



Review

# Human otoacariasis: Demographic and clinical outcomes in patients with ear-canal ticks and a review of literature

Taliye Cakabay<sup>a,\*</sup>, Ozan Gokdogan<sup>b</sup>, Murat Kocyigit<sup>a</sup>

<sup>a</sup> Kanuni Sultan Suleyman Training and Research Hospital, Otolaryngology Clinic, Istanbul, Turkey

<sup>b</sup> Memorial Hospital, Otolaryngology Clinic, Ankara, Turkey

Received 14 March 2016; revised 13 June 2016; accepted 14 June 2016

## Abstract

**Introduction:** Otoacariasis is a rare infestation of the ear canal, which affects the quality of life especially in rural areas. Different types of ticks and mites may cause otoacariasis. Although treatment of otoacariasis is simple, diseases transmitted through ticks and mites should be considered during diagnosis and treatment. Both local and systemic signs and symptoms of such diseases should be followed up.

A literature review was conducted in PubMed using the following terms: “otoacariasis,” “ticks,” “mites,” and “outer ear canal infestations.” Demographic, radiologic, and treatment options were discussed. Treatment hints and pitfalls were also discussed with the literature review.

**Conclusion:** In this paper, we describe otoacariasis in humans and discuss the appropriate interventions.

Copyright © 2016, PLA General Hospital Department of Otolaryngology Head and Neck Surgery. Production and hosting by Elsevier (Singapore) Pte Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Keywords:** Otoacariasis; Ticks; Mites; Outer ear canal

## Contents

1. Introduction .....	112
2. Tick species .....	112
2.1. Argasid ticks .....	112
2.2. Ixodid ticks .....	112
3. Ticks and tick-borne diseases .....	113
4. Seasons .....	114
5. Gender and age .....	114
6. Localization, symptoms, and signs in the ear .....	114
7. Removal of ticks .....	115
8. Conclusion .....	115
9. Conflict of interest .....	116
References .....	116

\* Corresponding author. Kanuni Sultan Suleyman Training and Research Hospital, Otolaryngology Clinic 34303 Istanbul, Turkey. Fax: +90 212 571 47 90.  
E-mail address: [cakabaytaliye@yahoo.com](mailto:cakabaytaliye@yahoo.com) (T. Cakabay).

Peer review under responsibility of PLA General Hospital Department of Otolaryngology Head and Neck Surgery.

## 1. Introduction

Ticks have coexisted for thousands of years with humans and animals. Worldwide, there are over 900 different tick species. Ticks may transmit a variety of pathogenic microorganisms including protozoa, rickettsiae, spirochetes, and viruses, more than any other arthropod vector group. These ticks may be vectors of diseases especially affecting livestock, humans, and companion animals. Ticks also can cause other severe toxic conditions such as paralysis, toxicosis, irritation, and allergies. Therefore, ticks are considered a global public health problem (Aktaş, 2008; Bursali et al., 2012; Horak et al., 2002; Vatanserver, 2008). In this paper, we compile and review the global importance of ticks, tick-borne diseases, and otoacariasis.

Otoacariasis is the presence or attachment of ticks and mites within the ear canal of humans and animals and is a common phenomenon especially in rural areas (Patrick et al., 2001). In livestock and domestic animals living in these areas, in addition to other body parts, the ears are also a common site of attachment for mites (e.g., *Psoroptes* and *Otodectes*) (Bates, 1996; Degiorgis et al., 2001; Engelen and Anthonissen, 2000; Yeraham et al., 1985), ticks (e.g., *Otobius megnini*) (Eads and Campos, 1984; Gökdoğan et al., 2016; Wallace, 2001), and several *Rhipicephalus* and *Hyalomma* spp (Dalgic et al., 2010; Diab et al., 2001; Dilrukshi et al., 2004; Doğan et al., 2012; Gurbuz et al., 2010; Kettle, 1995; Papazahariadou et al., 2003; Gorgulu et al., 2012).

One of the first reports of ear infestation by *Otodectes cynotis* (*Psoroptidae*) causing otitis externa was reported from Belgium by Van de Heyning and Thienpont (1977). This parasitic mite is a common cause of otoacariasis in dogs and cats. Subsequently, Rossiter (1997) reported two cases of otitis externa caused by *Dermanyssus gallinae* infestation, the red poultry mite (*Dermanyssidae*), as an occupational health hazard in poultry workers. In the following years, Paleri and Ruckley (2001) reported a case of recurrent infestation of otherwise healthy mastoid cavities with the storage mite *Sancassania (Caloglyphus) berlesei* [*Acaridae*]. Occupational exposure was also suspected in this case. The same species was reported in the external auditory canal of a 46-year-old South Korean man by Cho et al. (1999). This patient complained of feeling a foreign body sensation, pain, and itching in the left external ear canal. Three or more generations of ticks have probably lived in the ear canal regarding the life cycle of etiologic agent.

## 2. Tick species

Of the over 900 currently known tick species, approximately 80% are ixodid ticks (hard ticks), while the rest are argasid ticks (soft ticks) (Aktaş, 2008; Horak et al., 2002; Vatanserver, 2008). Most ticks have a preference for feeding on certain groups of wild animals, with some being rather host-specific. Consequently, the number of species pertinent to domestic animals and/or humans is limited. A few tick species, however, have successfully adapted to livestock or human feeding, and have become efficient vectors of a range of

pathogenic microorganisms; virtually all human tick-borne diseases are zoonoses. Ecological criteria were used to underpin the tick-host-pathogen relationships. When a tick feeds from an infected animal or human, the pathogens are transmitted to the tick through blood. After one or more life cycle in the tick, pathogens can be transmitted to another host through tick bites during feeding. Hosting and contaminating properties are very specific to tick species. Geographic regions also affect the tick type and population (Bratton and Corey, 2005; Dantas-Torres, 2007).

### 2.1. Argasid ticks

*Argas*, *Ornithodoros*, and *Otobius* are infectious species of argasid ticks in both humans and animals. The *Argasidae* live in close range of their favored hosts and the parasitic stages feed for a short period only on the host and then go back to their hiding place. Soft ticks often have several nymphal stages. *Argas miniatus* is widely distributed in the Neotropical region, and both *Argas persieues* and *Argas reflexus* are found in southern Europe and central Asia, where they usually feed on birds. *Argas monolakensis* is an important argasid tick of birds that can feed on humans in western USA (Schwan et al., 1992). Other ticks such as *Argas brumpti* and *Argas* (now *Carios*) *vespertilionis* can cause extensive, post-feeding local lesions resembling bruising in humans.

Larvae and nymphs of the spinose ear tick, *O. megnini*, can be found in the ear canals of livestock, companion animals. This tick occurs in the western parts of USA and parts of South America. It is also found in the Afro-tropical. Ticks are generally located in the ear canal of domestic animals like cattle, sheep, goats, South American camelids, dogs, and horses. Human infestations caused by these ticks were also reported in several cases. In addition to different reported infestations in veterinary medicine (Bulman and Walker, 1979; Parish, 1949; Madigan et al., 1995).

*O. megnini* can cause ear infestations in humans too. This tick may also play a role in the transmittance of Q fever disease (Jellison et al., 1948; Lasecka and Baron, 2014) and may have been associated with other toxic conditions such as paralysis of a child (Peacock, 1958; Yılmaz et al., 2009).

The widely distributed argasid genus *Ornithodoros* contains 38 species, with *Ornithodoros moubata* and *Ornithodoros porcinus* as important species in the relatively arid parts of Africa, where they find shelter in caves, rodent burrows, and bird nests and in cracks and crevices of huts and shelters of indigenous people and their domestic animals (Hoogstral, 1956).

### 2.2. Ixodid ticks

*Ixodidae* may be one-, two-, or three-host species depending on the number of host animals they attach to during their life cycle. The world's ixodid tick fauna consists of 241 species in the genus *Ixodes* and 442 species in the remaining genera. There are seven important genera of ixodid ticks (*Amblyomma*, *Boophilus*, *Dermacenor*, *Haemaphysalis*, *Hyalomma*, *Ixodes*, and *Rhipicephalus*).

Although the five species of genus *Boophilus* have been placed in the genus *Rhipicephalus* by Horak et al. (2002) to reflect their choice of phylogenetic relationship and evolution, this change in nomenclature has retained the name *Boophilus* in common usage as a subgenus (Horak et al., 2002). To avoid confusion, we continue to treat *Boophilus* separately from *Rhipicephalus*, because ticks of the genus *Boophilus* are among the most widely known in the world.

While the importance of tick-borne diseases for humans and companion animals is measured by morbidity and mortality, the diseases transmitted by ticks to livestock are an additional major constraint to animal production predominantly in (sub) tropical areas of the world. Some tick-borne protozoan diseases (e.g., theileriosis and babesiosis) and rickettsial diseases (e.g., anaplasmosis and heartwater or cowdriosis) are important health concerns of some domestic and wild animals (cattle [buffaloes] and small ruminants) which affect the agricultural and rural areas in Africa, Asia, and Latin America. In under developed and developing countries, tick-borne diseases are not so rare and may be an accepted public health problem (Perry et al., 2002). This is particularly relevant in parts of sub-Saharan Africa, Asia, and Latin America where the demand for livestock products is rapidly on the increase (Delgado et al., 1999).

Dilrukshi et al. (2004) reported *Amblyomma*, *Boophilus*, *Hyalomma*, *Rhipicephalus*, and *O. megnini* as causative factors of otoacariasis by. In this article, 384 surgically removed ticks were analyzed and these four genera were identified as etiologically relevant. *Argas integrum* was the most common etiologic species, followed by *Hyalomma brevipunctata* and *Hyalomma marginatum*. *Rhipicephalus haemaphysaloides* and *Rhipicephalus sanguineus* and *Rhipicephalus* spp. were also found to be causative agents with decreasing incidence. Gökdoğan et al. (2016) reported a total of 31 samples collected and removed tick from ear. All 31 ticks were analyzed and identified as *O. megnini*. Gorgulu et al. (2012) reported that a total of 4 samples collected and removed tick from ear. After sample analysis, all ticks were identified as *Hyalomma* spp.

Al-Arfaj et al. (2007) reported that otoacariasis is caused by infestation with a histiostomatid mite (*Histiostomatidae*). Mites may also be located in ear canals less frequently than ticks. *O. cynotis* (*Psoroptidae*) infestation that results in otitis externa was reported from Belgium by Van de Heyning and Thienpont (1977). Otoacariasis in domestic animals are generally caused by this agent. Rossiter (1997) reported two cases of otitis externa caused by *D. gallinae* infestation, the red poultry mite (*Dermanyssidae*) as an occupational health problem in poultry workers. Paleri and Ruckley (2001) reported a case of recurrent infestation of otherwise healthy mastoid cavities with the storage mite *Sancassania (Caloglyphus) berlesei* [*Acaridae*]), wherein occupational exposure was also suspected.

### 3. Ticks and tick-borne diseases

In under developed areas of the world, tick-related diseases are still a public health problem. The significance of ticks in

rural areas across the world are related not only to the associated health problems but also to the economic problems. Tick-related infestations have co-evolved with different hosts that often live in a state of equilibrium and constitute reservoir hosts for tick-related problems in all living animals. Ticks became a problem for domestic livestock when these wild hosts were exposed to them, because humans moved livestock into infested regions or moved tick-infested livestock into previously uninfested regions. An example of humans moving livestock into infested regions is the introduction of cattle in Africa, where they came into contact with *Rhipicephalus appediculatus*, the vector of *Theileria parva*, and the etiologic factor of East Coast fever and other related diseases. The African buffalo is the typical host of *T. parva*, and the infestation is normally subclinical in this animal. An example of man moving tick-infested livestock is the introduction of *Boophilus* ticks together with the livestock diseases they transmit into the American continent.

Ticks are an accepted public health problem, especially in the northern hemisphere, primarily because of Lyme borreliosis (LB), but also other zoonotic tick-borne illnesses of viral origin, which are characterized by encephalitis and hemorrhagic fevers, causing the highest morbidity and mortality in humans. Tick-borne pathogens of pets are of economic significance only in industrialized countries, whereas tick-borne pathogens infecting horses constitute important constraints to international trade and sporting events involving these animals.

Disease transfer starts with the feeding of a tick on an infectious vertebrate host. During feeding, they ingest the pathogen through the blood meal. Then, the pathogens are transferred to another host in the next feeding (Nava et al., 2009). Tick bites can result in paralysis, toxicosis, severe local reactions such as pruritus, secondary bacterial infections, and a variety of reactions caused by immune-mediated responses (Mastropaolo et al., 2011).

Crimean-Congo hemorrhagic fever (CCHF) is a common tick-borne viral disease of humans, causing both sporadic cases or out breaks, which may severely affect large populations. *Hyalomma* species are the main etiologic vector of this infestation. Nairovirus in the family Bunyaviridae is the etiologic agent of CCHF. Tularemia is a multi-systemic disease caused by the bacterial pathogen *Francisella tularensis*. Biting flies, water exposure, food, aerosols, and ticks can transmit the disease. *F. tularensis* is highly infectious, and clinical infection may be seen after exposure to very few amounts of bacteria. Lyme disease is caused by the spirochete *Borrelia burgdorferi*. The main vectors for Lyme disease are ticks. Mice and small mammals are natural reservoirs for *B. burgdorferi*. Rocky Mountain spotted fever is caused by *Rickettsia rickettsii*.

Patients with exposure history and symptoms including fever, malaria, and other nonspecific symptoms together with physical findings suggestive of vascular leak and coagulation defect must be evaluated for CCHF. Leucopenia, thrombocytopenia, and elevated serum liver enzymes may be seen in laboratory evaluation. Certain diagnosis is made by showing viral nucleotide and viral antigens.

Deaths related with CCHF have been increasingly reported in the last few years. Different treatment options including general supportive measures, antiviral therapy, antibody therapy, and vaccines are used in CCHF (Heim and Maughan, 2007).

Different forms of tularemia, including ulceroglandular, oculoglandular, pneumonic, oropharyngeal, gastrointestinal, and typhoidal forms may be seen in clinical practice. The most common type is the ulceroglandular form that is characterized by chills, fever, head and muscle pain, and prostration, usually 3–6 days after exposure. Prompt antibiotic treatment with fluoroquinolones, amino glycosides, and supportive therapy generally shows good results with favorable prognosis.

Moreover, different vaccines for tularemia have been developed (Balbani et al., 1998).

The first stage of Lyme disease is seen 7–10 days after exposure. A typical rash called erythema migrans occurs at the side of the tick bite. In addition, fever, fatigue, arthralgias, headaches, cough, and lymphadenopathy may be seen. In stage 2 of Lyme disease, also called the early disseminated stage, multiple secondary cutaneous annular lesions, fever, adenopathy, and central nervous system symptoms may occur. In stage 3, known as late chronic disease, symptoms include chronic arthritis, central nervous system complications, dermatitis, and keratitis. Laboratory tests including ELISA help diagnose Lyme disease. In most cases, antibiotic treatment including doxycycline or amoxicillin is curative (Bente et al., 2013).

In case of Rocky Mountain spotted fever, the first symptoms usually occur 5–7 days after exposure. Malaise, myalgia, fever, headaches, nausea, and vomiting are common symptoms. With nonspecific symptoms, an exanthema appears within the first few days of the symptoms. Skin lesions may change and coalesce to form large areas of ecchymosis and ulceration. Respiratory, circulatory, and neurological complications may occur. Patients with glucose-6-phosphate dehydrogenase deficiency are prone to more severe disease. Clinical signs and symptoms are important for the diagnosis of Rocky Mountain spotted fever. Laboratory tests, especially immunofluorescent staining for rickettsia, help diagnose Rocky Mountain spotted fever. Tetracycline, doxycycline, chloramphenicol, and fluoroquinolones are used in the treatment of Rocky Mountain spotted fever. Prompt antibiotic treatment aids good prognosis (Foley and Nieto, 2010).

The main complications of intra-aural foreign bodies are canal abrasion, laceration, and bleeding, but these can also cause otitis externa, eardrum perforations, and suppurative middle ear infections, affecting the middle ear (Al-Juboori, 2013).

#### 4. Seasons

Most people were infected in the spring and summer, especially by tick bites. Ticks are the main vector and the incidence of tick-borne disease is often seen from April to September. There is a peak of tick-borne disease in May to September, when the animals feed outside during better weather conditions in the place, and August is the month with

the highest number of cases, subject to increased exposure (Gökdoğan et al., 2016).

From January to December, a total of 5714 patients were admitted to the Ear, Nose, and Throat ward of Sri Lanka in 2004. Of these, 870 (15.23%) were found to have intra-aural ticks (Dilrukshi et al., 2004). All patients had pain in the affected ear, while some complained of the presence of dark-colored granules (tick feces) in the ear canal. A small group of patients also complained of ear bleeding. Although cases had occurred throughout the year, there was an increase during November–March with December having the maximum number of cases, relative to total patient admissions.

#### 5. Gender and age

In a study by Somayaji and Rajeshwari (2007) from January 2004 to December 2005, 144 cases presented to the hospital with live intra-aural foreign bodies. Of these, 126 patients had ear ticks. The youngest patient was one year old and the oldest was 70 years old. Maximum numbers of cases were found between 31 and 40 years (25 cases). There were more female patients than male patients. Man often gets infested during the dry season from October to February. Children and women get infested in similar ways because of co-sleeping at night, or because the children are often accompanied by their female guardians during every day activities within or outside domestic premises. Children could also be affected because of their close contact with pets.

The role of gender in tick infestation is not clearly understood. In a recent study, there was a high female preponderance with 29 female patients versus only 2 male patients. The age range of the patients was between 17 and 72 years. The source of income of all patients was agriculture and livestock farming, and 28 of them lived in rural areas, while 3 lived in the city (Gökdoğan et al., 2016). In another study comprising 208 cases, the youngest patient was one year old and the oldest was 73 years old (Dilrukshi et al., 2004). The data shows that generally younger age groups (age range, 1–10 years) and adults (age,  $\geq 21$  years) were the most affected, while adolescents (age range, 11–17 years) were the least affected. In this cohort too, there was a strong female preponderance ( $n = 143$  vs.  $n = 65$  [males]), but there was no proof of age-related differences among infested male and female patients who presented to the hospital.

#### 6. Localization, symptoms, and signs in the ear

Ear pain (90%) is the most common complaint of the intra-aural tick infestation. Sometimes infestation is symptomless. Families can seldom see foreign bodies, which might be the cause for hospital admissions (Erenler et al., 2014). A literature review reported some of the patients having dizziness, tinnitus, earache, bleeding, hearing loss, and facial paresis. An immediate presentation of symptoms was not observed in tick infestation, as is usually seen with other intra-aural foreign bodies such as cockroach and other insects. The ticks attach to the canal skin or tympanic membrane via their mouth parts. The

enzyme present in their saliva causes local pain. The tick's rostrum is burrowed into the skin to enable it to suck blood. As the tick feeds, it progressively gets engorged. Saliva containing toxins is concurrently secreted, and the neurotoxin can thereby cause facial or respiratory paralysis. In most cases, the paralysis symptoms are understood to be caused by female ticks. A single female tick can completely paralyze an adult human. Ticks can also pass on other kinds of diseases including tick typhus, Rocky Mountain spotted fever, and Kyasanur forest disease (Indudharan et al., 1999). Intra-aural ticks can cause otitis externa, tympanic damage, otitis media, and facial palsy. Most of the aural complications are a result of the overenthusiastic attempts at removal by untrained clinicians.

In the previously cited study by Somayaji and Rajeshwari (2007), ticks were generally found attached to the ear canal in 109 cases (86.5%), and to the eardrum in the remaining 17 cases (13.5%). On otoscopic examination, the blood filled bloated body of the tick was found within a hemorrhagic vesicle. In whole patients, just one tick was found and the eardrum was intact in all of the cases. The average time of presentation is 3–4 days.

Ear involvement varies from case to case. In the otoscopic examination, ticks were found in the right and left sides of 17 and 14 patients, respectively. Ticks were removed from the outer ear canal of 27 patients, 3 ticks were removed from the eardrum, and one was removed from the middle ear of a patient who had chronic otitis media at the same time. In one patient, 2 ticks were removed concurrently. In one case, 2 ticks were removed from different ears of the same patient at different times. Outer ear hyperemia and canal edema were seen in all patients (Gökdoğan et al., 2016).

While information regarding sleeping habits was not available for the majority of patients, the limited data collected showed that infestations of the most common intra-aural tick, *A. integrum*, were relatively similar in both mattress and floor sleepers (39/60; 65.0% vs. 50/78; 64.1%, respectively) (Dilrukshi et al., 2004).

There are less common reports of human-ear tick infestations in scientific literature, but there are recent reports of tick-caused otitis externa and otoacariasis from South Africa (Huchzermeyer, 2002; Naude et al., 2001; van der Merwe et al., 2002 and Chile (Burchard et al., 1984). Intra-aural foreign bodies such as ticks can perforate or damage the eardrum; cause otitis media, luxation of the incudomalleal or incudostapedial joints, and dislocation of the stapes from the footplate (Senturia et al., 1980); and damage the outer ear canal (Gökdoğan et al., 2016; Indudharan et al., 1999).

The bite of the *H. marginatum* species is reportedly a risk factor for the development of facial paralysis (Campbell, 1977; Doğan et al., 2012; Dworkin et al., 1999; Engin et al., 2006; Gothe et al., 1979; Grattan-Smith et al., 1997; Gurbuz et al., 2010; Patil et al., 2012; Pearn, 1977).

## 7. Removal of ticks

Ticks are typically resistant to most of the agents used to kill the intra-aural foreign body. Usually, 4% or 10%

lidocaine is ideal as it paralyzes the ticks and has a mild anesthetic effect over the tick bite area in the ear canal skin. Using of oil of turpentine may cause severe local damage (Patrick et al., 2001). Foreign bodies were reportedly removed under general anesthesia in some cases, mostly involving children who are typically not amenable to examinations or interventions.

Three kinds of reagents were studied for tick removal. In each of the 30 cases, 4% xylocaine was used with equal quantity of turpentine and 4% xylocaine solution. In 64 cases, 10% xylocaine spray was used. For 2 cases, general anesthesia was used as one patient was uncooperative and the other had psychological complications. Regardless of the agent used, all patients were made to lie with the affected ear facing upward for approximately 15–20 min. The tick was removed from the ear canal by using removal forceps. Fecal matter of the tick was removed by syringing the contents of the ear canal. Antibiotic eardrops were administered to patients who had ear canal inflammation. After tick removal, one patient developed suppurative otitis media, which required treatment with oral antibiotics. No patient had eardrum damage, perforation, or facial palsy (Somayaji and Rajeshwari, 2007).

Mechanical methods of tick removal, instead of using chemical agents, have also been suggested. (Due et al., 2013). Removal of ticks was mostly carried out with forceps (Gökdoğan et al., 2016; Gorgulu et al., 2012; Gurbuz et al., 2010; Ozdas et al., 2012; Keleş et al., 2010).

Otoendoscopy or otomicroscopy was used in every patient after the removal of the ticks and control was made with microscopic evaluation. Type analysis was not carried out during hospital admission. Ticks removed from the ear canal of patients were preserved in alcohol and collected in separate, labeled vials (Dilrukshi et al., 2004; Gökdoğan et al., 2016). Ticks were stored for both potential diseases that can improve by time and for the analysis of potential host diseases. Any complications such as outer ear canal damage or eardrum injury to patients with ear canal ticks were recorded. In 3 patients in whom the tick was removed from the eardrum, there were signs of extremely small tympanic membrane perforations. One patient had permanent eardrum perforation while two of the patients' perforations self-healed over time. No complications were observed in patients who had the tick removed from the middle ear. An infectious disease consultation was deemed appropriate in all cases as a measure to prevent host diseases. Patients were screened particularly for Crimean-Congo hemorrhagic fever and tularemia. No findings or symptoms of these diseases were observed, although tularemia is not rare in this region. Even Crimean-Congo hemorrhagic fever was not observed in their town in any patient checked for both diseases (Gökdoğan et al., 2016).

## 8. Conclusion

Ticks as the intra-aural foreign bodies in the ear canal were found particularly in patients in the rural regions. In the interest of public health and safety, it is important to refer all encountered cases of patients with bodily ticks to the

appropriate treatment facility for further screening and clinical understanding.

### Conflict of interest

None.

### References

- Aktaş, M., 2008. Kene biyolojisi. In: II. Türkiye Zoonotik Hastalıklar Sempozyumu: Kene Kaynaklı Enfeksiyonlar (27–28 Kasım 2008, Ankara) Bildiri Kitabı. Medisan Yayınevi, Ankara, pp. 21–25.
- Al-Arfaj, A.M., Mullen, G.R., Rashad, R., et al., 2007. A human case of otocariasis involving a histiostomatid mite (Acari: Histiostomidae). *Am. J. Trop. Med. Hyg.* 76, 967–971.
- Al-Juboori, A.N., 2013. Aural foreign bodies: descriptive study of 224 patients in Al-Fallujah general hospital. *Iraq. Int. J. Otolaryngol.* 2013, 401289.
- Balbani, A.P., Sanchez, T.G., Butugan, O., et al., 1998. Ear and nose foreign body removal in children. *Int. J. Pediatr. Otorhinolaryngol.* 46, 37–42.
- Bates, P.G., 1996. Epidemiology of subclinical ovine psoroptic otocariasis in Great Britain. *Vet. Rec.* 138, 388–393.
- Bente, D.A., Forrester, N.L., Watts, D.M., et al., 2013. Crimean-Congo hemorrhagic fever: history, epidemiology, pathogenesis, clinical syndrome and genetic diversity. *Antivir. Res.* 100, 159–189.
- Bratton, R.L., Corey, G.R., 2005. Tick-borne disease. *Am. Fam. Physician* 71, 2323–2330.
- Bulman, G.M., Walker, J.B., 1979. A previously unrecorded feeding site on cattle for the immature stages of the spinose ear tick, *Otobius megnini* (Dugès, 1844). *J. South Afr. Vet. Assoc.* 50, 107.
- Burchard, L., Larenas, N., Ramos, P., 1984. Human otocariasis caused by *Otobius megnini* in Calama, Chile. *Bol. Chil. Parasitol.* 39, 15–16.
- Bursali, A., Keskin, A., Tekin, S., 2012. A review of the ticks (Acari: Ixodidae) of Turkey: species diversity, hosts and geographical distribution. *Exp. Appl. Acarol.* 57, 91–104.
- Campbell, N.A., 1977. An unusual case of facial paralysis. *Cent. Afr. J. Med.* 23, 141–145.
- Cho, J.H., Kim, J.B., Cho, C.S., Huh, S., Ree, H., 1999. An infestation of the mite *Sancassania berlessei* (Acari: Acaridae) in the external auditory canal of a Korean man. *J. Parasitol.* 85, 133–134.
- Dalgic, A., Kandogan, T., Kavak, H., Ari, A., Erkan, N., Ozuor, M.Z., 2010. Ticks in the external auditory canal. *Hong Kong J. Emerg. Med.* 17, 2.
- Dantas-Torres, 2007. Rocky mountain spotted fever. *Lancet Infect. Dis.* 7, 724–732.
- Degiorgis, M.P., Segerstad, C.H., Christensson, B., Morner, T., 2001. *Otodectes* otocariasis in free-ranging Eurasian lynx in Sweden. *J. Wildl. Dis.* 37, 626–629.
- Delgado, C., Rosegrant, M., Steinfeld, H., et al., 1999. *Livestock to 2020: the Next Food Revolution* (Nairobi, Kenya).
- Diab, F.M., El-Kady, G.A., Shoukry, A., 2001. Bionomics of ticks collected from Sinai Peninsula: 2- abundance, attachment sites, and density estimators of ticks infesting Arabian camels. *J. Egypt Soc. Parasitol.* 31, 479–489.
- Dilrukshi, P.R., Yasawardene, A.D., Amerasinghe, P.H., et al., 2004. Human otocariasis: a retrospective study from an area of Sri Lanka. *Trans. R. Soc. Trop. Med. Hyg.* 98, 489–495.
- Doğan, M., Devge, Cem, Tanrıover, O., Pata, Y.S., Sonmezoglu, M., 2012. Facial nerve paralysis due to intra-aural *Hyalomma* tick infestation. *Türk. Parazit. Derg.* 36 (4), 254–257.
- Due, C., Fox, W., Medlock, J.M., et al., 2013. Tick bite prevention and tick removal. *BMJ* 347, 7123.
- Dworkin, M.S., Shoemaker, P.C., Anderson, D.E., 1999. Tick paralysis: 33 human cases in Washington State, 1946–1996. *Clin. Infect. Dis.* 29, 1435–1439.
- Eads, R.B., Campos, E.G., 1984. Human parasitism by *Otobius megnini* (Acari: Argasidae) in New Mexico, USA. *J. Med. Entol.* 21, 244.
- Engelen, M.A., Anthonissen, E., 2000. Efficacy of non-acaricidal containing otic preparations in the treatment of otocariasis in dogs and cats. *Vet. Rec.* 147, 567–569.
- Engin, A., Elaldi, N., Bolayir, E., Dokmetas, I., Bakir, M., 2006. Tick paralysis with atypical presentation: isolated, reversible involvement of the upper trunk of brachial plexus. *Emerg. Med. J.* 23, e42.
- Erenler, A.K., Kulaksız, F., Ulger, H., et al., 2014. Characteristics of patients admitted to the emergency department due to tick bite. *Trop. Doct.* 44, 86–88.
- Foley, J.E., Nieto, N.C., 2010. Tularemia. *Vet. Microbiol.* 140, 332–338.
- Gökdoğan, O., Çakabay, T., Baran, H., et al., 2016 July–August. Otocariasis: demographic and clinical outcomes of patients with ticks in the ear canal. *Braz. J. Otorhinolaryngol.* 82 (4), 416–421. <http://dx.doi.org/10.1016/j.bjorl.2015.07.018> pii: S1808–8694(15)00191-3.
- Gorgulu, O., Ozdemir, S., Selcuk, T., Canbolat, E.P., Akbaş, Y., 2012. Dış kulak yolunda kene ısırıklarında tedavi. *Türk. Klin. Tıp Bilim. Derg.* 32 (3), 827–831.
- Gothe, R., Kunze, K., Hoogstraal, H., 1979. The mechanisms of pathogenicity in the tick paralyses. *J. Med. Entomol.* 16, 357–369.
- Grattan-Smith, P.J., Morris, J.G., Johnston, H.M., Yiannikas, C., Malik, R., Russell, R., et al., 1997. Clinical and neurophysiological features of tick paralysis. *Brain* 120, 1975–1987.
- Gurbuz, M.K., Erdoğan, M., Doğan, N., Birdane, L., Cingi, C., Cingi, E., 2010. Olgu sunumu: kene ısırması ile oluşan izole fasiyal paralizi. *Türk. Parazit. Derg.* 34 (1), 61–64.
- Heim, S.W., Maughan, K.L., 2007. Foreign bodies in the ear, nose, and throat. *Am. Fam. Physician* 76, 1185–1189.
- Hoogstraal, H., 1956. *African Ixodoidea, Vol. I. Ticks of the Sudan with Special Reference to Equatoria Province and Bith Preliminary Reviews of the General Boophilus, Margaropus and Hyalomma.* Department of the Navy, Bureau of Medicine and Surgery, United States Government Printing Office, Washington D.C.
- Horak, I.G., Camicas, J.L., Keirans, J.E., 2002. The Argasidae, Ixodidae and Nuttalliellidae (Acari: Ixodida) a world list of valid tick names. *Exp. Appl. Acarol.* 28, 27–54.
- Huchzermeyer, H.F., 2002. Another human ear tick case. *J. South Afr. Vet. Assoc.* 73, 2.
- Induharan, R., Ahamed, M., Ho, T.M., et al., 1999. Human otocariasis. *Ann. Trop. Med. Parasitol.* 93, 163–167.
- Jellison, W.L., Bell, E.J., Huebner, R.J., Parker, R.R., Welsh, H.H., 1948. Q fever studies in southern California. IV. Occurrence of *Coxiella burnetii* in the spinose ear tick, *Otobius megnini*. *Public Health Rep.* 63, 1483–1489.
- Keleş, E., Karlıdağ, T., Işık, O., Saki, C.E., 2010. Dış kulak kanalında kene: olgu sunumu. *Fırat Tıp Derg.* 15 (2), 110–112.
- Kettle, D.S., 1995. *Medical and Veterinary Entomology*, second ed. CAB International, Wallingford, UK.
- Lasecka, L., Baron, M.D., 2014. The molecular biology of nairoviruses, an emerging group of tick-borne arboviruses. *Arch. Virol.* 159, 1249–1265.
- Madigan, J.E., Valberg, S.J., Ragle, C., Moody, J.L., 1995. Muscle spasms associated with ear tick (*Otobius megnini*) infestations in five horses. *J. Am. Vet. Med. Assoc.* 207, 74–76.
- Mastropaolo, M., Nava, S., Guglielmone, A.A., et al., 2011. Developmental changes in salivary glands of nymphs and adults of the spinose ear tick *Otobius megnini*. *J. Parasitol.* 97, 535–537.
- Naude, T.W., Heyne, H., van der Merwe, et al., 2001. Spinose ear tick, *Otobius megnini* (Duges, 1884) as the cause of an incident of painful otitis externa in humans. *J. South Afr. Vet. Assoc.* 72, 118–119.
- Nava, S., Mangold, J., Guglielmone, A.A., 2009. Field and laboratory studies in a neotropical population of the spinose ear tick, *Otobius megnini*. *Med. Vet. Entomol.* 23, 1–5.
- Ozdas, T., Karakus, F., Ozcan, M., Ozdogan, F., Koseoglu, S., Dere, H., 2012. Tinnutusa neden olan dış kulak yolunda kene: olgu sunumu. *KBB ve BBC Derg.* 20 (1), 41–44.
- Paleri, V., Ruckley, R.W., 2001. Recurrent infestation of the mastoid cavity with *Caloglyphus berlessei*: an occupational hazard. *J. Laryngol. Otol.* 115, 652–653.

- Papazahariadou, M.G., Saridomichelakis, M.N., Koutinas, A.F., et al., 2003. Tick infestation of dogs in Thessaloniki, northern Greece. *Med. Vet. Entomol.* 17, 110–113.
- Parish, H.E., 1949. Recent studies on life history and habits of the ear tick. *J. Parasitol.* 42, 416–419.
- Patil, M.M., Walikar, B.N., Kalyanshetkar, S.S., Patil, S.V., 2012. Tick induced facial palsy. *Indian Pediatr.* 49, 57–58.
- Patrick, J.A., Anis, B.S., Angela, B.S., 2001. Insecticidal activity of common reagents for insect foreign bodies of the ear. *Laryngoscope* 111 (1), 15–20.
- Peacock, E.B., 1958. Tick paralysis or poliomyelitis. *South Afr. Med. J.* 32, 201–202.
- Pearn, J., 1977. Neuromuscular paralysis caused by tick envenomation. *J. Neurol. Sci.* 34, 37–42.
- Perry, B.D., Randolph, T.F., Mcdermott, J.J., et al., 2002. Investing in Animal Health Research to Alleviate Poverty. International Livestock Research Institute, Nairobi, Kenya.
- Rossiter, A., 1997. Occupational otitis externa in chicken catchers. *J. Laryngol. Otol.* 111, 366–367.
- Schwan, T.G., Corwin, M.D., Brown, S.J., 1992. *Argas monolakensis*, species (Acari: Ixodidae Argasidae), parasite of California gulls islands in, Mono Lake, California: description, biology, and life cycle. *J. Med. Entomol.* 29, 78–97.
- Senturia, B.H., Marcus, M.D., Lucente, F.E., 1980. Diseases of the external ear. In: *Otologic Dermatological Manual*, second ed. Grune & Stratton, New York, pp. 108–109.
- Somayaji, K.S., Rajeshwari, A., 2007. Human otoacariasis. *Indian J. Otolaryngol. Head. Neck Surg.* 59 (3), 237–239.
- Van de Heyning, J., Thienpont, D., 1977. Otitis externa in man caused by the mite *Otodectes cynotis*. *Laryngoscope* 87, 1938–1941.
- van der Merwe, I.R., Benic, M.J., Naude, et al., 2002. Spinose ear tick as the cause of an incident of painful otitis externa. *S. Afr. Med. J.* 92, 712–713.
- Vatansever, Z., 2008. Vektor kenelerin ekolojisi. In: *II. Türkiye Zoonotik Hastalıklar Sempozyumu: Kene Kaynaklı Enfeksiyonlar (27–28 Kasım 2008, Ankara) Bildiri Kitabı*. Medisan Yayınevi, Ankara, pp. 27–36.
- Wallace, M.A., 2001. Spinose ear tick (*Otobius megnini*) infestation in Llamas in North Carolina. *Pediatrics* 108, 1367–1370.
- Yeruham, I., Hadani, A., Rosen, S., 1985. Psoroptic ear mange (*Psoroptes cuniculi*, Delafon, 1859) in domestic and wild ruminants in Israel. *Vet. Parasitol.* 17, 349–353.
- Yılmaz, G.R., Buzgan, T., Irmak, H., et al., 2009. The epidemiology of Crimean-congo hemorrhagic fever in Turkey, 2002–2007. *Int. J. Infect. Dis.* 13, 380–386.