

Original Article

Molecular Detection of Crimean-Congo Hemorrhagic Fever

Virus in Ticks in Qom Province, Iran, 2011-2012

Telmadarraiy^{Z1}, Saghafipour A^{2*}, Farzinnia B², Chinikar S³

1. Department of Medical Entomology and Vector Control, Tehran University of Medical Science, Tehran, Iran.
2. Department of Environment Health, Faculty of Health, Qom University of Medical Science, Qom, Iran.
3. National Reference Laboratory of Arboviruse and Hemorrhagic Fever, Pasteur Institute. Tehran, Iran.

Abstract

Background and Aims: Crimean-Congo hemorrhagic fever (CCHF) is a zoonosis caused by a Nairovirus of the family Bunyaviridae. Infection is transmitted to humans mostly by Hyalomma ticks. This study was conducted to determine the rate of CCHFV infection in ticks in Qom province of Iran.

Materials and Methods: In this study, Reverse transcription – polymerase chain reaction (RT-PCR) was used to detect partial sequence of the CCHF small (S) genome segment in ticks.

Results: CCHFV genome was found in 7.9% of hard ticks. All positive ticks were from Hyalomma genus and Hyalomma marginatum species. We were not able to find virus in in Hy. anatolicum, Hy. schulzei, Hy. dromedarii, Rhipicephalus Sanguineus and Argas persicus.

Conclusion: Results exhibited that Hyalomma marginatum is the main vector in the study area.

Keywords: Ticks; CCHF; Qom; Iran

Introduction

Crimean-Congo hemorrhagic fever (CCHF) is a zoonosis caused by a Nairovirus of the family Bunyaviridae. CCHF is one of the most widely distributed viral hemorrhagic fevers and has been reported in Africa, the Middle East and Asia, as well as parts of Europe. There is no approved vaccine or specific treatment against CCHF virus (CCHFV) infections (1). CCHFV was reported in Iran in 1970. There was no report of clinical CCHF until 1999, when an outbreak reports from Shahr-e-Kord town ship and subsequently other outbreaks were reported in different provinces of Iran. In 2000, CCHF was

recognized as a major public health problem necessitating implementation of reliable method for antibody detection (2-4). The most important source for acquisition of the virus by ticks is believed to be infected small vertebrates on which immature Hyalomma and Rhipicephalus ticks feed. Once infected, the tick remains infected through its developmental stages, and the mature tick may transmit the infection to large vertebrates, such as livestock. Domestic ruminant animals, such as cattle, sheep and goats, are viraemic (virus circulating in the bloodstream) for around one week after becoming infected (5). Humans who become infected with CCHF acquire the virus from direct contact with blood or other infected tissues from livestock during this time, or they may become infected from a tick bite (6). Clinical features usually include a rapid progression characterized by hemorrhage, myalgia and fever, with a lethality rate up to

*Corresponding author: Abedin Saghafipour, MSc.
Faculty of Health, Qom University of Medical Sciences, Qom, Iran.
Email: abed.saghafi@yahoo.com

Table 1. HBs Ag prevalence among blood donations in the whole country (30 provinces), and also in high prevalence area (S&B) and low prevalence area (Fars) during 2001-2010.

Genus/species	Plain		Mountain		Total	
	No of Samples.	%	Num.	%	Frequency	Percent
<i>Hyalomma dromedarii</i>	147	19.75	93	12.5	240	32.25
<i>Hyalomma schulzei</i>	117	15.72	79	10.61	196	26.34
<i>Hyalomma marginatum</i>	41	5.51	23	3.09	64	8.61
<i>Hyalomma anatolicum</i>	30	4.03	20	2.68	50	6.72
<i>Rhipicephalus sangiuneus</i>	81	10.88	51	6.85	132	17.74
<i>Argas persicus</i>	42	5.64	20	2.68	62	8.34
Total	458	61.55	286	38.45	744	100

30%. Numerous studies have been conducted on the CCHFV infection since 2000 and variant virus infection was found in deferent species of ricks in Iran (2, 7-11). So far, however, no study has been done in the Qom Province in this regard. Thus, this study aimed to find the rate of CCHFV infection in tick population in the Qom Province.

Methods

Study area

Qom province is located in the central part of Iran, between 50° 06'–51° 58' E and 34° 09'–35° 11' N with an area of 11,237 km² covering 0.89% of the total land of Iran. Its provincial capital is the city of Qom (Fig. 1). Based on the most recent census in 2010, the province has a population of approximately 1,200,000 out of which 91.2% resides in urban areas and 8.8% in rural vicinities. Geographically, the province comprises mountainous areas, foothills and plains. The annual rainfall was 86.9 mm and relative humidity was ranged between 8.5% in June and 89.1% in December. The province contains 1 city, 5 counties, 9 rural districts, and 256 villages. In the Qom

Province, there are 28,726 households, of which 17,559 families raise 133,650 sheep as their occupation (12).

Sample collection

Ticks collected from the mentioned sheep were kept alive in separate vials and labeled, collection points were noted. The ticks were sent to the entomology laboratory, school of Public Health and the Institute of Public Health Research, Tehran University of Medical Science for species identification. The identified ticks were pooled into micro tubes and transferred to the Arbovirus laboratory, Pasteur Institute of Iran. Eighty eight ticks (6 species) were tested for the presence of CCHF virus by reverse transcription-polymerase chain reaction (RT-PCR) method.

RNA Extraction and RT-PCR on ticks

Ticks were individually washed twice with PBS 1X and crushed with a mortar and pestle in 200-300 µL of PBS 1X. Total RNA was extracted from the samples using the RNA easy Kit (QLAGEN, Viral RNA mini kit, GmbH, Hilden, Germany) according to the recommendations of the supplier. The RNA was dissolved in 50 µl of RNase-free water and stored at -70° C until use. A master mix was

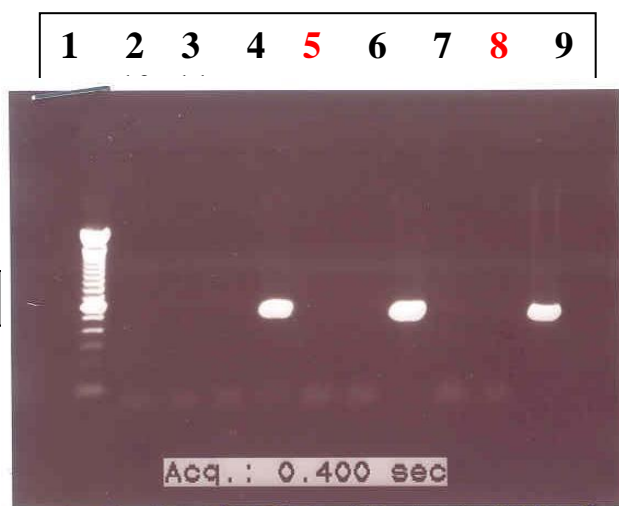


Fig. 1. A 536 bp region of the S segment of CCHF genome was amplified, directly from tick samples by RT-PCR. **Lane 1:** Marker (100 bp DNA ladder) CCHF positive control; **lane 2:** negative control; **Lane 11:** CCHF positive control; **lanes 5&8:** samples from infected ticks positive; **other lanes:** samples from infected ticks negative.

prepared with QIAGEN one step RT-PCR kit (QIAGEN GmbH, Hilden, Germany) as follow: 28 μ l of RNase Free water (RFW) 10UL buffer 5x ,2 μ l dNTP mix,2 μ l Reverse Transcriptas Enzyme and Taq Polymerase, 1 μ l of Primer A (Forward) (“5TGGACACCTTCACAAACTC-3”) and 1 μ l of Primer B (Reverse) (5”GACAAATTCCTACACCA-3”) and 1 μ L RNase inhibitor. Forty five microliter of master mix was added to PCR tubes and 5 UL of extracted RNA was added to the individual PCR tubes (total volume 50 μ L) (13). (The master mix typically contains all the components required for reverse transcription –

polymerase chain reaction (RT-PCR) except the template RNA.

Using a molecular-based diagnostic assay--the reverse transcription-polymerase chain reaction (RT-PCR)—88 ticks were examined for CCHFV infection. Out of these, 6 were diagnosed with CCHFV infection, all of which belonging to the family Hy. Marginatum (Table 2). All these infected ticks were caught in plain areas in the spring season (Table 3).

Results

This study was carried out in 25 villages, a total of 750 sheep and 200 camels were examined for infection during four seasons, out of which 72 sheep (9.6%) and 23 camels (11.5%) were discovered to be infected. A total number of 744 ticks were collected and identified using standard identification keys, out of which 91.7% were from the family Ixodidae (Hyalomma = 73.9% and Rhipicephalus = 17/8%) and 8.3% were from the family Argasidae and the genus Argas. 38.45% of the tick sample were caught in villages located in mountainous regions, and the rest, 61.55%, were collected from rural plain areas. (Table 1).

Discussion

In this study, 744 ticks were collected from ruminants' bodies in 25 villages, with the three genera including Hyalomma (73.9%), Rhipicephalus (17.8%) and Argas (8.3%). Like many studies in Iran (14, 15, 16) which have reported the dominant genus of hard ticks to be Hyalomma, our study revealed the same finding. The dominant species of hard ticks in

Table 2. The percentage of ticks infected with CCHFV based on tick species in Qom in 2011-2012.

Genus/species	No. of Samples	No. of infected ticks	% infected
<i>Hyalomma dromedarii</i>	17	0	0
<i>Hyalomma marginatum</i>	25	6	6.81
<i>Hyalomma anatolicum</i>	10	0	0
<i>Hyalomma schulze</i>	11	0	0
<i>Argas persicus</i>	12	0	0
<i>Rhipicephalus sanguineus</i>	13	0	0
Total	88	6	6.81

Table 3. The percentage of ticks infected with CCHFV based on the season and topographic conditions in the Qom Province in 2011-2012.

Season areas	Plain		Mountain		Total	
	Investigated. No (%)	Infected No (%)	Investigated. No (%)	Infected No (%)	Frequency of infected	Percent of infected
<i>Spring</i>	18(20.45)	6(6.81)	10(11.36)	0(0)	6	6.81
<i>Summer</i>	22(25)	0(0)	13(14.77)	0(0)	0	0
<i>Autumn</i>	12(13.64)	0(0)	7(7.95)	0(0)	0	0
<i>Winter</i>	4(4.54)	0(0)	2(2.27)	0(0)	0	0
Total	56(63.63)	6(6.81)	32(36.37)	0(0)	6	6.81

Qom was *Hy. Dromdoreii*, similar to a study in Yazd (16), while in Western Azerbaijan *Hy. Anatolicum* was dominant (15), in the north of the country the genus *Rhipicephalus* and the family, *Rh. Sanguineus* were dominant (17, 18). Regarding the geographical distribution of ticks in Qom, there was no significant difference between the sampled species and also between their population. More clearly, in both mountainous and plain areas, the species *Hy. dromdoreii* was dominant, while other species including *Hy. Schulzei*, *Rh. Sanguineus*, *Hy. marginatum*, and *Hy. anatolicum* were of less dominance. Although *Hyalomma* sp. Ticks are considered the most important in the epidemiology of CCHF as main vectors and reservoir of the virus, the virus has been reported in other 4 genera of hard ticks (*Rhipicephalus*, *Haemaphysalis*, *Dermacentor* and *Ixodid* sp.) and also in 2 species of soft ticks (*Argas persicus* and *Ornithodoros lahorensis*) (2, 19). 88 ticks from 3 different genera (*Hyalomma*, *Rhipicephalus*, *Argas*) were examined for CCHFV infection. Subsequently, the findings revealed that only the genus *Hyalomma* and the species *Hy. Marginatum* were positive. Other species including *Hy. anatolicum*, *Hy. schulzei*, *A. persicus*, *Rh. sanguineus*, and *Hy. dromedarii* were negative. In Zahedan, the genus *Hyalomma* was tested

positive (7), and, similarly, in the Yazd Province, only the genus *Hyalomma* was positive, with the species involving *Hyalomma dromedarii*, *Hyalomma marginatum*, *Hyalomma anatolicum*, *Hyalomma detritum*, and *Hyalomma asiaticum* (8). On the other hand, the species *Rhipicephalus sanguineus* and *Dermacentor marginatus* were not found to be infected (8). Likewise, in the studies conducted in Kurdistan, the CCHFV infection test was positive solely for the genus *Hyalomma* whereas the other genera *Haemaphysalis*, *Rhipicephalus*, and *Dermacentor* were not infected (9). Concerning other species, *Rhipicephalus* sp. and *Haemaphysalis* sp. were reported to be CCHFV-infected in Hamadan for the first time in Iran (2). In the same study, in addition to the *Hy. Dromedarii*, *Hy. Marginatum* and *Hy. Anatolicum*, the species *H. punctata*, *Rh. Bursa* and *Rh. Sanguineus* were reported to be CCHFV-infected. As for the family *Argasidae*, the genera *Ornithodoros lahorensis* was tested positive in the Khorasan Province for the first time (10) and then in the Chahar-Mahal-o Bakhtiari Province (11). Although in the Qom Province the species *Hy. anatolicum*, *Hy. schulzei*, *Rh. sanguineus*, *Hy. dromedarii* tested negative for CCHFV, the conclusion can safely be drawn that all species of hard ticks in Qom can be potential carriers of CCHFV

considering the epidemic statistics. This study conducted in Hamadan (2) infective ticks was collected in both mountainous (16%) and plain areas (5%). However, in our study, 33.3% of ticks caught in plain areas were CCHFV-infected whereas, in mountainous regions, no infected tick was found. Also, the findings of researches in other country have showed that the vectors of CCHF are many species of ticks. It depends on the distribution of ticks in every area. For instance in turkey, the virus has been reported in *R. bursa* and *H. Marginatum* (20). And in India *Hyalomma anatolicum* ticks have transmitted the CCHFV (21). As was reported, the dominant species in the Qom Province was *Hy. Dromdoreii*. However, *Hy. Marginatum* was also reported to be infective. Thus, it can be concluded this species can have a significant role in the transmission cycle of CCHF virus in the province.

References

- Escadafal C, Olschläger S, Avšič-Županc T, Papa A. First international external quality assessment of molecular detection of Crimean-Congo hemorrhagic Fever virus. *Journal of PLoS Neglected Tropical Disease*. 2012;6(6):1706.
- Telmadarraiy Z, Moradi AR, Vatandoost H, Mostafavi E, Oshaghi MA, Zahirnia AH, and et al. Crimean-Congo hemorrhagic fever: a sero-epidemiological and molecular survey in Bahar, Hamadan province of Iran. *Asian Journal of Animal and Veterinary Advances*. 2008;3(5):321-327.
- Chumakov MP, Smirnova SE. Detection of antibodies to CCHF virus in wild and domestic animal blood sera from Iran and Africa. *Institute of Polio and viral Encephalitis, Moscow*. 1972;367-368 (In Russian).
- Chinikar S, Fayaz A, Mirahmadi R, Mazaheri V, and et al. The specific serological investigation of suspected humans and domestic animals for Crimean- Congo hemorrhagic fever in Iran using ELISA techniques. *Hakim Journal*. 2002;4(4):294-300.
- Chinkar S. A seroepidemiological survey of Crimean-Cong Hemorrhagic fever in Iran in animals and human. *The veterinary council quarterly*. 2003;3(3):63-73.
- Mehrabi-Tavana A, Chinikar S, Mazaheri V. The Seroepidemiological aspects of Crimean-Congo hemorrhagic fever in three Health Workers: A report from Iran. *Arch Iranian Medical Journal*. 2002;5:255-258.
- Chinikar S, Persson SM, Jahansson M, Bladh L, Gooya M, Houshmand B. Genetic analysis of Crimean-Congo hemorrhagic fever virus in Iran. *Journal of Medical Virology*. 2004;73(3):404-411.
- Salim abadi Y, Chinikar S, Telmadarreyi Z, Vatandoost H. Crimean--Congo hemorrhagic fever: a molecular survey on hard ticks (Ixodidae) in Yazd province, Iran. *Asian Pacific Journal Tropical Medicine*. 2011;4(1):61-3.
- Fakoorziba MR, Golmohammadi P, Moradzadeh R, Moemenbellah-Fard MD, Azizi K, Davari B, Alipour H, Ahmadnia S, Chinikar S. Reverse Transcription PCR-Based Detection of Crimean-Congo Hemorrhagic Fever Virus Isolated from Ticks of Domestic Ruminants in Kurdistan Province of Iran. *Vector Borne Zoonotic Diseases*. 2012;12(9):794-9.
- Sureau P, Klein J, Digouth J. Isolation of Thogota, Wad Medani, Wanowrie and Crimean-Congo hemorrhagic fever viruses from ticks of domestic animals in Iran. *Annu. Virology*. 1980;131(E):185-200.
- Shirani M, M. Asmar S, Chinikar S, Mirahmadi. Detection of CCHF virus in soft ticks (Argasidae) by RT-PCR method. *Journal of Infectious Disease Tropical Medicine*. 2004;9(24):11-15.
- Islamic Republic Of Iran. Weather Meteorological Organization. <http://www.weather.ir>
- Burt FP, Lemon JF, Swanepol R. The use of reverse transcription polymerase chain reaction for the detection of viral nucleic acid in the diagnosis of Crimean Congo haemorrhagic fever. *Journal of Virological Methods*. 1998;70(2):129-137.
- Davoudi J, Hoghooghi Rad N, Golzar Adabi Sh. Ixodid tick species infesting cows and buffaloes and their seasonality in West Azerbaijan. *Journal of Parasitology Reserch*. 2008;3(3):98-103.
- Salari-Lak Sh, Vatandoost H, Telmadarraiy Z, Entezar Mahdi R, KIA EB. Seasonal activity of ticks and their importance in tick-borne infectious diseases in West Azerbaijan, Iran. *Iranian Journal of Arthropod Borne Disease*. 2008;2(2):28-34.
- Salim-abadi Y, Telmadarraiy Z, Vatandoost H, Chinikar S, Oshaghi MA, Moradi M. Hard ticks on domestic ruminants and their seasonal population dynamics in Yazd province, Iran. *Iran J Arthropod Borne Dis*. 2010;4(1):66-71.

17. Hosseini-vasoukolaei N, Telmadarraiy Z, Vatandoost H, Yaghoobi Ershadi MR. Survey of tick species parasiting domestic ruminants in Ghaemshahr country, Mazandaran province, Iran. *Asian pacific Journal of Tropical medicine*. 2010;804-806.
18. Nabian S, Rahbari S, Shayan P, Haddadzadeh HR. Current status of tick fauna in North of Iran. *Iranian Journal of Parasitology*. 2007;2:12-17.
19. Logan, TM, Linthicum KJ, Bailey CL, Watts DM. Experimental transmission of Crimean-Congo hemorrhagic fever virus by *Hyalomma truncatum*. *The American Journal of Tropical Medicine and Hygiene*. 1989;40:207-212.
20. Sukru T, Munir A, Kursat A, Ahmet K. Crimean-Congo Hemorrhagic Fever Virus: Genetic Analysis and Tick Survey in Turkey. *Journal of Clinical Microbiology*. 2006;44(11):4120.
21. Pragma D, Yadav F, Sarah S, Divya Z, Prasad K, Rashmi G, Santosh J, Akhilesh C, Devendra T. Genetic characterization and molecular clock analyses of the Crimean-Congo hemorrhagic fever virus from human and ticks in India, 2010–2011. *Journal of Infection, Genetics and Evolution*, 2013;14:223–231.