycline-loaded calcium sulfate beads. (R) Implantation of the antibiotic-loaded beads into the residual cavity. (S) Placement of a drainage tube and wound closure. (T) Follow-up at 3 months post-operation showing a well-healed surgical incision with scar formation.

intravenous ceftizoxime (2 g, twice daily) and Tramadol for analgesia. However, specific serological tests for antibodies against *Mycobacterium tuberculosis* (IgG and IgM) were negative. As emphasized in current literature, brucellosis should be included in the differential diagnosis within appropriate clinical and epidemiological contexts.<sup>13</sup> Although

blood culture remains the gold standard for diagnosis, serological tests are frequently relied upon in clinical settings.<sup>1,14,15</sup> A detailed history-taking revealed a critical epidemiological link: the patient raised livestock at home. Subsequent serological testing yielded a positive Rose Bengal plate test, and a tube agglutination test confirmed a *Brucella* antibody titer of 1:400. Consequently, the final diagnosis was established as a sternoclavicular joint abscess caused by *Brucella* infection.

The local condition progressed rapidly following admission. By the third day of hospitalization, the swelling had expanded to approximately 8 cm × 6 cm, elevated about 2 cm above the skin, and presented with intensified erythema and fluctuation (Figure 1H and I). Given the rapid deterioration, emergency surgical debridement of the peristernal tissues combined with vacuum sealing drainage (VSD) was performed. Intraoperatively, upon incision, a substantial volume of yellowish-white pus was evacuated from the region superior to the sternoclavicular joint (Figure 1J). Following thorough evacuation of the abscess (Figure 1K) and excision of necrotic tissues for pathological analysis, the wound was copiously irrigated with a gentamicin-normal saline solution, followed by the placement of a VSD system (Figure 1L). Histopathological analysis of the tissue obtained during surgery revealed findings consistent with acute suppurative inflammation (Figure 1M and N), and continuous irrigation with gentamicin-saline under negative pressure was maintained.

Six days later, a small amount of residual purulent fluid was observed upon removal of the VSD. Consequently, a second debridement and VSD placement were performed, adhering to an identical postoperative management regimen. Seven days after the second procedure, fresh granulation tissue was observed lining the joint cavity upon VSD removal (Figure 1O). At this stage, definitive reconstruction was undertaken: several doxycycline-loaded calcium sulfate beads were prepared (Figure 1P and Q) and implanted directly into the debrided wound bed (Figure 1R). A drainage tube was positioned, the wound was sutured (Figure 1S), and a new VSD was applied superficially. Throughout the perioperative period, targeted anti-brucellosis therapy was administered, consisting of intravenous ceftriaxone sodium (2 g, once daily), oral doxycycline hydrochloride (100 mg, every 12 hours), and oral rifampin (450 mg, once daily). Hepatoprotective agents and traditional Chinese medicine were also utilized adjunctively during the treatment course.

The surgical incision healed well by 3 months postoperatively, leaving a scar with no signs of infection recurrence (Figure 1T). Follow-up monitoring continued over a 24-month period, during which healing remained excellent. Serial laboratory parameters are summarized in Table 1. By 3 months postoperatively, all inflammatory and infection markers—including ESR, WBC, NE, IL-6, CRP, and PCT—had returned to normal levels. The mild anemia (low Hb) noted during the acute phase also resolved without the need for transfusion once the infection was controlled. At the final 24-month follow-up, the patient remained recurrence-free with excellent clinical outcomes.

## Discussion

Epidemiologically, brucellosis predominantly affects middle-aged and elderly males, with a reported male-to-female ratio of approximately 3.75.<sup>16</sup> While the disease is systemic, the most common complications involve the osteoarticular

**Table 1** Infection-Related Markers During Treatment and Follow-Up

	ESR mm/h	WBC ×10 <sup>9</sup> /L	NE ×10 <sup>9</sup> /L	IL-6 pg/mL	CRP mg/L	PCT ng/mL	Hb g/L
POD1	55	-	-	37.37	140.67	0.063	93
POD6	-	9.2	7.01	-	-	-	112
POD12	-	6.4	3.83	16.2	-	0.115	113
POD14	45	5.8	3.36	11.98	-	0.09	99
POD18	-	-	-	3.47	<10	0.041	107
POD24	-	5.2	2.92	2.39	<10	0.047	107
POM3	5	5.4	3.43	1.47	<10	0.022	126
POM24	10	6.4	3.76	-	0.499	-	132

**Note:** Timing is calculated from the date of the initial surgery.

**Abbreviations:** POD, postoperative day; POM, postoperative month; ESR, erythrocyte sedimentation rate; WBC, white blood cells; NE, neutrophil count; IL-6, interleukin-6; PCT, procalcitonin; CRP, c-reactive protein; Hb, hemoglobin.

system,<sup>17,18</sup> particularly affecting the sacroiliac joints and the spine; notably, arthritis in other peripheral locations, such as the sternoclavicular joint observed in this case, is significantly less frequent.<sup>19</sup> The atypical clinical manifestations often lead to high rates of misdiagnosis. Hematological abnormalities, including anemia, thrombocytopenia, and variable white blood cell counts, are common but nonspecific.<sup>20,21</sup> Although leukopenia is classic, elevated WBC and inflammatory markers like CRP and ESR (cut-off >25 mm/h) remain key indicators of focal complications.<sup>22–24</sup> Despite standardized treatment, approximately 13.3% of cases progress to chronicity.<sup>25</sup>

Regarding diagnosis, blood culture remains the gold standard, while imaging—particularly MRI—is superior for identifying focal infections and differentiating *Brucella* spondylitis from tumors.<sup>26–28</sup> In this case, while imaging strongly suggested infection, the diagnosis relied heavily on the patient’s epidemiological history.

Current therapeutic strategies necessitate a combination of pharmacological and surgical interventions.<sup>29</sup> Effective antibiotic regimens typically involve combinations of doxycycline, rifampin, and aminoglycosides.<sup>13</sup> To balance efficacy and reduce the 5–15% recurrence rate, a multimodal approach is often required for complex focal infections.<sup>28,30,31</sup> In recent years, calcium sulfate has been utilized as an adjunctive antimicrobial carrier due to its biocompatibility and ability to maintain high local bactericidal concentrations while minimizing systemic toxicity.<sup>32–36</sup>

In the present case, we adopted a “local reinforcement plus systemic maintenance” strategy. We selected a reduced systemic rifampin dose (450 mg) to minimize potential hepatotoxicity, supplemented by local doxycycline-loaded calcium sulfate beads. This multimodal approach, integrating radical surgical debridement, drainage, and tailored systemic therapy, facilitated the successful resolution of the infection with no recurrence over a 2-year follow-up.

This case also underscores an important epidemiological observation: the patient’s husband subsequently developed *Brucella* arthritis. This highlights the necessity of routine serologic screening for at-risk family members upon the diagnosis of an index case.<sup>37</sup> We acknowledge the limitations of this single-case report. While the outcome was favorable, the specific contribution of the local delivery system cannot be isolated from the foundational roles of thorough surgical debridement and prolonged systemic therapy. Future large-scale multicenter trials are required to further validate this integrated approach.

## Conclusion

In conclusion, brucellosis of the sternoclavicular joint is a rare entity that poses significant diagnostic challenges. This case demonstrates that a comprehensive management strategy—integrating radical surgical debridement, standardized systemic antibiotic therapy, and adjunctive local implantation of antibiotic-loaded calcium sulfate—can lead to successful long-term outcomes. While local antibiotic delivery ensures high drug concentrations at the site of bone defects, early diagnosis and adherence to established surgical and systemic principles remain the cornerstones of effective treatment.

The patient reported a high level of satisfaction with the treatment outcome, including complete symptom resolution and return to daily function. She remains sincerely grateful to the medical team for the comprehensive care provided throughout her recovery.

## Ethical Statement

This study was approved by the Ethics and Scientific Committee of Gansu Provincial Hospital with approval number 2025-565. Written informed consent was obtained from the individual for the publication of any potentially identifiable images included in this article. Institutional approval was obtained from Gansu Provincial Hospital and Xinqiao Hospital, Army Medical University for the publication of the case details.

## Consent for Publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically

reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Disclosure

The authors declare no competing interests in this work.

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