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Infectious and non-infectious eye affections in camel : A review

Muna Tawfeeq Abd[1*], Ghasaq Sami Mshary[2], Sarah A. Al_Khafaji [3], Iman K. M. Alabadi[4], Mohenned A. Alsaadawi[5]

[1]*Department of Internal and Preventive Medicine/ Veterinary Medicine College, Al-Muthanna University, Iraq. https://orcid.org/0000-0003-4024-9487. munatawfeeq87@mu.edu.iq

[2] Department of physiology and Pharmacology/ Veterinary Medicine College, Al-Muthanna University, Iraq. https://orcid.org/0000-0002-8770-7468. ghassaq51@mu.edu.iq

[3] Department of Microbiology / Veterinary Medicine College, Al-Muthanna University, Iraq. sarahbiology89@mu.edu.iq

[4] Department of pathology and poultry/ Veterinary Medicine College, Al-Muthanna University, Iraq. imankmalabadi@mu.edu.iq

[5] Department of Microbiology / Veterinary Medicine College, Al-Muthanna University, Iraq. https://orcid.org/0000-0003-1087-015X . mohenned.hemza@mu.edu.iq

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***Corresponding author:**
Muna Tawfeeq Abd: Email address: munatawfeeq87@mu.edu.iq

Abstract

Camel environment can be varied as this animal is a well-adapted in arid and semi-arid areas and contributing greatly to the food security of pastoralist. This kind of livestock animal can resist different illnesses. However, a lot of research discussed the increasingly sensitivity to a wide range of eye diseases. This review will explain the ophthalmic diseases either that being infectious and non- infectious. The bacterial pathogens are responsible of the most prevalent pathogenic infections. Other infectious pathogens of eye diseases could be parasitic, fungal or viral. The non-infectious ophthalmic diseases relate mainly to laceration of cornea and eyelids, ophthalmitis, rupture or absent of eyeballs, uveitis, corneal opacity (cataract), conjunctivitis, keratitis, Blepharitis, glaucoma, entropion, corneal neoplasm, dacryocystitis and staphyloma. The research about eye infections in camels need more deepest and accurate studies focusing on detection of etiology, diagnosis and treatment since these diseases have serious effects and could be zoonotic.

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Introduction

The dromedary camel (*Camelus dromedaries*), often known as the Arabian camel, is the largest chorionic mammal and a pseudo-rumen in the world. It belongs to the Camelidae

family of animals (Fowler,1998). A large number of single-humped camels were bred in difficult environments hot (high temperatures occasionally exceeding 50 degrees Celsius), dry (near-zero relative humidity), and dusty (sand storms) summer seasons (Chen *et al.*, 2011) in different locations in Central Asia, East and North Africa. Furthermore, the camel tear contains several specific components that help to stabilize the tear film in hostile environments (Chen *et al.,* 2011). The dromedary has been brought up for their milk, meat, skins, racing, and tourism importance (Marzok & El-Khodery, 2015). These animals could be highly resistant to diseases and dry conditions (Sabri, 2018). However, Camels can be susceptible to a variety of infectious and noninfectious agents that lead to induce different diseases (Fowler, 2010).

Camel Eye Anatomy and Structure

The eye of camels appeared to be spherical in shape and smaller than that of a cow or a horse (El-Tookhy *et al*., 2012). The camel's eyeball measures 4.5 cm in length and 4.0 cm in width (Abuelhassan, 2007). When compared to other domestic animals, there are significant differences in the general anatomy of eye; these differences could be structural changes to suit the harsh desert circumstances. The eyes of the dromedary are enormous, with thick, double-layered eyelashes and bushy eyebrows, and they have keen vision. Their orbits are round, equidistant, totally osseous, and protrude laterally significantly (Noor & El-bably, 2018). In this study, the eyeball's internal anatomy is similar to that of other domestic animals (Rahmoun *et al*., 2020).
The cornea was thicker in the center than the periphery, the lens diameter was more than the thickness, and the depth of the vitreous body was less than the axial length, according to biometrics. In the arid and sandy environment, the camel's long, robust, and densely organized eyelashes at the edges of the eyelids are crucial. A broad conjunctival semi-lunar fold stretching from the third eyelid of a camel up to 3 cm along the anterior surface of the eyeball from the medial canthus (Al-Ramadan & Ali, 2012).

Infectious eye affections

According to our knowledge a number of parasitic, bacterial, fungal, viral, and traumatic eye infections have been described in previous studies. 19.6% of dromedary camels were infected with ocular diseases (Ranjan *et al*., 2016). Ranjan and his group mentioned several notes that could be obviously showed the ocular problems in camel. The most common problem was corneal injury/ulceration, which was followed by acute conjunctivitis, unclassified eye ball problem, blepharitis, chronic conjunctivitis, and keratitis. The infections tend to be affected by the gender as the females were more susceptible. The age group 10 years and older, showed the highest prevalence of ocular infections followed by those aged 5 to 10 years and those aged less than 5 years. The researchers concluded that the occurrence of ocular abnormalities in camels appeared to rise with the animal's age (Ranjan *et al*., 2016).

Bacterial eye affections

Numerous pathogenic bacteria can enter the eye via the exterior surface, neighboring orbital tissue, or the bloodstream. It is known that Primary infections with blood-borne bacteria can be significant, however, secondary infections could also be having that big

kind of importance such as those that arise as a result of unintentional or surgical complications. The lens and vitreous of the eye are particularly sensitive are highly vascularized and protein-rich constructions, making them suitable environment for the growth of bacteria (Lee, 2001).

Bireir (2008) found that the bacterial infections isolated from camel eyes with conjunctivitis were distributed between 60% gram-positive bacteria (35% *Staphylococcus spp*, 20% *Corynebacterium*, and 5% *Streptococcus spp*) while 40% were Gram-negative bacteria (20% *Neisseria spp*, 15%*Moraxella spp*, and 5% *Enterobacter spp*). On the other hand, Tejedor. *et al.* (2010) were showed that *Moraxella bovis* cause keratoconjunctivitis (IKC) in Camelus dromedaries which affects both young and adult animals in both sexes equally. Moreover, many types of bacteria were isolated from normal eyes of camels which were as follows: *Bacillus spp* (84%), *E. coli* (72%), *Staph. arues* (52%), *Staph. epidermdis* (32%), *Strept. faecalis* (16%), *Staph. saprophyticus* (16%), *Coryn. xerosis* (12%), *Proteus vulgaris* (8%), *Coryn. tuberculosis* (8%), *Coryn. renale*(4%).While other types of bacteria, such as *Coryn. ulceran*, *A.pyogens*, *Strept.pyogens*, *Branhamella* (*Nisseria*) *catarrhalis*, *Moraxella lacunata*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Pseudomonas aeruginosa* were found in infected camels eyes (Fahmy.,*et al*., 2003).

Bacterial eye infections can be treated with variety types of antibiotics such as chloramphenicol, gentamycin, tetracycline, streptomycin, cloxacillin ampicillin, erythromycin, penicillin (Bireir ,2008).

Parasitic eye affections

Arthropods and tick infections are the most common type of ectoparasitic infestation of eyes. The symptoms of arthropod infestation vary in affected camels, such as blepharitis, which manifests as swollen eyelids, blepharospasm, and epiphora, as well as chemosis of the conjunctiva (Hegazy *et al*., 2004; Ranjan *et al*., 2016). Tick infestation (*Hyaloma* species) was observed around the periphery of the lower eyelid in several cases (Hegazy *et al*.,2004). Two species of *Hyalomma* Spp. and *Boophilus Spp* were recorded in Iraqi *Camelus dromedaries* (83% and 16.6% respectively) which isolated from thickened eyelids (Hussein & AL- Fatlawi.,2009). The recorded clinical signs were thickening eyelids, redness, edema, blepharospasm, and epiphora due to tick infestation extending around the periphery of the lower and/or upper eyelid, and the damage reaches near the eyeball leading to crust and erosion of the eyelid. In addition, there are Hyperemia, swelling, and pain in the upper eyelid margin, termed as hordeolum, occurred in one case (stye) (Abdella *et al*., 2018). Sarcoptic mite in the skin exhibited alopecia, pruritis, and hemorrhagic scabs along the upper eyelid. The severe irritation by parasitic infestation led to traumatic injury by the animal itself in an effort to reduce the discomfort (Hegazy *et al*.,2004). *Sarcoptic* and *Psoroptic* mange cause thickening and crust in upper eyelid (Abdella *et al*., 2018). The topical treatment's effectiveness has been reduced due to hyperkeratosis and acanthus, which needs to treat the animal parenterally (Hegazy *et al*.,2004).

The Infections with Thelazia leesi (eye worm) are unusual in camels (Parsani *et al.,*2008, Hegazy *et al*., 2004). No clinical signs of thelazia or filarial were recorded. It has been reviewed that Thelazia was recorded in Tehran when 400 eyeballs isolated from slaughtered dromedaries were examined in Iranian camels (Sazmand & Joachim, 2017). The number of worms per affected eye ranged from three to ten. Cutaneous periocular

Habronema infection was recorded in a 6-year-old dromedary camel suffering from a non-healing, itchy, ulcerative fibrotic plaque on the medial canthus. Histological examination showed nematode larvae within eosinophilic granulomas. The lesion was repeatedly debrided, and treated with ivermectin, anti-inflammatory medications, and topical antibiotics. A specifically designed mask with goggles was used to protect the eye from injury by the camel itself (Myers *et al*.,2010)

Fungal eye affections

Fungi are abundant in the eyes of animals, and they can cause disease. Corneal fungal infections can be occurred by injury to the epithelial layer or by opportunistic fungus accessing the corneal collagen-rich stroma (Rudi, 2019). *Cladosporium* (38.2%) and *Candida krusei* (34.9%) were the most common fungal isolates in the eye of camels from January to May 2009 in the eyes and noses of healthy dromedary camels (Khosravi *et al.,*2009). Another study has been conducted on the detection of the fungal flora of camel's eye Conjunctiva in healthy camels. The samples were taken from 50 camels to evaluate the fungal infections in eyes which showed that seven genera and three species of fungi were isolated including *Aspergillus fumigatus* (22%), *Penicillium* (18%), *Aspergillus flavus* (16%), *Mucor* (12%), *Aspergillus niger* and *Rhizopus* (6%), *Cladosporium* (4%) and *Absidia* and *Trichophyton* (2%) (Rudi.,2019). *Candida albicans* has been implicated as a cause of eye infection in addition to skin, gastrointestinal tract, genital tract, ear infections, systemic candidiasis, and mastitis in camels (Hussein, 2021).

Viral eye affections

Viral infections in camels need more explanation and research. Betaretrovirus infections in dromedary camels was documented (Hemida & Alnaeem, 2022) who described noticeable warts and crusts around the eyes and the nostrils. The surgical removal was conducted to treat these wart-like or mass tumors.
Camel pox; caused by *Orthopoxvirus cameli* (members of the Orthopoxvirus genus in the Poxviridae family), showed pathogenic lesions range from unnoticeable and mild local infections restricted to the skin to moderate and severe systemic illnesses, presumably reflecting changes in camel pox strains or animal immunological state (OIE, 2018). The clinical signs include fever, increase in heart rate and respiratory rate, ataxia, loss of appetite, mucopurulent discharge, salivation, lacrimation enlargement of lymph nodes. The typical skin lesions (papules or vesicles, blisters, sores and scars); appeared firstly on the head, eyelids, nostrils and the margins of the ears and then spread onto every part of the body with difficulties in suckling and eating (Abdo el Motalab *et al.,* 2015; Gatie, 2016; OIE, 2018). Corneal opacity and blindness have been reported in camels after 8-10 days of Camel pox infection without any improvement in the blindness after application of therapy (Kachhawaha *et al*.,2014). Secondary bacterial infections and pox lesions on eyelids can also result in blindness (Abdo el Motalab *et al*., 2015).
Contagious ecthyma also known as orf caused by *parapoxvirus* was showed in camels (Mombeni *et al*., 2013; Narnaware *et al*., 2013; Barani *et al*., 2015; Oryan *et al*., 2017). The disease characterized by fever, edema on the face, developing of pustular skin lesion on lips, nose, face, eyes and neck area (Nagarajan *et al*., 2010; Narnaware *et al.,* 2013), emaciation, loss of appetite, decreased rumination, Conjunctivitis and epiphora were

documented (Barani *et al*., 2015) and bad mouth smell (Nagarajan *et al.,* 2010; Mombeni *et al*., 2013).
Other viruses that were recorded were peste des petits ruminants viruses (PPRV), which belong to the Morbillivirus, Genus, member of the family Paramyxoviridae. Although PPR is mainly a disease of small ruminants, it has been described in other ruminants, including camels (Khalafalla *et al*., 2010). The main symptoms of the disease were fever, loss of body condition and general weakness, diarrhea, conjunctivitis in addition to ocular and nasal discharges (Omani *et al*., 2019). Also, it has been reported sudden death, ulcerative keratitis, and conjunctivitis, yellowish diarrhea, oral erosion, and ecthyma like lesions, enlargement of lymph node, dermatitis, pneumonia and respiratory distress, severe dehydration as a major clinical sign (Zakian *et al*., 2016).
Papillomatosis has been reported in a 15-year-old dromedary male with a corneal papilloma tumor in the left eye accompanies with chronic severe keratoconjunctivitis (Kılıç *et al.,* 2010). Two outbreaks of papillomatosis have been recorded in Saudi Arabia between 2013 and 2015, the disease impacted both young and adult animals, and it happened at the same time as a demodectic mange outbreak. Papillomatosis appeared as dark-colored papillary masses resembled cauliflowers and were about 2 cm in diameter particularly on lips, eyes, nose, and mandible (Khalafalla *et al.,*2017).

Non-infectious ocular problem

Camels are susceptible to a number of ophthalmic illnesses, including corneal and eyelid laceration, panophthalmos, corneal opacity, and descemetocele (Gahlot, 2012). Camels, like most other livestock, can suffer from ocular affections, which can be debilitating and have a significant impact on output. Damage to the eye can be serious enough to result in blindness on rare occasions (Gilger, 2017).
The age group of 6-10 years were found to have a significant risk of blindness (Abdella *et al*., 2019). The most common ocular disorders seen in camels were trauma-related problems. The winter season has the highest frequency of eye problems, followed by summer and rainy seasons (El-Tookhy & Tharwat,2012). Camels have been observed to have ocular anomalies that necessitate ultrasonographic evaluation, such as congenital cataract and persisting hyaloid artery (Moore *et al*., 1999). Ultrasonography can also be used to confirm ophthalmoscopic findings like retinal detachment or early cataracts (Whitcomb, 2002).

Eye injures

Camels can expose to eye injury more frequently because they frequently feed on thorny trees and bushes. The majority of eye disorders seen in dromedary camels were traumatic, with one or more ocular tissues being involved (El-Tookhy & Tharwat 2012). The most prevalent eye disorders presented to veterinarians by camelids, according to Gionfriddo (2010), are trauma-related diseases. Trauma with foreign objects was the leading cause of ocular diseases and the cause of injury was unknown in 36.58 %, whereas trauma (thorny bushes, stick, plant juices, nails, and camel cart fittings) and systemic infections were responsible for 57.07 % and 6.34 % of cases, respectively (Kumar *et al*. 2016). Moreover, the majority of eye injuries shown in dromedary camels were traumatic, involving one or more ocular tissues.

Corneal wounds

Penetrating corneal wounds

The most prevalent noninfectious ocular problem in camels is traumatic injury to the eyeball, particularly the cornea (El-Tookhy & Tharwat 2012) also, El-Tookhy (2015) has compiled a list of the most common eye disorders in camels were trauma-related diseases as well as penetrating corneal injuries (23%). Sharp objects cause inadvertent penetrating ocular wounds in dromedaries. The severity of the damage ranged from a simple corneal cut to complete sight loss due to problems involving other ocular tissues such as lens dislocation, vitreal prolapse, vitreal hemorrhage, and retinal detachment (Tharwat & El-Tookhy ,2021). Fahmy *et al.*, (2003) has recorded perforating wound with iris prolapse in camels and the prolapsed iris was visible as a little sparkling protrusion through the corneal wound and one of the repercussions of an untreated corneal wound is panophthalmitis. According to Siddiqui and Telfah (2010), iris prolapse through the cornea is caused by a sharp item, such as a thorn, stick, or barbed wire, perforating the cornea and if the injury is left untreated for 2 to 3 days, it will result in a loss of aqueous humor, corneal edema, and opacity. Panophthalmia may develop as a result of untreated cases that have gone unnoticed for a long time. Hegazy *et al.,* (2004) has demonstrated same observation. Corneal ulceration or injury was the most common ocular issue, with degrees of injury ranging from partial to total perforation of the cornea. Corneal oedema and hyphema were observed in moderate cases, but in severe cases, the iris protruded through the cornea as a tiny fleshy congested mass. The vision was completely lost in this form (Ranjan *et al.*,2016). In camels, a penetrating wound in the eyeball happened as a result of external trauma, such as a thorn or a wooden rod. Xylazine sedation, auriculopalpebral nerve block, and retrobulbar anesthesia were used in these cases. To do the enucleation, the eyeball was detached from the tenon's capsule (Gharu & Gahlot, 2015).

Lacerated corneal wound

Occasionally, a lacerated wound across the cornea and sclera was observed. Photophobia, blepharospasm, and extreme lacrimation are all symptoms of this condition, which is usually unilateral. Corneal lacerations were healed with surgical therapy and xylazine sedation. Antibacterial drugs were sub-conjunctively administered for 3-5 days, and eye drops were instilled. Antibiotics containing an anti-inflammatory drug were administered (Gharu & Gahlot ,2015). Comparable observations have been made by Gahlot (2000), Yeruh (2002), Dudi & Gahlot (2003), Denis (2004), and Bishnoi & Gahlot (2004).

Lacerated wound of eyelid

Because male camels are kept for breeding purposes, the incidence of wound affections of the head and neck region was observed to be higher in males than in females. Lacerations in camels have been described as a result of a sharp object or fixture grabbing the eyelid or its edges, such as hooks, nails, or metallic objects from the camel cart. The lacerated area of the lid, or the sliced edges of the lid, were curled downward. Under xylazine anesthesia, the incision margins were sutured with silk No. 1 and healing

took 10-15 days. Within 48 hours, the oedema and inflammation in the eyelid had significantly decreased. Topical gentamicin eye drops were taken for 5 days after surgery, and the eye was covered with a bandage to minimize self-inflicted injuries and contaminating. To avoid subsequent infection and inflammation, antibiotics and anti-inflammatory medications were given intravenously (Gharu & Gahlot, 2015).

Corneal opacity (cataract)

Change in lens color to dark blue and corneal opacity with total deficient response of pupil and eyelids, as well as loose vision in affected eyes, were the clinical symptoms of corneal opacity (Abdella *et al.,* 2018). According to El-Tookhy & Tharwat (2012), cataracts can be bilateral or unilateral, and the lens can show as a hyperechoic mass in situ or displaced, with a clearly defined thickened echogenic lens capsule with or without irregular edges. Kumar *et al.* (2016) mentioned that corneal opacity is the most common. El-Tookhy (2015) found that cataracts were present in just 16 % of the observations. When corneal opacity inhibits visibility of the retrobulbar area, ocular ultrasonography allows visualization of inner ocular structures

Glaucoma

A condition of increased intra ocular pressure causing gradual loss of sight. Tensed cornea looked to protrude out of the orbit, according to Hegazy *et al.*, (2004), the eyelids had not shown any signs of alteration and the cornea had lost its clarity and was edematous. Also exhibit that despite the presence of glaucoma lesions, the condition was not clinically seen due to problems in assessing intraocular pressure with the available tools. According to Abdella *et al.*, (2018) glaucoma is defined by redness of the eye, massive vascular injection of the episclera, mild dilated pupil, projecting eye ball and conspicuous (Buphthalmia), also a change in the optic nerve when inspected with an ophthalmoscope. These findings coincide with those of El-Tookhy & Tharwat (2012) clinically, glaucoma was detected in a camel with buphthalmia, dilated pupil, chemosis, and blindness. Glaucoma was observed in a smaller percentage of cases (2%) according to El-Tookhy (2015). These findings are consistent with those of Gionfriddo *et al.* (1997), who found that glaucoma was a relatively uncommon disease in the cases studied. Other camelids, such as llamas, have shown similar results. Microscopical examination of the cornea revealed that the epithelial layer was abnormally projected into the underlying stroma (Hegazy& Shamaa 2004).

Ruptured eyeball

According to Abdella *et al.,* (2018), rupture of the eyeballs was observed without any symptoms of infection or unusual discharges.

Congenital ocular anomalies

Moore *et al.* (1999) has demonstrated bilateral corneal dermoids, incomplete congenital cataracts and a left persistent hyaloid artery (PHA) in dromedary camel. According to Kumar *et al.* (2016), congenital and acquired ocular affect were recorded and acquired affect were identified more frequently. Descemetocele and subconjunctival hemorrhage

were the only congenital ocular abnormalities found during the retrospective investigation (Kumar *et al.*, 2016). A dermoid cyst is a rare non-neoplastic skin abnormality that can be congenital or hereditary (Adams *et al.,* 1983). It is marked by a focal duplication of the entire dermatologic structure, including skin and associated structures (Freitas *et al.,* 2005), as well as the presence of sebaceous and sudoriparous glands and/or hair follicles (Pereira *et al.,* 2008). The limbus, conjunctivae, and cornea are the most common sites for skin-like appendages (Gelatt, 1981). A dermoid cyst of the eye was described by El-Shafaey *et al.,* (2020), and the contents were a black fluid including hair. A dermoid cyst, according to Tmumen (2019), is a non-neoplastic, benign dermatologic injury that can surgically extracted on-field in a dromedary camel with a massive peduncle mass at the left eye, at the central corneal site, with copious lacrimation due to continuous irritation of avulsed large, edematous bleeding and constant irritation.

Eye tumors

El-Tookhy & Tharwat (2012) are recorded that unilateral intraocular tumor occur in 2% of cases and the tumor mass appears hyperechoic when compared to the surrounding ocular structure with well-defined boundaries. El-Tookhy & Tharwat (2012) also have shown that ultrasound can be effective in assessing camels with intraocular tumors. According to Abdella *et al.,* (2018), Staphyloma is characterized by a dark to black protrusion in the layer of the eye. Squamous cell carcinoma was also discovered surrounding the cornea. Lacrimation due to irritation and blepharospasm was seen, as well as blood expelled from the tumor and bloody discharge

Melanoma of the uvea

Hegazy *et al.*, (2004) has recorded uveal melanoma in camels and a black discoloration was visible on the eyeball. Numerous melanocyte accumulations were seen microscopically on the internal surface of the iris, ciliary body, and internal surface of the cornea. The camel was the first to be diagnosed with uveal melanoma.

Conclusions

In conclusion, this review article approved the incidence of various infectious and noninfectious ophthalmic diseases in camelids. The authors recommend more studies focusing on camelids eye diseases and its etiology, diagnosis and treatment since these diseases have serious effects and could be zoonotic.

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Conflict Of Interest

The authors declare there is no conflict of interest.

Author Contributions

All authors participated equally in writing this review article.

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