Journal of Microbiology, Immunology and Infection (2018) 51, 82–87

Available online at www.sciencedirect.com

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ORIGINAL ARTICLE

Testicular infection in brucellosis: Report of 34 cases

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Received 20 August 2015; received in revised form 9 November 2015; accepted 1 February 2016
Available online 10 March 2016

KEYWORDS
brucellosis;
epididymitis;
orchitis;
relapse;
treatment

Abstract *Background/Purpose:* To present clinical and laboratory features, treatment options, and outcome in patients with brucellar testicular infection and to compare them with analogous in brucellar patients without testicular involvement.
Methods: Thirty four brucellar patients with testicular infection treated in two general hospitals in the Republic of Macedonia, during the period 1998–2009, were retrospectively analyzed. Their clinical and laboratory characteristics were compared with analogous in 364 male brucellar patients without testicular infection, who were treated at the same hospitals during the same time period.
Results: Brucellar testicular infection was evident in 34 (8.5%) out of 398 male patients with brucellosis. The median age of the patients was 46.5 years. In all patients testicular involvement was presented as an acute form with a median duration of 5 days (range, 2–14 days) prior to diagnosis. Twenty-three of the patients had at least one other simultaneous focal infection. After starting with the treatment testicular infection lasted a median 10 days, range 7–21 days. Brucellar patients with testicular infection when compared with other brucellar patients more frequently manifested fever (97% vs. 61%), concomitant spondylitis (32% vs. 16%), and urinary system involvement (12% vs. 2%). Also, the relapse rate in patients with testicular involvement was significantly higher (24% vs. 9%).
Conclusion: In endemic regions brucellosis should be taken into consideration in any patient with testicular infection. Brucellar testicular involvement is usually characterized with a severe acute clinical presentation and a high percentage of relapses which entails the need of timely recognition and proper treatment duration of at least 60 days.

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http://dx.doi.org/10.1016/j.jmii.2016.02.004

Introduction

Human brucellosis is a zoonosis that is characterized by a wide clinical heterogeneity affecting different systems of the human body. Genitourinary involvement is among the commonest focal manifestations of human brucellosis,[1–4] presented as epididymo-orchitis, prostatitis, cystitis, interstitial nephritis, pyelonephritis, immunoglobulin A nephropathy, exudative glomerulonephritis, and renal and testicular abscess.[5,6] Brucellar epididymo-orchitis (BEO), by far the commonest genitourinary manifestation, was described for the first time by Hardy in 1928[7] and Wainwright in 1929.[8] This focal manifestation is a result of urine *Brucella* removal or as a blood-borne septic metastasis.[9–11] Clinical presentation of BEO is most frequently acute,[6,11–14] rarely subacute[10,15,16] or chronic.[6,15] BEO may cause complications like necrotizing orchitis,[5,17,18] testicular abscess,[11,15,19] infarction,[17,20] atrophy,[21] and suppurative necrosis.[17,20] Also, cases with aspermia and infertility have been described.[11,14,15]

Characteristics and prognosis of BEO have been described in many studies and communications, but comprising a small number of patients.[13,22–24] This clinical entity is also rarely presented in studies related to the Balkan Peninsula,[10,11] a region where brucellosis is considered to be an endemic disease. In this retrospective study we attempted to present the main demographic, clinical, and laboratory features, therapeutical experiences and outcome in patients with brucellar testicular infection in the Republic of Macedonia as an endemic region and to compare them with analogous in brucellar patients without testicular involvement.

Methods

The medical records and follow-up protocols of 34 brucellar patients with testicular infection treated at the Departments for Infectious Diseases in Veles and Bitola, Republic of Macedonia, during the period 1998–2009, were retrospectively analyzed. Their clinical and laboratory features were compared with analogous in 364 male brucellar patients, 18 years or older, without testicular infection that were treated at the same hospitals during the same period. The study was approved by the Ethics Committee of the Medical Faculty in Skopje, Republic of Macedonia.

The diagnosis of brucellosis was based on clinical findings compatible with brucellosis, supported by detection of specific antibodies at significant titers and/or demonstration of at least a fourfold rise in antibody titer in serum samples obtained 3–4 weeks apart. Antibody titers were determined by the standard tube agglutination, Brucella Coombs, and/or Brucellacapt assays as previously described.[25,26]

All of the patients underwent standard diagnostic protocol including detailed history, physical examination, and laboratory analysis—erythrocyte sedimentation rate, C-reactive protein, hemoglobin, white blood cells, lymphocytes, platelets, urine analysis, alanine aminotransferase, and serological tests for brucellosis. Patients were treated with various antimicrobial combinations that contained two or three of the following antimicrobials: oral doxycycline 100–200 mg/d; oral rifampin, 900 mg/d; oral trimethoprim/sulfamethoxazole (co-trimoxazole) 960 mg twice daily; and intramuscular gentamicin, 5 mg/kg/d. Gentamicin was administered 7–14 days, and the other drugs were given 45 days or longer if spondylitis, brucellosis of the central nervous system or therapeutic failure was evident. After finishing the treatment all patients were followed-up clinically and serologically every other month during the first 3 months, and every 3–4 months afterwards.

The investigated patients were divided into two groups: with ($n = 34$) and without ($n = 364$) testicular infection. The comparisons were performed in terms of the demographic and epidemiological data, clinical manifestations, laboratory characteristics, and outcome. Orchitis and epididymitis were diagnosed by the presence of acute scrotal pain, swelling and tender scrotal, and/or epididymal enlargement which were associated with the first episode of the actual disease and could not be attributed to other causes. Duration of testicular infection was defined as the number of days that elapsed from the start of treatment until the disappearance of all inflammatory signs. Relapse was accepted as the reappearance of symptoms and signs after the antibrucellar treatment was completed and therapeutical failure as persistence of symptoms and signs of the disease for more than 45 days of antibiotic therapy initiation.

The Chi-square test or Fisher's exact test (when Chi-square could not be applied) were used for comparison of qualitative variables between the groups. For quantitative variables Mann–Whitney *U* test was performed. A *p*-value of < 0.05 was considered significant.

Results

Among 398 male patients with brucellosis that were treated during the analyzed period at the Departments for Infectious Diseases in Veles and Bitola, 34 (8.5%) had testicular involvement. Besides orchitis and/or epididymitis, 23 of the patients had other coexisting focal forms of brucellosis: 13 peripheral arthritis; 11 spondylitis; three sacroiliitis; three radiculitis; three cystitis; two respiratory; two gastrointestinal; and one each of bursitis, tendinitis, and pyelonephritis (some of the patients had more than 1 simultaneous focal form). Out of the patients with brucellar testicular infection 21 manifested orchitis, 12 epididymo-orchitis, and one patient had epididymitis. Their distribution is presented in Table 1.

Testicular infection was the only manifestation of the disease in four patients, and in 30 other patients besides testicular, other symptoms and signs attributable to brucellosis e.g., fever, sweating, arthralgia, headache, loss of appetite, backache, malaise, hepatomegaly, splenomegaly, and osteoarticular involvement were also present. In three patients testicular manifestations appeared parallel with the general signs and symptoms; in one patient they were preceding them, whereas in the remaining 26 patients testicular infection appeared after initiation of brucellosis. In all cases the clinical presentation was acute and the brucellar etiology of testicular symptoms and signs

Table 1 Distribution of testicular infections in 34 patients with brucellosis.

Infection	Orchitis	Epididymitis	Epididymo-orchitis	Total
Left	11	1	5	17
Right	7	0	5	12
Bilateral	3	0	2	5
Total	21	1	12	34

was achieved in a median of 5 days (range, 2—14 days) since the beggining. The affected testicle was two to six times enlarged in comparison to the unaffected one.

As presented in Tables 2 and 3 significant differences between the two groups were found concerning the presence of fever, concomitant spondylitis, and urinary tract involvement, as well as higher values of white blood cells and C-reactive protein in favor of patients with testicular involvement.

Patients were treated with various therapeutic combinations and different time duration (Table 4). Combination with rifampin/doxycycline/co-trimoxazole was performed in 24 (70%) patients and 197 (54%) patients with and without testicular infection, respectively. The combination rifampin/doxycycline/gentamicin was used in 8 (24%) patients and 133 (37%) patients of the designated groups respectively, whereas with the combination rifampin/doxycycline were treated 2 (6%) of the patients and 34 (9%) of the patients, respectively ($p = 0.181$).

After initiation of therapy testicular infection lasted for median of 10 days (range, 7—21 days). As shown in Table 5, a significantly higher number of patients from the group with testicular infection was followed for at least 6 months, and the frequency of relapses was also higher than in the other group. Remarkably, all eight relapses in the group with testicular involvement were in patients that were treated for 45 days. No differences in demographic and clinical parameter between patients with testicular infection that relapsed and those without relapses were noted (data not shown). All four cases with therapeutic failure in the group with testicular involvement had a concomitant spondylitis which was the cause for failure. However, we had no cases with necrotizing orchitis, atrophy, infarction, testicular abscess, suppurative necrosis, or cases requiring surgery.

Discussion

In our study testicular infection was found in 8.5% of male patients with brucellosis, which is in agreement with data in the literature (1.4—25%).[3,5,12,13,27—30] The reasons for the wide range of presented frequency in the literature are to be explored in the characteristics of the examined population, the used criteria for defining the entity, the used diagnostic procedures as well as whether the study is a prospective or retrospective one. Testicular microtraumas or nonspecific infections in the past, as well as genetic predisposition might be a speculative explanation why some of the patients with brucellosis are prone to testicular infection. Still, until now we do not have a satisfactory answer.

Brucellar testicular infection is usually unilateral,[10,13,15,20,22] which was the case in most of our patients. However, unlike other studies where simultaneous involvement of the testicle and epididymis predominated,[15,21,23,27] or there was an equal presentation of orchitis and epididymo-orchitis[17] in two-thirds of our series

Table 2 Demographic and clinical features in patients with and without testicular involvement.

Parameter	Patients with BEO ($n = 34$)	Patients without BEO ($n = 364$)	p
Age (y)	46.5 (18—77)	40 (18—82)	0.068
Direct contact with animals	25 (74)	251 (69)	0.580
Illness duration prior to diagnosis (d)	30 (3—360)	30 (5—360)	0.110
Fever	33 (97)	221 (61)	<0.001
Sweating	28 (82)	279 (77)	0.449
Arthralgias	28 (82)	309 (85)	0.695
Malaise	24 (71)	263 (72)	0.836
Weight loss	11 (32)	98 (27)	0.497
Hepatomegaly	19 (56)	190 (52)	0.681
Splenomegaly	11 (32)	92 (25)	0.367
Focal involvement	22 (65)	225 (62)	0.740
Spondylitis	11 (32)	57 (16)	0.013
Sacroiliitis	3 (9)	47 (13)	0.786*
Peripheral arthritis	13 (38)	106 (29)	0.267
Respiratory system	2 (6)	20 (5)	1.000*
Nervous system	3 (9)	13 (4)	0.148*
Urinary system	4 (12)	6 (2)	0.006*
Hematopoietic system	1 (3)	24 (7)	0.711*
Hepatic and gastrointestinal system	2 (6)	17 (5)	0.672*

Data are presented as median (range) or n (%).
* Fisher exact test.
BEO = brucellar epididymitis/orchitis.

Table 3 Laboratory characteristics in patients with and without testicular involvement.

Parameter	Patients with BEO ($n = 34$)	Patients without BEO ($n = 364$)	p
Erythrocyte sedimentation rate (mm/h)	29 (2–90)	28 (2–103)	0.938
Hemoglobin (g/L)	135.5 (105–169)	137 (73–177)	0.277
White blood cells ($\times 10^9$/L)	7.4 (4.1–15.1)	6.4 (2.8–16.0)	0.007
Lymphocytes (%)	32 (8–54)	34 (11–74)	0.200
Platelets ($\times 10^{12}$/L)	246 (115–622)	222 (93–491)	0.061
C–reactive protein (mg/L)	42 (12–164)	18 (2–290)	<0.001
Alanine aminotransferase (>45 U/L)	12 (35)	123 (34)	0.859

Data are presented as median (range) or *n* (%).
BEO = brucellar epididymitis/orchitis.

Table 4 Therapeutic options in patients with and without testicular involvement.

Therapeutic combination	Patients with BEO: treated/followed ≥6 mo/relapsed	Patients without BEO: treated/followed ≥6 mo/relapsed
R+D+TMP-SMZ[a]	16/16/7	162/131/17
R+D+G[a]	3/2/0	99/75/3
R+D[a]	2/2/1	32/16/3
R+D+TMP-SMZ[b]	8/8/0	35/33/2
R+D+G[b]	5/5/0	34/29/0
R+D[b]	0	2/2/1
Total	34/33/8	364/286/26

[a] Therapy duration of 45 days.
[b] Therapy duration of >45 days.
BE/O = brucellar epididymitis/orchitis; D = doxycycline; G = gentamicin; R = rifampin; TMP-SMZ = trimethoprim/sulfamethoxazole.

of patients orchitis has been a predominating inflammation, which might be due to using only clinical criteria in establishing the diagnosis. BEO may occur as an isolated brucellar manifestation[5] or it might be within a systemic generalized disease. In the latter case BEO precedes the diseases,[13] starts at the same time,[14,18] or follows after the general manifestations of brucellosis, which was the case with the largest number of our patients. Even in endemic regions brucellosis recognition is especially difficult when testicular infection is either the first or only manifestation of the disease.

In this study 68% of the patients with testicular infection at the same time had another concomitant focal involvement, osteoarticular in the first order. Simultaneous infection of genital and other organ system in brucellosis is the previously known phenomenon,[13,14,17,21,31] usually with much lower percentages than the percentage reported by us. Simultaneous osteoarticular and testicular infection in brucellosis was already described[32] as well as spondylitis and orchitis[33,34] but much less frequently compared to our investigations. There is only one study comprising seven patients with BEO where frequency of coexisting focal diseases, including those with osteoarticular involvement, is similar to ours.[13] We have no adequate sustainable arguments about the frequent presence of spondylitis in our patients with testicular infection, except for the fact that the majority of our patients were treated in hospitals and underwent careful clinical examinations and follow-up. By contrast, in another study BEO was more frequently found in patients without osteoarticular manifestations.[35]

Table 5 Outcome in patients with and without testicular involvement.

Parameter	Patients with BEO ($n = 34$)	Patients without BEO ($n = 364$)	p
Defervescence (d)	2 (0–45)	1 (0–35)	0.115
Followed-up ≥ 6 mo	33 (97)	286 (79)	0.010
Favorable outcome[a]	21 (64)	241 (84)	0.004[b]
Relapse[a]	8 (24)	26 (9)	
Therapeutic failure[a]	4 (12)	19 (7)	0.003[c]

[a] Calculated in patients followed for ≥6 months.
[b] Favorable outcome vs. relapses.
[c] Favorable outcome vs. relapses + therapeutic failures.
Data are presented as median (range) or *n* (%).
BEO = brucellar epididymitis/orchitis.

Patients with BEO in our series were older in comparison with other studies.[6,10,13,18,20,22–24,36] Also, our examinations did not confirm the notion that patients with BEO were younger than those without testicular infection,[6,15] which might be a result of the larger number of patients with concomitant spondylitis that we had. We have shown that patients with BEO significantly more often manifested fever compared to those without this focal form. These cases presented acute testicular infection and besides local manifestations a lot of additional signs and symptoms predominated, including fever. The presence of urinary symptoms in BEO has been described with a wide range from 0%[18] to 69%.[27] This was one of the characteristics that distinguished our patients with and without brucellar testicular infection, and with the frequency of 12% was similar to those reported by others.[12,14] Also, higher CRP levels and higher leukocyte counts were found in our patients with testicular infection than in brucellar patients without BEO, which has been demonstrated in other studies, too.[6,15] In the literature, patients with BEO are more frequently reported to have blood culture positivity,[15] abdominal pain, lack of appetite and headache.[6]

Treatment of BEO is almost identical with treatment of nonlocalized brucellosis and lasts for 45 days.[10,12,13,22,23] However, there are reports presenting treatment duration of 8 weeks[17,21] or 12 weeks.[14,16] Applying these therapeutic regimens therapeutic failure rate ranges from 0%[10] to 26.5%,[18] and the frequency of relapses is from 0%[10,16] to 25%.[14] According to Roushan et al[17] by increasing the duration of therapy from 45 days to 60 days the percentage of cured patients significantly increased. In our study, the treatment duration of patients with testicular infection but without simultaneous spondylitis or brucellosis of the central nervous system lasted for 45 days.

Defervescence in our patients was comparable with defervescence in some other studies,[14,18] as was the time for resolution of testicular signs.[16,22] The reasons for therapeutic failures in our patients with testicular involvement were completely due to the concomitant spondylitis and the frequency of relapses we had in this category of patients, although high, is comparable to the percentages reported by others.[11,14,22] When compared to patients without testicular involvement, a significantly increased rate of relapses was noted in the group with testicular infection, which was also reported by Navarro-Martínez et al.[14] It is to be emphasized that relapses appeared in our patients treated for 45 days, and there were no relapses in patients treated for a longer period. Therefore, we think that treatment duration in brucellar testicular infection should be routinely extended to at least 60 days.

Our study has several limitations including retrospective design, a limited number of patients, absence of bacteriological isolation, not using ultrasound as a routine method for diagnosis and follow-up of BEO, as well as absence of spermograms. In endemic countries, besides other causes for testicular infection like mumps, tuberculosis, gonorrhea, *Chlamydia trachomatis* or enterobacterial infection, hydrocellae, testicular torsion and tumor,[5,22,37] brucellosis should have priority in the differential diagnostic considerations. Therefore, until results from larger prospective studies are obtained, our study has shown that testicular involvement in brucellosis is a serious condition with acute and severe presentation, simultaneous infection of other organ systems, and a high percentage of relapses. Consequently, its fast and timely recognition and proper and sufficient, long treatment duration are recommended priorities.

Conflict of interest

The authors declare that they have no conflict of interest.

References

1. Colmenero JD, Reguera JM, Martos F, Sanchez de Mora D, Delgado M, Causse M, et al. Complications associated with *Brucella melitensis* infection: a study of 530 cases. *Medicine* 1996;**75**:195–211.
2. Andriopoulos P, Tsironi M, Deftereos S, Aessopos A, Assimakopoulos G. Acute brucellosis: presentation, diagnosis, and treatment of 144 cases. *Int J Infect Dis* 2007;**11**:52–7.
3. Lulu AR, Araj GF, Khateeb MI, Mustafa MY, Yusuf AR, Fenech FF. Human brucellosis in Kuwait: a prospective study of 400 cases. *Q J Med* 1988;**66**:39–54.
4. Bosilkovski M, Krteva L, Dimzova M, Vidinic I, Sopova Z, Spasovska K. Human brucellosis in Macedonia—10 years of clinical experience in endemic region. *Croat Med J* 2010;**51**:327–36.
5. Al-Tawfiq JA. Brucella epididymo-orchitis: a consideration in endemic area. *Int Braz J Urol* 2006;**32**:313–5.
6. Celen MK, Ulug M, Ayaz C, Geyik MF, Hosoglu S. Brucellar epididymo-orchitis in southeastern part of Turkey: an 8 year experience. *Braz J Infect Dis* 2010;**14**:109–15.
7. Hardy AV. Undulant (Malta) fever: clinical aspects of cases which have occurred in Iowa. *J Iowa State Med Soc* 1928;**18**:387–91.
8. Wainwright CW. Malta fever in the US. *Bull Johns Hopkins Hosp* 1929;**45**:133–6.
9. Romero Pérez P, Navarro Ibañez V, Amat Cecilia M, Villanueva Garcia R. Brucellar orchiepididymitis in acute brucellosis. *Actas Urol Esp* 1995;**19**:330–2 [In Spanish].
10. Papatsoris AG, Mpadra FA, Karamouzis MV, Frangides CY. Endemic brucellar epididymo-orchitis: a 10-year experience. *Int J Infect Dis* 2002;**6**:309–13.
11. Stamatiou K, Polyzois K, Dahanis S, Lambou T, Skolarikos A. *Brucella melitensis*: a rarely suspected cause of infections of genitalia and the lower urinary tract. *Braz J Infect Dis* 2009;**13**:86–9.
12. Memish ZA, Venkatesh S. Brucellar epididymo-orchitis in Saudi Arabia: a retrospective study of 26 cases and review of the literature. *BJU Int* 2001;**88**:72–6.
13. Karakose A, Yuksel MB, Aydoğdu O, Hamidi AA. Epididymoorchitis as the first finding in patients with brucellosis. *Adv Urol* 2013;**2013**:765023.
14. Navarro-Martínez A, Solera J, Corredoira J, Beato JL, Martínez-Alfaro E, Atiénzar M, et al. Epididymoorchitis due to *Brucella mellitensis*: a retrospective study of 59 patients. *Clin Infect Dis* 2001;**33**:2017–22.
15. Akinci E, Bodur H, Cevik MA, Erbay A, Eren SS, Ziraman I, et al. A complication of brucellosis: epididymoorchitis. *Int J Infect Dis* 2006;**10**:171–7.
16. Yetkin MA, Erdinc FS, Bulut C, Tulek N. Epididymoorchitis due to brucellosis in central Anatolia, Turkey. *Urol Int* 2005;**75**:235–8.
17. Roushan MR, Baiani M, Javanian M, Kasaeian AA. Brucellar epididymo-orchitis: review of 53 cases in Babol, northern Iran. *Scand J Infect Dis* 2009;**41**:440–4.

18. Gul HC, Akyol I, Sen B, Adayener C, Haholu A. Epididymoorchitis due to *Brucella melitensis*: review of 19 patients. *Urol Int* 2009;**82**:158—61.
19. Guinda Sevillano C, Arévalo Velasco JM, Pérez Arbej JA, Armáiz Esteban F, Martínez Pérez E, Nogueras Gimeno MA, et al. Brucellar orchitis. Report of a series of 16 cases. *Actas Urol Esp* 1995;**19**:455—8 [In Spanish].
20. Ozturk A, Ozturk E, Zeyrek F, Onur K, Sirmatel O, Kat N. Comparison of brucella and non-specific epididymorchitis: gray scale and color Doppler ultrasonographic features. *Eur J Radiol* 2005;**56**:256—62.
21. Colmenero JD, Muñoz-Roca NL, Bermudez P, Plata A, Villalobos A, Reguera JM. Clinical findings, diagnostic approach, and outcome of *Brucella melitensis* epididymo-orchitis. *Diagn Microbiol Infect Dis* 2007;**57**:367—72.
22. Kadikoylu G, Tuncer G, Bolaman Z, Sina M. Brucellar orchitis in Innerwest Anatolia Region of Turkey. A report of 12 cases. *Urol Int* 2002;**69**:33—5.
23. Afsar H, Baydar I, Sirmatel F. Epididymo-orchitis due to brucellosis. *Br J Urol* 1993;**72**:104—5.
24. Patel PJ, Kolawole TM, Sharma N, al-Faqih S. Sonographic findings in scrotal brucellosis. *J Clin Ultrasound* 1988;**16**:483—6.
25. Bosilkovski M, Kirova-Urosevic V, Cekovska Z, Labacevski N, Cvetanovska M, Rangelov G, et al. Osteoarticular involvement in childhood brucellosis: experience with 133 cases in an endemic region. *Pediatr Infect Dis J* 2013;**32**:815—9.
26. Bosilkovski M, Katerina S, Zaklina S, Ivan V. The role of Brucellacapt test for follow-up patients with brucellosis. *Comp Immunol Microbiol Infect Dis* 2010;**33**:435—42.
27. Khan MS, Humayoon MS, Al Manee MS. Epididymo-orchitis and brucellosis. *Br J Urol* 1989;**63**:87—9.
28. Ibrahim AI, Awad R, Shetty SD, Saad M, Bilal NE. Genito-urinary complications of brucellosis. *Br J Urol* 1988;**61**:294—8.
29. Gonen I, Sozen H, Kaya O, Unal O, Guloglu G, Akcam FZ. Brucellosis: evaluation of 201 cases in an endemic area of Mediterranean basin. *Acta Medica Mediterranea* 2014;**30**:121—6.
30. Fallatah SM, Oduloju AJ, Al-Dusari SN, Fakunle YM. Human brucellosis in Northern Saudi Arabia. *Saudi Med J* 2005;**26**:1562—6.
31. Erdem H, Elaldi N, Ak O, Gulsun S, Tekin R, Ulug M, et al. Genitourinary brucellosis: results of a multicentric study. *Clin Microbiol Infect* 2014;**20**:O847—53.
32. Khateeb MI, Araj GF, Majeed SA, Lulu AR. Brucella arthritis: a study of 96 cases in Kuwait. *Ann Rheum Dis* 1990;**49**:994—8.
33. Ariza J, Gudiol F, Valverde J, Pallarés R, Fernández-Viladrich P, Rufí G, et al. Brucellar spondylitis: a detailed analysis based on current findings. *Rev Infect Dis* 1985;**7**:656—64.
34. Solera J, Lozano E, Martínez-Alfaro E, Espinosa A, Castillejos ML, Abad L. Brucellar spondylitis: review of 35 cases and literature survey. *Clin Infect Dis* 1999;**29**:1440—9.
35. Mousa AR, Muhtaseb SA, Almudallal DS, Khodeir SM, Marafie AA. Osteoarticular complications of brucellosis: a study of 169 cases. *Rev Infect Dis* 1987;**9**:531—43.
36. Savasci U, Zor M, Karakas A, Aydin E, Kocaaslan R, Oren NC, et al. Brucellar epididymo-orchitis: a retrospective multicenter study of 28 cases and review of the literature. *Travel Med Infect Dis* 2014;**12**:667—72.
37. Guler E, Guler S, Ucmak H, Gul M. Epididymoorchitis and pancytopenia caused by brucellosis. *Indian Pediatr* 2007;**44**:699—700.