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Corneal dystrophies and degenerations in dogs

Dystrofie i degeneracje rogówki u psów

SUMMARY

The aim of the paper is the presentation of a not very well known group of corneal diseases in dogs: dystrophies and degenerations. The course of these diseases involves changes in the metabolism of corneal cells, which leads to the loss of corneal transparency and constitutes a threat to the process of vision. Both these groups present very similar clinical images and it is difficult to differentiate them accurately. Dystrophies are divided into: endothelial dystrophy, stromal dystrophy and epithelial dystrophy. Each of these forms has been described and characterized, and appropriate therapeutic procedures have been specified. Among degenerations lipid and calcium degenerations were distinguished. Their clinical forms were described, primary causes and therapeutic procedures were specified as well.

Key words: dog, corneal dystrophy, corneal degeneration

INTRODUCTION

The most significant feature of cornea is its transparency, which conditions passing of light rays into the eyeball. Clarity is maintained thanks to the specific structure of cornea with the dominating system of collagen fibers (the stroma of cornea), parallel, properly hydrated and nourished. The layers of anterior and posterior epithelium secure the conditions for corneal transparency. It happens so, because they are the places where the corneal metabolism is the most intensive and they contain numerous enzymes and nutritious, mineral and energetic compounds. When changes occur in the work of epithelia, there are disorders in the transport of nutritious substances and water. Then, the inappropriately hydrated or nourished cornea loses its ideal structure and, consequently, its transparency. Among the causes that lead to the loss of corneal transparency as a result of changes in its metabolism there are dystrophies and degenerations. These diseases are not very well known and they are rarely described. They are discussed jointly, because they are mutually connected by the similarity of visible changes, although in the physiological sense their causes distinctly differ [Slatter 1990, Furowicz 1991, Petersen-Jones and Crispin 1993, Clerc 1997].

Clinically, dystrophies and degenerations manifest themselves with very similar symptoms, which makes precise differentiation quite difficult. However, the correct diagnosis is of crucial importance from the prognostic and therapeutic points of view. It allows for the application of symptomatic treatment in cases of dystrophy, or taking up the therapy aimed at removal of the primary cause in cases of degeneration.

The objective of this paper is to outline a not very well known group of corneal diseases. Dystrophies and degenerations were presented with their ophthalmologic characterizations, clinical data, which are significant for differential diagnostics and kinds of the chosen therapy. No elaborations of this subject have been found in Polish literature.

DYSTROPHIES OF THE CORNEA

Corneal dystrophies are primary disorders of the cellular metabolism that lead to changes in the functioning and structure of normal corneal tissue. They can cause a loss of its transparency. In recent years the hereditary character of dystrophies has been emphasized, although changes do not start appearing at birth, but as late as in adulthood. Dystrophies are bilateral, more or less symmetrical and they are not related to systemic diseases. They can be constant, unchanged, or progressive. When they are progressive, they develop slowly, from the middle of cornea towards its periphery. The dystrophic changes are not accompanied by any inflammatory symptoms.

Dystrophies are classified on the basis of the depth of the layer affected by changes. That is why we distinguish the dystrophy of anterior epithelium, dystrophy of the stroma (proper substance of the cornea) and dystrophy of the posterior epithelium.

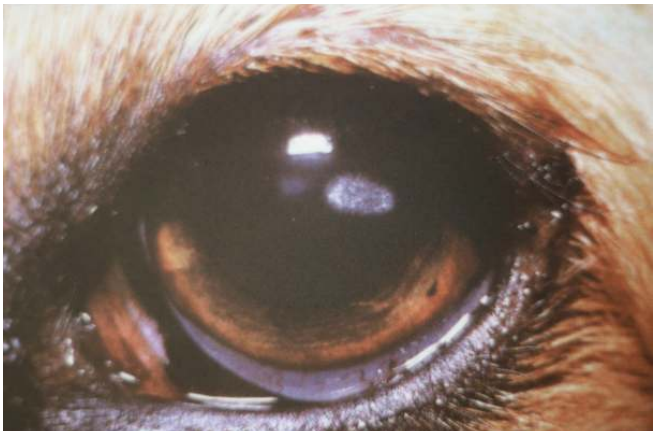
Dystrophy of the anterior epithelium of the cornea (epithelial dystrophy)

This change occurs relatively often in boxers and is known as „the recurring ulceration of the cornea, „the boxers' ulcer", „the recurring anterior corneal epithelium defect syndrome". It also occurs, though less often, in dogs of other breeds: poodles, spaniels, Nordic dogs and corgis. This change is of the nature of superficial, recurring ulcerations, but it is a dystrophy *ex definitione* and most often occurs in dogs aged 5–7 years [Gelatt i Samuelson 1982, Slatter 1990, Kiełbowicz 2004].

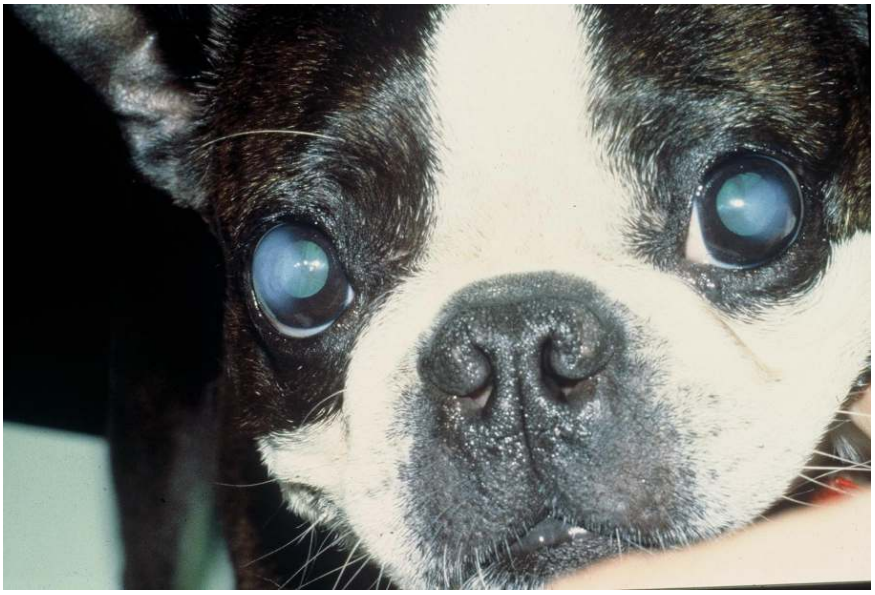
Phot. 1. Epithelial dystrophy, „boxers' ulcer" – changes in the form of superficial ulcerations stained with fluorescein; intensely green color occurs in the peripheral part of ulceration

Fot. 1. Dystrofia epitelialna, „wrzód bokserów" – zmiany w postaci powierzchownych owrzodzeń wybarwiających się fluoresceiną; barwa intensywnie zielona występuję w części obwodowej owrzodzenia

First lesions are visible in the light of a slit lamp as white-grayish zones of various shapes. They coincide with the zones of changed epithelium. Then there are defects in the anterior epithelium, which create superficial ulcerations of various sizes, most often situated centrally. They are stained with fluorescein, in a characteristic way: more intensely green on the periphery of the changes and less intensely in the middle (Phot. 1).



Phot. 2. Stromal dystrophy (of the corneal stroma) – changes in the form of white-grayish, oval, non-homogenous cloudings in the middle part of the cornea
Fot. 2. Dystrofia stromalna (zrębu rogówkowego) – zmiany w postaci biało-szarawych zmętnień, owalnego kształtu, o niehomogenicznym charakterze w środkowej części rogówki



Phot. 3. Endothelial dystrophy in a Boston terrier – bilateral and symmetrical corneal edema; it takes almost half of the surface of cornea
Fot. 3. Dystrofia endotelialna u boston terriera – obustronny i symetryczny obrzęk rogówki zajmujący blisko połowę jej powierzchni

In the light of a slit lamp we can see the edges of defects, „unstuck" from the anterior limiting membrane, rising upwards and showing ragged edges. The changes most frequently appear in one eye and after a few weeks they occur in the other as well. They are rather painful, because the defects of epithelium reveal sensory nerve endings. The disease is accompanied by lacrimation and the „red eye" symptoms.

In the histochemical tests it was found that the observed changes involve a loss of connection between the anterior epithelium and the anterior limiting membrane (Bowman's membrane). The loss of connection is caused by changes in the epithelial cell metabolism – enzymes connecting the epithelium with Bowman's membrane are not produced. Then the epithelium gets unstuck, as there are no specific links – hemidesmosomes. Besides, the cells of the basic epithelial layer undergo deformations. Vacuolar degenerations and intracellular microcysts and significant augmentation of cellular walls are observed. Bowman's membrane also gets augmented, the effect of which is weakening of the connection with the epithelium [Chaudieu and Molon-Noblot 1997, Clerc 1997].

The diagnosis of anterior epithelium dystrophy is quite easy. This kind of changes is the most common from among all dystrophies, has a distinct and characteristic clinical course and concerns selected breeds of dogs at a definite age.

In these cases therapeutic management is possible and is of symptomatic nature. The prognoses are favorable, because the lesions are superficial and do not cause the danger of corneal perforation, unless there are complications and secondary infection with bacteria.

Treatment involves surgical removal of the changed and unstuck epithelium (scarification) and provoking the anterior limiting membrane, by means of micropuncture (superficial keratotomy) to create a new generation of regular epithelial cells. The effects of treatment, in definite majority of non-inveterate cases, are good and lead to restoration of continuity to the superficial epithelial layer and reproduction of conditions for corneal transparency without leaving a scar [Furowicz 1991b, Champagne and Munger 1992, Clerc 1997, Kiełbowicz 2004].

Dystrophy of corneal stroma (proper substance)

The forms of this dystrophy are similar, but certain differences and specific features, characteristic of some breeds, can be distinguished:

– In Afghan hounds, beagles, Cavalier King Charles spaniels, American spaniels, Siberian huskies, Shetland sheepdogs, pinchers and terriers the lesions occur from the age of a few months to 4 years. They are visible as non-transparent places, slowly expanding or not, situated centrally and bilaterally. They occur in the middle, or more superficial layer of the stroma. They are shaped like oval or circular dots or spots, with dimensions of a few millimeters. They are white, or grayish white in color, homogenous, more dense, or irregular edges with lighter centers (Phot. 2). These changes, due to their small sizes and poor evolution, do not constitute a real threat for the remaining part of cornea and the process of seeing in future.

In certain breeds the hereditary character of this disease has already been confirmed. In Siberian huskies it is transmitted in autosomally recessive way [Waring 1986], and in American spaniels – by the autosomally dominant gene [Clerc 1997].

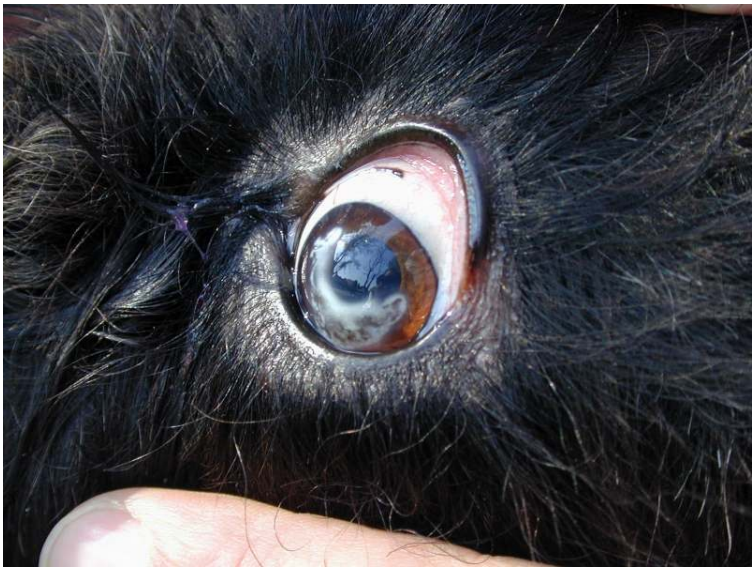
– „Subepithelial" dystrophy was described in bichons, Collie sheepdogs, miniature poodles and Ihassa-apsos. These changes are specifically localized – in the upper part of

Phot. 4. Lipid degeneration, secondary to other diseases of the eyes – changes in the corneal stroma were caused by chronic inflammation of the uvea and the formation of anterior adhesion

Fot. 4. Degeneracja tłuszczowa wtórna do innych chorób oczu – zmiany dotyczące zrębu rogówki powstały w wyniku przewlekłego zapalenia błony naczyniowej i wytworzenia się zrostu przedniego

Phot. 5. Lipid degeneration, secondary to disorders in fat metabolism; a dog, female schnauzer, 4 years old, the right eye – changes are in the form of a white-gray crescent and they occupy the lower half of the cornea

Fot. 5. Degeneracja tłuszczowa wtórna do zaburzeń gospodarki tłuszczowej suka, sznaucer, lat 4; oko prawe – zmiany mają kształt półksiężyca, są barwy biało-szarej i zajmują dolną połowę rogówki



Phot. 6. The same dog as in Phot. 5, left eye – changes are symmetrical

Fot. 6. Ten sam pies co na fot. 5, oko lewe – zmiany mają charakter symetryczny

corneal stroma, right under the surface of Bowman's membrane and anterior epithelium. They are similar to those described in the breeds mentioned before and constitute no threat to vision [Chaudieu and Molon-Noblot 1997, Clerc 1997].

– Dystrophy of Airedale terriers: here the changes occur mainly in 4–10 month old males. Non-transparent areas are distributed in the middle of the stroma and are progressive. They can take the whole surface of cornea and contribute to significant impairment of vision [Clerc 1997].

– Dystrophy of Collie sheepdogs. The dystrophic changes were found in individuals with „Collie's eye anomaly" and in those without it. The dystrophic changes may evolve. Then eyesight is impaired [Chaudieu and Molon-Noblot 1997, Clerc 1997].

All the corneal stroma dystrophies described above are formed of lipid compounds. These are phospholipids, as well as cholesterol and its esters that crystallize in different parts of the stroma, thus limiting the corneal transparency. It is important for the diagnostics that the presence of lipid compounds is neither connected with systemic lipoidemia nor with other local ophthalmologic symptoms.

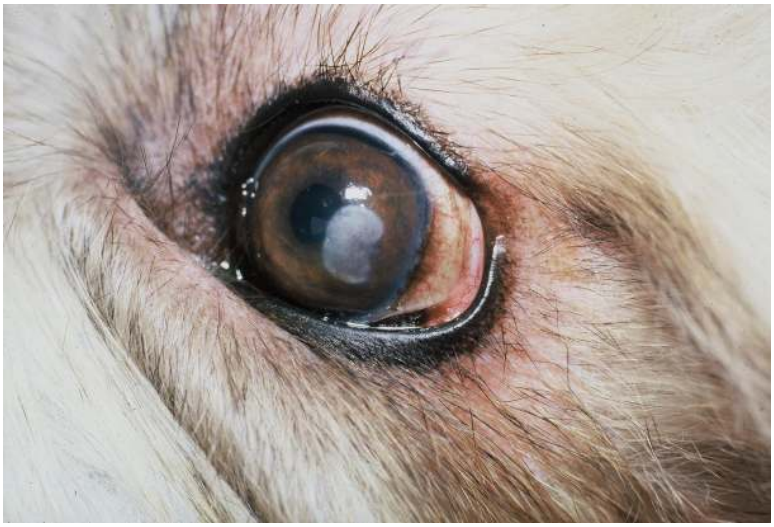
No treatment is undertaken if changes are known as non-progressive. Actions are then limited to control observation of the lesions. In cases of dystrophy with occupation of a substantial part of cornea and sight impairment (Airedale terrier, Collie sheepdog), surgical treatment is applied, choosing the method in accordance with the depth of the lesions. In subepithelial dystrophies it can be superficial keratotomy, keratotomy with transplantation of conjunctival flap, or even transplantation of the cornea in changes in deeper layers of the stroma [Slatter 1990, Chaudieu and Molon-Noblot 1997, Clerc 1997].

Endothelial dystrophy (of the posterior epithelium)

It is encountered in mastiffs, terriers, German sheepdogs, Collie sheepdogs, poodles, Chihuahua and basenji. In the latter breed it was found that this defect may accompany the persistent papillary membrane and is transmitted in autosomally dominant way [Roberts and Bitsner 1968]. However, the best-known breed in which this kind of dystrophy occurs is Boston terrier. In individuals of this breed changes occur at the age of 5 years. They are progressive and within 2–3 years they lead to a loss of sight (Phot. 3) [Chaudieu and Molon-Noblot 1997, Clerc 1997].

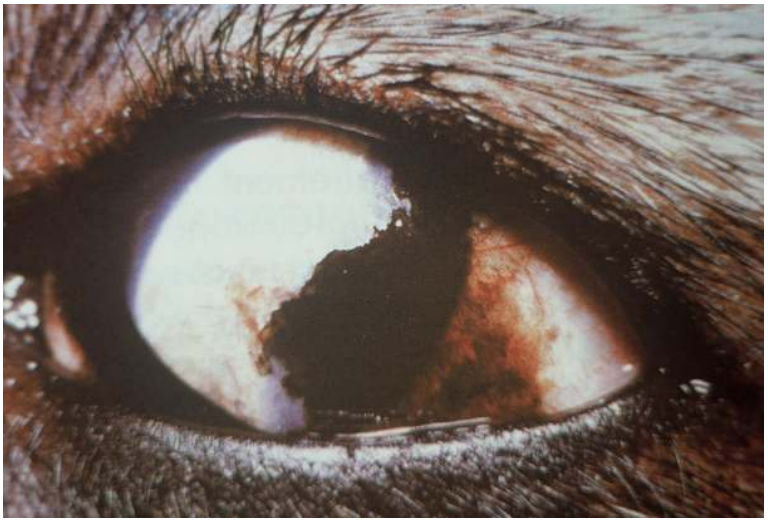
The observed lesions are caused by irregularities in the structure of one-layer posterior epithelium. They involve a decrease of the cell number, increase of the distance between them, a loss of regulatory ability of nutrition and control of the quantity of fluids penetrating into the proper substance of the cornea [Brooks 1990]. The main consequence of these changes is penetration of a larger quantity of fluid from the anterior chamber into the stroma and the occurrence of corneal edema, which decreases its transparency. The edema is clearly visible in the form of whitish-bluish „mist", usually symmetrically distributed on both surfaces of the cornea. It may be of different intensity, both as far as the occupied area is concerned, and the saturation degree. In most breeds it occurs in a small area, with small saturation degree, without impairment to sight. In Boston terriers it may take the whole surface of cornea, be strongly saturated and impair the sight.

Pharmacological treatment undertaken in this form of dystrophy is ineffective. The only solution in absolute loss of transparency can only be transplantation of the cornea [Slatter 1990, Chaudieu and Molon-Noblot 1997, Clerc 1997].



Phot. 7. Calcium degeneration – limited changes, formed as a consequence of chronic keratitis, visible superficial blood vessels in the area of lesions

Fot. 7. Degeneracja wapniowa – ograniczone zmiany powstałe w następstwie przewlekłego zapalenia rogówki; widoczne powierzchowniowe naczynia krwionośne w obszarze zmian



Phot. 8. Calcium degeneration – extensive changes, formed after Stenon channel transposition and crystallization of mineral compounds on the surface of the cornea

Fot. 8. Degeneracja wapniowa – zmiany rozległe, powstałe po transpozycji kanału Stenona i krystalizacji związków mineralnych na powierzchni rogówki

DEGENERATIONS OF THE CORNEA

Degenerations are secondary changes in the metabolism of corneal cells, leading to a loss of its transparency. They occur as a result of the occurrence of foreign compounds in the stromal cells, which are usually absent (they accumulate during the course of other, earlier corneal diseases, e.g. lipid compounds after inflammatory states of the cornea), accumulation of cellular depot on the surface of the cornea, or in its stroma, from mineral compounds during systemic diseases. Calcium compounds may be deposited during D-hypervitaminosis, or lipid compounds may be deposited as an effect of nutrition or metabolic errors. In these cases visible changes are bilateral, often symmetrical and progressive.

Corneal degenerations are acquired are not transmitted genetically. They may manifest themselves as unilateral or bilateral changes, symmetrical, or not.

Lipid degeneration concerning the corneal stroma

Most often it occurs in middle-aged and old animals. Changes, in the form of white-grayish masses, appear in the corneal stroma, below the anterior limiting membrane, where they can occupy a larger or smaller surface. In the light of a slit lamp we can see an accumulation of non-transparent masses with irregular contours between the stromal laminas. The following lipid degenerations can be distinguished:

Degeneration that is secondary to chronic illnesses of the cornea – for instance, as a consequence of chronic, superficial, pigment inflammation of the cornea in German sheepdogs. At first, the lipid infiltrations localize in the external angle of the eye, then they aim at the center, often taking the shape of concentric rings. Also other corneal diseases, as well as aveitis, can cause lipid-degenerative complications, if there is no specific treatment, or if it is delayed (Phot. 4). Besides, the lipid deposits may occur as a consequence of corneal ulceration, when scarring is prolonged. The degenerative changes are distinctly accompanied by local inflammatory symptoms from additional structures of the eye, or from intraocular structures. They are not accompanied by clinical symptoms of general character [Slatter 1990, Chaudieu and Molon-Noblot 1997, Clerc 1997].

In these cases therapy involves symptomatic and causal treatment. Applying anti-inflammatory medicines stabilizes the changes, and causal medicines should remove the reason for the disease, where it is possible. When lipid infiltrations impair the sight, keratotomy is performed, but the recurrence of changes is possible. Then transplantation of the cornea can be considered [Chaudieu and Molon-Noblot 1997, Clerc 1997].

Degeneration that is secondary to general metabolic disorders, mainly these of lipid management. In this situation lipid deposits are created of lipids, phospholipds and cholesterol. They enter the corneal area from the limbus towards the center. They are visible as compact, quite thick, white masses, with irregular edges, arranged in arches, crescents, or circles, sometimes reaching deeper layers of the stroma (Phot. 5 and 6). In certain breeds of dogs, especially in German sheepdogs and golden retrievers, these deposits may be related to hypothyroidism, or hypercholesterolemia, with a lack of other ophthalmologic symptoms [Chaudieu and Molon-Noblot 1997, Clerc 1997].

The treatment involves restoration of the proper lipid level in the serum through curing the basic disease. In such situations it is possible that the degenerative changes will subside, but the effects are very slow.

Calcium degeneration

This type of lesions is encountered less frequently than lipid infiltrations. Calcium compounds accumulate in the stroma mainly as an effect of a previous diseases of cornea, or general (systemic) diseases, which may happen to animals of different breeds and at different ages. Visible changes occur as white-grayish depot, partially or totally eliminating the transparency of cornea. It comprises the corneal stroma, reaches extensively to the subepithelial area, and it may also occur on the surface of the epithelium. Calcium infiltrations are encountered as a consequence of severe post-inflammatory lesions of the cornea (Phot. 7), persistent changes with the presence of scars, and also as an effect of Stenon channel transposition in cases of dry keratitis (Phot. 8). Calcium infiltrations may also occur as a result of D hypervitaminosis and hypercalcaemia caused by hyperthyroidism, or hyperadrenocorticalism [Slatter 1990, Chaudieu and Molon-Noblot 1997, Clerc 1997].

The applied treatment includes causal and symptomatic actions. Where the causes are noticed, attempts should be made at eliminating them, i.e. metabolic or hormonal disorders should be cured. Local symptomatic treatment is not very effective. Applying glycocorticoids suppresses neovascularization, but it does not decrease the areas of calcium infiltrations. Performing keratotomy is a certain solution, but calcium infiltrations tend to recur.

CONCLUSIONS

Concluding the review of corneal dystrophies and degenerations occurring in dogs we should emphasize that it is not a very well known group of diseases and it is seldom diagnosed properly. Similarities of clinical symptoms, areas of occurrence and changes in ophtalmoscopic images significantly hinder the correct diagnosis. The fact that the changes appear in characteristic breeds and at a definite age can make it a little easier. However, in every case the basis of the correct diagnosis should be an accurate anamnesis concerning previously suffered ophthalmologic and general (systemic) illnesses, as well as performing full clinical examinations with basic additional tests (hematology, biochemistry) and then, as the next step – analysis of ophthalmologic symptoms with their thorough characteristics and topography of the lesions. Inappropriate diagnosis or failure to take up treatment may consequently lead to disorders in the correct process of vision.

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STRESZCZENIE

Celem pracy jest prezentacja mało znanych chorób rogówki psów: dystrofii i degeneracji. Przebiegają one ze zmianami w metabolizmie komórek rogówki, doprowadzając do utraty jej przejrzystości, a także stanowiąc zagrożenie dla widzenia. Dystrofie są to pierwotne zmiany, pojawiające się w różnym wieku, mające charakter dziedziczny. Degeneracje są chorobami wtórnymi w stosunku do innych chorób oczu lub chorób ogólnoustrojowych. Obie grupy przedstawiają bardzo podobny obraz kliniczny i ich dokładne różnicowanie jest trudne. Wśród dystrofii zaprezentowano: dystrofię nabłonka przedniego, dystrofię zrębu i dystrofię nabłonka tylnego. Każda z tych postaci została opisana, scharakteryzowana i podano sposób postępowania leczniczego. Wśród degeneracji wyróżniono: degenerację lipidową oraz degenerację wapniową. Opisano ich postacie kliniczne, podano przyczyny pierwotne oraz postępowanie lecznicze.

Słowa kluczowe: pies, dystrofia rogówki, degeneracja rogówki