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ORIGINAL RESEARCH

Clinical and therapeutic insights into brucellar epididymo-orchitis: a retrospective analysis in a brucellosis endemic area

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Abstract

Background: Brucellosis is an endemic, occupational and travellers' zoonotic disease. Involvement of testis and epididymis can occur in acute and chronic forms of systemic brucellosis. If the diagnosis and treatment is delayed, young men may suffer with complications resulting in permanent damage to reproductive system and infertility. This study gives an insight into clinical and therapeutic approaches used in brucellar endemic area and also highlight clues that can help in early detection of Brucellar epididymo-orchitis. **Methods**: This is retrospective, hospital record-based study. After ethical approval and record de-identification, data from Urology clinic of King Abdullah hospital, Bisha was collected for 2 years. All cases presenting with swelling or pain in scrotal region with suggestive radiological features of epididymo-orchitis and brucellar antibody titre $\geq$1:160 were included in our study. **Results**: Brucella contributed to 18 (30.51%) of epididymo-orchitis cases during study period. Young men were affected with mean age $\pm$ standard deviation (SD) 36.78 $\pm$ 7.93. History of animal contact and ingestion of unpasteurized dairy products was positive in all cases. Most common presenting symptoms were scrotal pain (18, 100%), swelling (10, 55.56%) and fever (8, 44.44%) with an average duration of 20 days. Leukocytosis with lymphocytic predominance was observed. All patients were treated medically with no complications and unremarkable follow up. **Conclusions**: Brucellar epididymo-orchitis must be considered by physicians in patients with prolong duration of illness, systemic symptoms and relative lymphocytosis. Strict follow up for compliance to therapy, relapse and complication is needed.

Keywords

Scrotal pain; Brucellosis; Epididymo-orchitis; Occupational disease; Zoonosis

Perspectivas clínicas y terapéuticas sobre la orquiepididimitis brucelar: un análisis retrospectivo en una zona endémica de brucellosis

Resumen

Antecedentes: La brucelosis es una enfermedad zoonótica endémica, ocupacional y de viajeros. La afectación de los testículos y el epidídimo puede ocurrir en formas agudas y crónicas de brucelosis sistémica. Si el diagnóstico y el tratamiento se retrasan, los hombres jóvenes pueden sufrir complicaciones que resultan en daño permanente al sistema reproductivo e infertilidad. Este estudio brinda una perspectiva de los enfoques clínicos y terapéuticos utilizados en el área endémica de brucelosis y también destaca pistas que pueden ayudar en la detección temprana de la epididimoorquitis brucelar. **Métodos**:Este es un estudio retrospectivo basado en registros hospitalarios. Después de la aprobación ética y la desidentificación de los registros, se recopilaron datos de la clínica de urología del hospital King Abdullah, Bisha durante 2 años. Todos los casos que presentaban hinchazón o dolor en la región escrotal con características radiológicas sugestivas de epididimoorquitis y título de anticuerpos brucelares $\geq$1:160 se incluyeron en nuestro estudio. **Resultados**: Brucella contribuyó a 18 (30.51%) de los casos de epididimoorquitis durante el período de estudio. Se afectaron hombres jóvenes con una edad media de $\pm$ desviación estándar (DE) 36.78 $\pm$ 7.93. La historia de contacto con animales e ingestión de productos lácteos no pasteurizados fue positiva en todos los casos. Los síntomas de presentación más comunes fueron dolor escrotal (18, 100%), hinchazón (10, 55.56%) y fiebre (8, 44.44%) con una duración media de 20 días. Se observó leucocitosis con predominio linfocítico. Todos los pacientes fueron tratados médicamente sin complicaciones y seguimiento sin novedades. **Conclusiones**: La epididimoorquitis brucelar debe ser considerada por los médicos en pacientes con duración prolongada de la enfermedad, síntomas sistémicos y linfocitosis relativa. Es necesario un seguimiento estricto para el cumplimiento de la terapia, recaídas y complicaciones.

Palabras Clave

Dolor escrotal; Brucelosis; Orquiepididimitis; Enfermedad profesional; Zoonosis

1. Introduction

Epididymo-orchitis (EO) is most commonly caused by pathogens linked to urinary tract infections (UTIs) or sexually transmitted diseases (STDs), though the causative agent remains unidentified in up to 46% of cases [1]. The other potential causes include viral infections, trauma, the use of amiodarone, and autoimmune disorders [2]. EO can also occur as a complication of systemic diseases, such as mumps, tuberculosis or brucellosis [1, 3].

Human brucellosis is the most widespread zoonotic infection in the Mediterranean region, South America and the Middle East, including Saudi Arabia [2–5] and can present in acute, subacute, or chronic forms, predominantly affecting young men in rural areas who are involved in animal husbandry [3, 6–9]. Its transmission may occur through direct contact with infected animal tissues and fluids, such as the placenta or products of abortion, or the consumption of contaminated dairy products [1, 8, 10].

The diagnosis of brucellosis is complicated by limitations in commonly used serological tests, such as the Standard Agglutination Test (SAT) and the Rose Bengal Test, which are hindered by a lack of standardized interpretive criteria, species cross-reactivity, and low sensitivity during the early stages of the disease [11]. Although blood culture is considered the gold standard for diagnosis, it has significant drawbacks, such as delayed results due to slow growth of Brucella and potential false negatives when patients have received empirical antibiotics prior to testing [4, 10, 11].

Involvement of the genitourinary system (GUS) occurs in 2–20% of brucellosis cases, manifesting as EO, prostatitis, cystitis, pyelonephritis, testicular abscess, renal abscess or glomerulonephritis [2, 4, 6, 8, 12]. Brucellar epididymo-orchitis (BEO) is the most frequent of these manifestations, accounting for 10–20% of all EO cases in brucellosis-endemic regions [3, 4, 10, 13]. Acute BEO typically presents with fever, scrotal swelling and pain, while chronic BEO can result in complications such as erectile dysfunction and testicular atrophy, significantly impairing the reproductive system [6].

In areas where brucellosis is endemic, BEO should be considered in the differential diagnosis of acute scrotal conditions. Delayed diagnosis and treatment often lead to severe complications, such as testicular abscesses, necrotizing orchitis, infarction, testicular scarring, atrophy, and infertility, which may necessitate orchidectomy [1, 2, 4, 7, 8, 10, 14]. Additionally, BEO has the potential to recur and may mimic the clinical presentation of a testicular tumor [3, 8].

Currently, the World Health Organization (WHO) does not provide specific treatment guidelines for BEO [3, 15]. Clinicians commonly use either a two-drug regimen (intravenous gentamicin and doxycycline) or a three-drug regimen (intravenous gentamicin, doxycycline and rifampicin) for a duration of 6 to 8 weeks, depending on the severity of the clinical presentation and the patient's response to therapy [8, 16].

The diagnosis and management of BEO are particularly challenging due to the variability of its symptoms, the limitations of routine diagnostic tests, and the absence of well-defined treatment protocols and follow-up strategies [11, 13]. Given that brucellosis is an occupational disease in endemic areas and a concern for travelers, BEO represents a significant global public health issue [15]. In young men, the consequences of BEO are especially profound due to the risk of infertility, loss of workforce productivity, and the potential need for orchidectomy. This study aims to explore the clinical, laboratory and therapeutic strategies used for the management of BEO in the Bisha governorate, an endemic area for brucellosis in southern Saudi Arabia.

2. Material and methods

This descriptive study was conducted based on a retrospective review of hospital records.

After institutional ethical approval and record de-identification data was collected from the Urology clinic of King Abdullah hospital, Bisha's database for 2years. BEO was defined by the presence of scrotal swelling and/or pain, radiological findings consistent with EO, and a positive brucellar antibody titer ($\geq$1:160). All adult patients of BEO, residing in Bisha region were included. All case belonging to pediatric age group, lacking radiological record or clinical finding of EO, having brucellar antibody titer $<$1:160 and residing outside of Bisha governate were excluded.

Patients' age, occupation, personal and family medical history, clinical presentation, laboratory findings (complete blood count, SAT for Brucella, urinalysis, urine culture, and urethral swab results), ultrasound (U/S) findings, treatment strategies, and follow-up information was recorded.

Data analysis was conducted using IBM SPSS (version 27, IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data, with categorical variables reported as frequencies and percentages, and continuous variables presented as either median values or mean $\pm$ standard deviation (SD), depending on their distribution.

3. Results

During the study period, 59 adult patients presented to the urology clinic and were diagnosed with EO based on clinical and radiological features. Of these, 18 patients tested positive for Brucella with a SAT titer of $\geq$1:160 and were included in this study.

All patients were residents of the Bisha governorate, with more than half (10, 55.56%) living in rural areas. The patients' ages ranged from 20 to 48 years, with a mean age of 36.78 $\pm$ 7.93 years. Most patients were Saudi nationals and public servants, and had a normal body mass index (BMI). The demographic characteristics of the investigated patients are presented in Table 1.

The most common presenting symptom was scrotal pain, reported by all patients (18, 100%), followed by scrotal swelling (10, 55.56%) and fever (8, 44.44%). The left side was predominantly affected (10, 55.56%), with one patient (5.56%) experiencing bilateral involvement. The average duration of symptoms was 20.27 $\pm$ 9.67 days, with a range of 2 to 45 days. All patients (18, 100%) had a history of exposure to risk factors such as contact with animals and/or consumption of raw dairy products. None of the patients had a history of testicular or inguinal surgery, STD or recurrent UTIs. Only one patient

TABLE 1. Demographic profile of patients of brucellar epididymo-orchitis (N = 18).

Parameter	Category	Frequency (n)	Percentage (%)
Age			
	20–29	3	16.67
	30–39	10	55.56
	40–49	5	27.28
Nationality			
	Saudi	13	72.22
	Egyptian	1	5.56
	Bangladeshi	1	5.56
	Indian	3	16.67
Residence			
	Rural	10	55.56
	Urban	8	44.44
Occupation			
	Shepherd	4	22.22
	Public servant	9	50.00
	Farmer	1	5.56
	Student	1	5.56
	Others	3	16.67
BMI			
	Under weight (<18.5)	0	0.00
	Normal (18.5–24.9)	6	33.33
	Overweight (25–29.9)	7	38.89
	Obesity (≥30)	5	27.78

BMI: body mass index; N: total sample size; n: frequency distribution.

(5.56%) reported a family history of EO. Additionally, 3 patients (16.67%) had type 2 diabetes mellitus, and 2 (11.11%) had systemic hypertension. Ultrasonography and Doppler scans revealed increased vascularity in the epididymis, testis or both. Focal hypoechoic lesions in the testis were observed in 3 patients (16.67%). The clinico-radiological features of all cases are summarized in Table 2, and all cases were confirmed for brucellosis by SAT (Table 3).

Complete blood count (CBC) analysis showed leucocytosis in 10 patients (55.56%), with an average total leukocyte count (TLC) of 13.4 × 10^9/L. The neutrophil-to-lymphocyte ratio (NLR) was 2.14. Platelet counts were within normal limits for all patients. Urinalysis was normal in all cases except one (5.56%), which showed pyuria with 40–60 pus cells/high-power field (HPF). Culture from this patient revealed growth of E. coli, while all other urine cultures were negative. Urethral swab results were negative for all patients.

All patients with BEO were managed with medical treatment. Initial treatment involved inpatient care with bed rest, scrotal support, and intravenous antibiotics, followed by oral antibiotics after discharge. The average hospital stay was 10.38 ± 7.32 days (range: 4–30 days). Table 4 presents the distribution of patients according to the inpatient and outpatient treatments received. The most frequently administered inpatient treatment was a combination of doxycycline, rifampicin and gentamicin (7 patients, 38.89%), followed by ciprofloxacin plus rifampicin (5 patients, 27.78%). Following the initial treatment, antibiotics were continued for 4–6 weeks. Doxycycline plus rifampicin was the most commonly used outpatient regimen, given to 10 patients (55.56%). Ciprofloxacin plus rifampicin was administered to 6 patients (33.33%). One patient (5.56%) did not complete the treatment, leaving against medical advice and being lost to follow-up. Another patient (5.56%) experienced a relapse within three weeks of completing treatment with doxycycline and rifampicin but recovered after extending the same regimen for an additional two months. Three patients (16.67%) developed reactive hydrocele. All patients recovered fully, and no severe complications were observed during one year of routine follow-up.

4. Discussion

Brucellosis is an endemic disease in the Bisha region, and urologists routinely consider Brucella as a potential etiologic agent of EO after ruling out other common causes, such as UTIs or STDs. In these cases, the SAT is performed, while blood cultures are reserved for undiagnosed cases. Our study included 18 confirmed cases of BEO, representing 30.51% of the 59 cases of EO diagnosed at the urology department during the two-year study period. This prevalence is higher than the

TABLE 2. Clinical and radiological features patients of brucellar epididymo-orchitis (N = 18).

Parameter	Category	Frequency (n)	Percentage (%)
Laterality			
	Right side	7	38.89
	Left Side	10	55.56
	Bilateral	1	5.55
Presenting symptoms			
	Scrotal pain and fever	7	38.89
	Scrotal Pain and swelling	10	55.56
	Scrotal pain, fever and dysuria	1	5.55
Exposure to risk factors			
	Contact with animal	8	44.44
	Ingestion of raw milk or dairy product	3	16.67
	Both contact with animal and raw milk ingestion	7	38.89
Past medical history			
	Hypertension	2	11.11
	Diabetes Mellitus	3	16.67
	Others	0	0.00
	Not significant	13	72.22
Past surgical history			
	Previous testicular or inguinal surgery	0	0.00
	Not significant	18	100.00
Family history of epididymo-orchitis			
	Yes	1	5.56
	No	17	94.44
Duration of symptoms (in days)			
	1–10	2	11.11
	11–20	9	50.00
	21–30	5	27.78
	31–40	1	5.56
	41–50	1	5.56
Radiologic finding			
	Increased vascularity	8	44.44
	Increased vascularity with hypoechoic lesion	3	16.67
	Consistent with epididymo-orchitis	7	38.89

N: total sample size; n: frequency distribution.

TABLE 3. Result of Standard agglutination test (SAT) for brucellosis (N = 18).

Brucellar titter	Frequency (n)	Percentage (%)
1/160	1	5.56%
1/320	7	38.89%
1/640	6	33.33%
1/1280	4	22.22%

N: total sample size; n: frequency distribution.

TABLE 4. Treatment regimen used for Brucellar epididymo-orchitis (N = 18).

Inpatient therapy	Outpatient therapy	n	%
Doxycycline, rifampicin, gentamicin[a]	Doxycycline, rifampicin	7	38.88
Ciprofloxacin, doxycycline, rifampicin	Ciprofloxacin, rifampicin	1	5.56
Ciprofloxacin, rifampicin	Ciprofloxacin, rifampicin	5	27.78
Ceftriaxone and doxycycline	Doxycycline, rifampicin	1	5.56
Levofloxacin and rifampicin	Levofloxacin, rifampicin	2	11.11
Gentamicin	Doxycycline, rifampicin	1	5.56
Meropenem, doxycycline[b]	Doxycycline, rifampicin	1	5.56

[a]*Relapsed (n = 1), complete remission on extended therapy.*
[b]*Left against medical advice.*
N: total sample size; n: frequency distribution.

generally reported 10–20% incidence of BEO in endemic areas [13]. However, it is lower than the findings of Jozpanahi *et al.* [7] (2022) in Zanjan, Iran, where Brucella accounted for 45% of all EO cases. Similarly, Ayed *et al.* [17] (2024) found that Brucella was responsible for 34.9% (22 of 63) of EO cases, which closely aligns with our findings, although they used a lower SAT cutoff value (1:80) for diagnosing brucellosis.

The age range of patients in our study was 20 to 48 years, with a mean age of 36.78 ± 7.93 years, consistent with previous studies, in which the reported mean ages were 38.12 ± 15.26 years, 34.66 ± 14.54 years and 35.3 ± 12.12 years, respectively [2, 8, 10]. In our study, most of the cases (10, 55.56%) were within the 30–39-year age group. Bülbül *et al.* [18] (2024) demonstrated a statistically significant difference (p-value < 0.0001) between the age groups of patients with BEO (median age = 35) and those with non-BEO (NBEO) (median age = 54). BEO represents a significant public health issue, particularly in young males, not only due to the loss of the workforce but also due to the risk of long -term complications, including infertility.

In our study, most patients (9, 50%) were employed in public service roles. Although brucellosis and BEO are typically more common in individuals involved in animal husbandry [3, 7, 8, 16], 5 cases (27.78%) in our study could be attributed to occupation, with 4 (22.22%) being shepherds and 1 (5.56%) a farmer. These results align with the findings of Bapir *et al.* [8] (2023), who reported that 55% of cases involved workers and 27% involved shepherds. Similarly, Öztürk-Çerik *et al.* [4] (2023) found that 11 out of 18 BEO patients (61.1%) were involved in animal husbandry. A larger study by Celik *et al.* [10] (2023), which included 194 cases of testicular involvement by brucellosis, also found that more than half of the patients were farmers. In another study, occupational exposure was documented in 38.1% of BEO cases [18]. Jozpanahi *et al.* [7] (2022) found a statistically significant correlation ($p < 0.001$) between occupation and the type of EO (BEO *vs.* NBEO), with 40.5% of BEO patients being farmers or ranchers, while 80.8% of NBEO patients had no involvement in animal husbandry. Thus, controlling occupation-related brucellosis requires the vaccination of animals and raising awareness about transmission routes among individuals working in animal husbandry.

Brucellosis is more prevalent in rural areas due to increased exposure to infected animals. Although our study was conducted at a tertiary care hospital in Bisha city, many cases were referred from neighboring villages. In our study, 10 patients (55.56%) resided in rural areas, which is consistent with previous studies that reported 60–80% of cases originating from rural regions [10, 12].

Brucellosis is primarily contracted through direct contact with infected animals or by consuming unpasteurized dairy products. In our study, all patients had a history of exposure to these risk factors, among whom 8 (27.78%) had direct contact with animals, 3 (16.67%) had consumed raw dairy products, and 7 (38.89%) reported both exposures. Several studies have similarly reported an association between BEO and these risk factors, with similar frequencies [2, 4, 12, 19]. Jozpanahi *et al.* [7] (2022) demonstrated a significant difference in the consumption of local dairy products between patients with BEO and those with NBEO ($p < 0.001$). Contact with animals can be related to occupation or occur through non-occupational exposure. The consumption of unpasteurized dairy products, particularly cheese, has been frequently linked to brucellosis transmission [7, 8]. To prevent the spread of the disease, it is essential to raise awareness of these risk factors among populations living in endemic areas.

In our study, only one patient (5.56%) had a family history of BEO. Similarly, cross-transmission within families was documented in just 1% of cases in a study conducted in the Aseer region [19]. However, Gozdas *et al.* [12] (2019) reported a much higher family history of brucellosis in their study, with 56% (14 out of 25) of BEO patients having a family history. The difference in family dynamics and living conditions between these regions may explain this discrepancy. Although a history of unsafe sexual intercourse, STDs and UTIs are common in EO cases, BEO is not typically associated with these conditions. None of the patients in our study had such a history, consistent with previous reports [2].

The patients in our study presented after 2 to 45 days of symptom onset, with a median duration of 20 days, which aligns with the findings of Gozdas *et al.* [12] (2019), who reported a median duration of 20 days (range: 2–90 days). The mean duration of symptoms in our study was 20.27 ± 9.67 days. Other studies have reported mean symptom durations of 16.6 ± 13.8 days and 30.51 ± 23.69 days for BEO [4, 10]. In contrast, the mean duration of symptoms in NBEO is typically

around 6 days [7], suggesting that BEO has a more insidious onset compared to unspecified EO. Early diagnosis of BEO in its acute stage can be achieved through a higher level of clinical suspicion, particularly in endemic regions. For example, Eroglu *et al*. [20] (2020) found that more than three-quarters of BEO cases in Turkey (76.9%) presented in the acute stage, while 23.1% were in the sub-acute stage. Similarly, Bosilkovski *et al*. [21] (2016) reported that all 34 cases of testicular involvement by brucellosis in Macedonia presented in the acute stage, with a median symptom duration of 5 days.

Scrotal pain was present in all patients in our study (18, 100%), and scrotal swelling was reported in 10 patients (55.56%). Fever was also present in 8 patients (44.44%) at the time of presentation, which are consistent with those of other studies, which have documented pain, scrotal swelling, and fever as the major presenting symptoms of BEO [2, 4, 8, 10, 18]. The prolonged duration of symptoms, along with generalized symptoms such as fever, sweating, weight loss, and arthralgia in patients with EO, may indicate BEO rather than non-brucella causes [7, 17].

In our present study, most cases (10, 55.56%) involved unilateral left-sided disease, and only one patient (5.56%) had bilateral involvement. Bilateral BEO is rare [8, 13, 21]. In studies by Öztürk-Çerik *et al*. [4] (2023) and Celik *et al*. [10] (2023), the reported incidence of bilateral involvement was 5.56% and 6.2%, respectively.

Various serological tests, including the Standard Tube Agglutination Test (SAT), Coombs test, 2-Mercaptoethanol test, and Rose Bengal test, are used to confirm the diagnosis of brucellosis [2, 4, 10]. SAT is typically considered positive when the antibody titer is $\geq$1:80 [2, 17]. However, given that Bisha is an endemic area for brucellosis, our study used a higher cutoff value of $\geq$1:160. The median brucella antibody titer observed in the investigated patients of our study was $\geq$1:320.

In addition to serological testing, all patients underwent CBC, urethral swab, and urine analysis. CBC results showed leucocytosis in 10 patients (55.56%), with an average total leukocyte count (TLC) of 13.4 $\times$ 10^9/L. Öztürk-Çerik *et al*. [4] (2023) similarly reported leucocytosis in 44% of patients, with a median TLC of 11.4 $\times$ 10^9/L. Another study by Bapir *et al*. [8] (2023) found that 18.2% of patients had elevated white blood cell (WBC) counts, while 9% had low WBC counts. Notably, the increase in WBC count in BEO is often less pronounced than in non-BEO (NBEO) [22, 23]. Relative lymphocytosis, commonly seen in BEO, occurs because Brucella is an intracellular bacterium that elicits a cellular immune response [23]. Consequently, the neutrophil-to-lymphocyte ratio (NLR) tends to be lower in BEO compared to NBEO cases [22, 23]. In our study, lymphocyte predominance was observed, with an NLR of 2.14. Bülbül *et al*. [18] (2024) also noted that lymphocyte and monocyte percentages were significantly higher in BEO patients than in NBEO patients. Bulut *et al*. [22] (2023) reported a statistically significant difference between the NLR of BEO (1.68) and NBEO (3.21). Furthermore, Cift *et al*. [23] (2018) found that an NLR lower than 2.3 was associated with a significantly increased risk of BEO. In our study, all patients had normal platelet counts, while Khodadadi *et al*. [2] reported thrombocytopenia with leucocytosis in 26% of cases. However, a Turkish study found no significant difference in platelet counts between BEO and NBEO patients [22].

Urethral swabs were performed to rule out common pathogens, and all results were negative, which is consistent with the lack of history of unprotected sexual activity or sexually transmitted infections (STIs) in our patient group.

Only 1 patient (5.56%) presented with dysuria. Urinalysis for this patient revealed 40–60 pus cells per high-power field (HPF), and urine culture confirmed the presence of Escherichia coli. All other patients had normal urine analysis and negative urine cultures. In the case of the patient with E. coli infection, the brucella antibody titer was 1:320, indicating a concomitant infection. The frequency of leukocyturia and positive urine cultures is generally lower in BEO compared to EO caused by other pathogens [2, 7]. Celik *et al*. [10] (2023) found that 71.3% of BEO patients had normal urinalysis, 17.4% had microscopic hematuria, and 11.3% had pyuria. Although BEO is a rare condition, it should be considered a potential cause of EO in regions where brucellosis is endemic. Prompt diagnosis and appropriate treatment are crucial to prevent long-term complications.

All of our patients were treated using medical treatment. The initial treatment involved inpatient care, including bed rest, scrotal support, and intravenous antibiotics. Upon discharge, patients were transitioned to oral antibiotics, which were continued for 6–8 weeks. The duration of hospital stay ranged from 4 to 30 days, with an average stay of 10.38 $\pm$ 7.32 days. A study by Zhou *et al*. [16] (2020) in China reported a similar average hospital stay of 9.68 $\pm$ 4.20 days. Bosilkovski *et al*. [21] (2016) found a median duration of 10 days between the initiation of treatment and the improvement of testicular symptoms. Khodadadi *et al*. [2] (2023) demonstrated that the addition of rifampicin to the gentamicin and doxycycline regimen reduced the length of hospital stay from 10 to 7 days. In our study, 7 treatment groups were identified based on the administered therapies. The most commonly used combination for inpatient treatment was doxycycline, rifampicin, and gentamicin (7 patients, 38.89%), followed by ciprofloxacin and rifampicin (5 patients, 27.78%). One patient's treatment was changed from ceftriaxone to ciprofloxacin and rifampicin due to a lack of response. At discharge, doxycycline and rifampicin were the most frequently prescribed medications (10 patients, 55.56%), followed by ciprofloxacin and rifampicin (6 patients, 33.33%). Standard dosages were used: doxycycline (100 mg twice daily), rifampicin (600–900 mg once daily), ciprofloxacin (500 mg twice daily), and gentamicin (5 mg/kg/day). Sixteen patients (88.89%) were successfully treated with a maximum of 6 weeks of oral antibiotics. One patient (5.56%) left the hospital against medical advice and was lost to follow-up. Another patient (5.56%) experienced a relapse within 3 weeks of completing treatment, which initially included 7 days of intravenous gentamicin, doxycycline, and rifampicin, followed by 6 weeks of oral doxycycline and rifampicin. As suggested by evidence, relapse cases can be managed with extended therapy for an additional 2 months [9, 17]. The relapsed patient in our study fully recovered after extending the same treatment regimen for another 2 months. All patients were followed for up to 1 year, and no further

complications were reported. There are no specific international guidelines for the treatment of focal organ involvement in brucellosis. Most treatment protocols for BEO follow the World Health Organization (WHO) guidelines for uncomplicated brucellosis. Celik *et al.* [10] (2023) reported that the most frequently used drug combinations for BEO were doxycycline plus rifampicin (40.1%) and doxycycline plus streptomycin (34.4%), with a mean treatment duration of 9 weeks. In a study by Bapir *et al.* [8] (2023), the investigators included 11 BEO cases treated with gentamicin, doxycycline and rifampicin for 6–8 weeks and reported that 1 patient required an orchidectomy due to a testicular abscess, while all others fully recovered. Öztürk-Çerik *et al.* [4] (2023) also reported successful treatment regimens using aminoglycosides, gentamicin, and rifampicin, with 1 patient (5.56%) experiencing a relapse and one (5.56%) requiring an orchidectomy. Zhou *et al.* [16] (2020) recommended the use of doxycycline and rifampicin for treating BEO and suggested levofloxacin or moxifloxacin for patients intolerant to rifampicin. Bülbül *et al.* [18] (2024) documented that 1 patient of 84 required an orchidectomy due to refractory BEO, although details on the drug regimen used were not provided. Prompt diagnosis and appropriate treatment can help prevent unnecessary orchidectomies. Eroglu *et al.* [20] (2020) treated 108 brucellosis patients with doxycycline and rifampicin for 6 weeks, achieving a low relapse rate of 0.9%. In the same study, 72 cases were treated with doxycycline and either streptomycin for 21 days or gentamicin for 7 days, resulting in a relapse rate of 2.9% [20].

During routine follow-up, 3 (16.67%) patients developed reactive hydrocele, although none required hydrocelectomy. Additionally, no major drug side effects, contralateral involvement, abscess formation, necrosis, or other complications were observed in any patient throughout the follow-up period. Similarly, Khodadadi *et al.* [2] (2023) reported no treatment failures or complications in their study. In contrast, Bapir *et al.* [8] (2023) documented 1 case of a testicular abscess that required an orchidectomy. No other complications or recurrences were reported in their study [8]. In a larger study by Celik *et al.* [10] (2023), only 1 patient of 194 required an orchidectomy due to a testicular abscess. These findings emphasize the importance of early diagnosis and treatment to prevent serious complications and reduce the risk of orchidectomy in patients with BEO. Overall, the success rate of medical treatment is high. Regular follow-up is recommended to ensure compliance with therapy, monitor for drug side effects, detect complications, and identify any signs of relapse.

Although most scientific literature on BEO originates from Turkey and Iran, brucellosis is also a significant occupational disease in Saudi Arabia. This study provides valuable insights into the clinical and therapeutic aspects of BEO in an underrepresented region. However, our study had some limitations. First, being a single-center study with a small sample size, it does not reflect the nationwide incidence of BEO. Second, as a retrospective study, it has inherent limitations, such as missing or incomplete data. Nonetheless, we hope that this study lays the groundwork for larger, multicenter studies in Bisha and across Saudi Arabia.

5. Conclusions

Physicians in endemic regions must remain vigilant for signs of focal organ involvement in brucellosis cases. Early diagnosis and prompt treatment are key to achieving favorable outcomes and preventing complications in patients with BEO.

AVAILABILITY OF DATA AND MATERIALS

The raw data of the study are available upon reasonable request. All the data generated or analyzed during the study are included in this manuscript.

AUTHOR CONTRIBUTIONS

This is a single author study. AA—designed and implemented the study; collected, analyzed and interpreted the data; manuscript writing and proof reading.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study included all confirmed cases of BEO in adults who were admitted to the Urology Department at King Abdullah Hospital during 2020–2022, in Bisha, Saudi Arabia, between 2020 and 2022. Ethical approval for this study was granted by the Ethical Committee at King Abdullah Hospital, Bisha, Saudi Arabia (ECTS REF no. BIS-23-00008-20062024) and adhered to the ethical principles outlined in the Helsinki Declaration. All patients were de-identified to ensure confidentiality. Since this is a retrospective study, the Ethical committee has exempted the study from informed consent requirements and data were solely extracted from the hospital database.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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