Clinical and cytological characteristics and prognostic implications on sheep and goat *Theileria* infection in north of Iran

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Abstract The present research was carried out during 3 months from early June through late August, in northern zones of Iran. In addition, the present study was performed on 300 sheep and goats, in which 50 specimens were isolated based on clinical signs, blood smears and lymph node puncture. The results indicated clinical signs of theileriosis in sheep (with more prominent signs) and goats were diagnosable. The reliable clinical signs in sheep and goats included fever, tachycardia, cough, increased respiratory rate, mucosal pallor, anorexia, ruminal hypomotility and lymph node enlargement. Furthermore, the frequency of cough, abnormal pulmonary sounds, anorexia and ruminal hypomotility were significantly more in sheep than goats ($P < 0.05$).

Keywords Theileriosis · Sheep · Goat · Clinical signs · Blood smears

Introduction

Theileria infection in small ruminants is due to the presence of at least four parasitic species. *Theileria lestoquardi* is a highly pathogenic parasite of sheep and goats. Non-pathogenic or mildly pathogenic *Theileria* spp. of small ruminants include *T. separata*, *T. ovis* and *T. recondite*.

However, there is considerable confusion in the taxonomy of non-pathogenic *Theileria* spp. of small ruminants (Uilenberg 1995). According to Hashemi-Fesharaki (1997), two species of *T. lestoquardi* and *T. ovis* cause ovine theileriosis in Iran. *T. lestoquardi* which is a causal agent of malignant sheep and goat theileriosis (Hooshmand-Rad and Hawa 1973) was more highly reported from the south and south-east of Iran (Hashemi-Fesharaki 1997; Razmi et al. 2003). Diagnosis of theileriosis is based on the clinical findings and microscopic observation of thin blood and lymph node smears stained with Giemsa in acute cases. Species identification based only on morphological features is, however, very subjective especially in mixed infections. Frequently, serological methods are employed in determining subclinical infections. False positive and negative results are commonly observed in serological tests due to cross reactions, weakening in specific immune response as well as lack of determination of antibodies in carriers because of long-term infection (Burridge et al. 1974; Leemans et al. 1999). Recently, polymerase chain reaction (PCR) has been the preferred method of diagnosis of bovine and ovine theileriosis in epidemiological studies since this technique is more sensitive and specific than other conventional methods (d'Oliveira et al. 1995; Almeria et al. 2001). This study was aimed to research the clinical signs of theileriosis in sheep and goats in North regions of Iran.

Materials and methods

In this assessment 300 sheep and goats during a 3-month period, from early June through late August 2012, were evaluated in northern zones of Iran. History taking and clinical examination were done and 50 specimens were

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collected. Clinical examination including taking temperature, heart rate and intensity, respiratory rate, mucosal observation (for jaundice, pallor, hemorrhages), prescapular and prefemoral lymph nodes palpation and respiratory sound auscultation.

Examination of blood smears was used for diagnosis. Peripheral blood samples were taken from auricular veins and blood smears were stained by Giemsa. The slides were examined through light microscope, in which the piroplasmic forms of the parasite were assessed. The ring and occasionally comma-like shape parasites were concerned as positive samples. Suspected samples were confirmed by lymph node puncture and Giemsa staining which determined *Theileria* schizont forms (Koch's blue bodies). All data were analyzed by χ^2 test.

Results

In the present study 30 suspected cases out of 50 positive specimens were confirmed by lymph node puncture. Of 30 specimens, 20 and 10 samples belonged to goats and sheep, respectively. The results of clinical examination indicated increased heart beat intensity in 34 % of cases with no significant difference between goat and sheep. Cough was recorded in 76 % with significant difference between such two sorts of animals, so that it was more in sheep than goats. In addition, no remarkable respiratory sound intensity occurred in 26 % of cases. Significant abnormal respiratory sounds were recorded in 52 % of cases ($P < 0.05$). Mucosal pallor took place in 72 % of cases and no considerable difference was observed. Mucosal jaundice and petechiation were recorded as 4 and 8 %, respectively. Both ruminal hypomotility and anorexia occurred in 68 % of cases, whereas in sheep were more significant than goats. Diarrhea and constipation were recorded as 20 and 4 %, respectively without any remarkable difference. The frequency of respiratory sounds intensity, diarrhea and lymph nodes enlargement were more in goats than sheep, whereas no significant difference was observed. Fever, tachycardia and increased respiratory rate were recorded in both species and lymph node enlargement only in goats were determined in 100 % of cases. Thus, these are considered as valid signs for Theileriosis (Tageldi et al. 1992). Additionally, this research indicated coughing occurred in 75 % of male goats. Although respiratory sound intensity was more in female goats (50 %), mucosal pallor was recorded as 68 % in female goats. Ruminal hypomotility and anorexia in female goats were as 56 and 50 %, respectively (Ranjbar-Bahadori et al. 2007). Coughing in lambs (87.5 %) and kids (100 %) were more than adult sheep and goats, respectively. Abnormal pulmonary sounds in sheep (68.8 %) were more than lambs, whereas in kids

(50 %) was found more than adult goats. Mucosal pallor in kids (100 %) was more than adult goats. The ruminal hypomotility in goats (100 %) were more than adult sheep; however, anorexia in lambs (87.5 %) and kids (100 %) were more than adult sheep and goats, respectively. Lymph node enlargement in lambs were more than adult sheep (Tables 1, 2, 3).

Discussion

According to obtained results of present study the valid clinical signs for clinical diagnosis of Theileriosis in sheep and goats included fever, tachycardia, cough, increased respiratory rate, mucosal pallor, anorexia, ruminal hypomotility and lymph node enlargement; hence pneumonia should be differentiated from such disease due to its similar signs. A study by Ranjbar-Bahadori et al. (2007) demonstrated fever, lymph node enlargement and mucosal pallor as 98.8, 98.8 and 96.6 % for bovine Theileriosis, respectively. The present study indicated that clinical signs of Theileriosis in sheep and goats were diagnosable which they were more prominent in sheep than goats. The results revealed increased respiratory rate, tachycardia and fever in both sheep and goats and lymph node enlargement solely in goats (100 %) as valid signs. A study on slaughtered sheep indicated no positive blood smears (Lotfolahzadeh et al. 2010). In a study by Rosen (1997) in Palestine reported that 54.58 % of sheep and 45.75 % of lambs developed to Theileriosis and all of affected sheep had no

Table 1 The definite and relative frequencies of clinical signs of theileriosis in sheep and goats

Species Clinical signs	Sheep Fr (%)	Goat Fr (%)	Total Fr (%)
Fever	30 (100)	20 (100)	50 (100)
Tachycardia	30 (100)	20 (100)	50 (100)
Increased heart sound intensity	11 (36.6)	6 (30)	17 (34)
Cough	25 (83.3)*	13 (65)	38 (76)
Increased respiratory rate	30 (100)	20 (100)	50 (100)
Increased respiratory sound intensity	4 (13.3)	9 (45)	13 (26)
Abnormal respiratory sounds	19 (63.3)*	7 (35)	26 (52)
Mucosal pallor	23 (76.66)	13 (65)	36 (72)
Mucosal jaundice	2 (6.66)	0 (0)	2 (4)
Mucosal petechiae	4 (13.3)	0 (0)	4 (8)
Ruminal hypomotility	23 (76.6)*	11 (55)	34 (68)
Anorexia	25 (83.3)*	9 (45)	34 (68)
Diarrhea	5 (16.6)	5 (25)	10 (20)
Constipation	2 (6.66)	0 (0)	2 (4)
Lymph nodes enlargement	28 (93.33)	20 (100)	48 (96)

Fr (%) frequency, * $P < 0.05$

Table 2 The definite and relative frequencies of clinical signs of theileriosis in male and female sheep and goats

Sex Clinical signs	Sheep		Goat		Total	
	Male Fr (%)	Female	Male Fr (%)	Female	Sheep Fr (%)	Goat
Fever	12 (100)	18 (100)	4 (100)	16 (100)	30 (100)	20 (100)
Tachycardia	12 (100)	18 (100)	4 (100)	16 (100)	30 (100)	20 (100)
Increased heart sound intensity	5 (41.6)	6 (33.3)	2 (50)	4 (25)	11 (36)	8 (40)
Cough	10 (83.3)	15 (83)	3 (75)	10 (62.5)	25 (96.6)	13 (65)
Increased respiratory rate	12 (100)	18 (100)	4 (100)	16 (100)	30 (100)	20 (100)
Increased respiratory sound intensity	2 (16.6)	2 (11.11)	1 (25)	8 (50)	4 (13.3)	9 (45)
Abnormal respiratory sounds	7 (58)	12 (66.6)	3 (75)	4 (25)	19 (63.3)	7 (35)
Mucosal pallor	10 (83.3)	13 (72.2)	2 (50)	11 (68)	23 (76.6)	13 (65)
Mucosal jaundice	2 (16.6)	0 (0)	0 (0)	0 (0)	2 (6.6)	0 (0)
Mucosal petechiae	1 (8.3)	3 (16.6)	0 (0)	0 (0)	4 (10)	0 (0)
Ruminal hypomotility	10 (83.3)	13 (72.2)	2 (50)	9 (56.25)	23 (76.6)	11 (55)
Anorexia	10 (83.3)	15 (83.3)	1 (25)	8 (50)	25 (83.3)	9 (45)
Diarrhea	4 (33.3)	1 (5.5)	0 (0)	5 (31.25)	5 (16.6)	5 (25)
Constipation	0 (0)	2 (11.11)	0 (0)	0 (0)	2 (6.6)	0 (0)
Lymph nodes enlargement	12 (100)	16 (88.88)	4 (100)	12 (100)	28 (93.33)	20 (100)

Table 3 The definite and relative frequencies of clinical signs of theileriosis in adult and young sheep and goats

Maturity Clinical signs	Sheep		Goat		Total	
	Adult Fr (%)	Lamb	Adult Fr (%)	Kid	Sheep Fr (%)	Goat
Fever	22 (100)	8 (100)	18 (100)	2 (100)	30 (100)	20 (100)
Tachycardia	22 (100)	8 (100)	18 (100)	2 (100)	30 (100)	20 (100)
Increased heart sound intensity	6 (27.7)	5 (62.5)	6 (33.3)	0 (0)	11 (36.6)	6 (30)
Cough	18 (81.81)	7 (87.5)	11 (61.11)	2 (100)	25 (83.3)	13 (65)
Increased respiratory rate	22 (100)	8 (100)	18 (100)	2 (100)	30 (100)	20 (100)
Increased respiratory sound intensity	2 (9.09)	2 (25)	7 (38.8)	2 (100)	4 (13.3)	9 (45)
Abnormal respiratory sounds	15 (68.18)	4 (50)	6 (33.3)	1 (50)	19 (63.3)	7 (35)
Mucosal pallor	16 (72.2)	7 (87.5)	11 (61.11)	2 (100)	23 (76.6)	13 (65)
Mucosal jaundice	2 (9.09)	0 (0)	0 (0)	0 (0)	2 (6.66)	0 (0)
Mucosal petechiae	4 (18.18)	0 (0)	0 (0)	0 (0)	4 (13.33)	0 (0)
Ruminal hypomotility	15 (68.18)	8 (100)	10 (55.5)	1 (50)	23 (76.6)	11 (55)
Anorexia	18 (81.81)	7 (87.5)	7 (38.8)	2 (100)	25 (83.3)	9 (45)
Diarrhea	4 (18.18)	1 (12.5)	4 (22.22)	1 (50)	5 (16.66)	5 (25)
Constipation	2 (9.09)	0 (0)	0 (0)	0 (0)	2 (6.66)	0 (0)
Lymph nodes enlargement	20 (90.9)	8 (100)	18 (100)	2 (100)	28 (93.33)	20 (100)

clinical signs (Rosen and Schlien 1992). In present research, abnormal pulmonary sounds in adult sheep and goats were more than lambs and kids which may be due to lung involvement to other diseases other than theileriosis because by age increase the possibility of respiratory diseases rises. The mucosal pallor in kids was more than adults that may be due to body conformation due to theileriosis affection give rise to anemia manifestation rapidly. Ruminal hypomotility in lambs took place more than adult

sheep, whereas anorexia in lambs and kids were more than adults. Consequently, if the ruminal hypomotility and anorexia produce due to fever, the probable effects of fever will emerge more in kids and lambs. In a study in Iran of 60 affected cattle by theileriosis, 22 cases indicated icterus and in some cases mucosal pallor were observed. In addition, the heart rate and respiratory rate were significantly more in positive cases. In a study in Sudan out of 872 sheep, 190 cases affected by theileriosis, which all

demonstrated clinical signs of the disease (Tageldi et al. 1992). An assessment on sheep in Spain indicated that affected sheep by theileriosis encompassed higher temperature than non-affected ones significantly (Habela et al. 1989).

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