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Importance of direct ophthalmoscopy and ultrasound in the diagnostics of equine recurrent uveitis*)

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Summary

The aim of this study was to describe the occurrence of individual clinical symptoms associated with equine recurrent uveitis (ERU) and compare the diagnostic yield of direct ophthalmoscopy and ultrasonography (B-mode imaging). The collection of evaluated horses included patients treated in the Equine Clinic, the University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic, which were diagnosed with acute equine recurrent uveitis in the period from 1st June 2003 to 30th March 2006. Patients were prepared for the examination so as to achieve sedation, palpebral akinesis and corneal topical anaesthesia. If the pupil responded to application of mydriatics, mydriasis was achieved. Depending on the method used, ultrasound coupling gel was applied on the upper eyelid or cornea. Ophthalmoscopic examination was performed using a direct ophthalmoscope Beta 200, Heine. Two ultrasound devices equipped with a 10 MHz transducer, i.e., Dynamic Imaging Concept/SV and Hitachi EUB-6500, were used for the examination. Only in 10 eyes (18.9%) of the 53 affected ones was clinical examination possible as far as the fundus. Clinical signs of ERU such as corneal oedema, corneal vascularization, effusions within the anterior chamber, miosis, anterior synechiae, posterior synechiae, cataract, lens dislocation, vitreous opacities, retinal detachment and bulbar atrophy affected 28.3, 15.1, 15.1, 18.9, 11.3, 43.4, 60.4, 9.4, 54.7, 32.1 and 32.1 % of eyes, respectively. Direct ophthalmoscopy, the main method of ocular examination, was carried out first and allowed exact evaluation of all eyes as far as the iris. When compared with ultrasonography, its diagnostic yield in cases of corneal vascularization ($p < 0.01$) and miosis ($p < 0.001$) was significant. Ultrasonography as a complementary diagnostic method followed the direct ophthalmoscopy and its diagnostic yield for the assessment of individual ocular structures from the pupil to the posterior segment of the eye was evaluated. Evaluating posterior ocular structures, ultrasonographic B-mode was quite rewarding in cases of findings such as lens cataract ($p < 0.001$), lens subluxation or luxation ($p < 0.05$), vitreous opacity ($p < 0.001$) and retinal detachment ($p < 0.001$).

Keywords: horse, uveitis

Equine recurrent uveitis (ERU, iridocyclochoroiditis, periodic ophthalmia, moon blindness), a specific disease of equids, is the most common cause of blindness in horses around the world. There are many theories which attempt to explain the origin of ERU in horses (32). The etiopathogenesis of moon blindness is not quite clear. It is, however, evident that there is an immune-mediated reaction leading to recurrent inflammation of the eye. This is a delayed-type of hypersensitivity immunologically (DTH), in which Th1 lymphocyte activation plays the main role (12). *Leptospira interrogans* seems to be the main infectious agent (8, 16, 31). ERU diagnosis is carried out on the basis of typical clinical signs and case history. ERU is characterized by recurring episodes of acute uveitis separated by quiescent periods of variable durations. Clinical signs of ERU include pain, eyelid oedema, conjunctival hyperaemia, corneal vascularization, fibrin and/or cells in the anterior chamber, miotic pupil, anterior and/or posterior synechiae, lens and vitreous changes, and fundus changes. Blindness is caused by cataracts or/and retinal detachment. The prognosis is poor in many cases even when there has been optimal medical treatment. Vitrectomy has been reported to prevent uveitic attacks and improve the prognosis for vision (10, 30).

Severe anterior segment alterations may prevent adequate evaluation of posterior structures using ophthalmoscopy. In contrast to these examination techniques, ultrasound has the advantage of obtaining a complete image regardless of opacities in the anterior ocular segment and lens. The technique is safe and practical, requiring only sedation and topical anaesthesia (29).

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The aim of this study was to analyse the occurrence of individual clinical symptoms associated with equine recurrent uveitis and compare the importance of direct ophthalmoscopy and ultrasound in detecting them.

Material and methods

The horses used in the study included patients treated in the Equine Clinic, the University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic, who had suffered from the disease for variable periods, but had been diagnosed with acute equine recurrent uveitis from 1st June 2003 to 30th March 2006. A total of 40 horses were examined. The majority of horse breeds were Warmbloods (21) and Thoroughbreds (17) but one Hucul horse and one Appaloosa was also examined. The collection included 20 mares, 8 stallions and 12 geldings. The age of the patients varied from 1.5 to 17 years. Both eyes were affected in 13 horses, the left one in 16 horses and the right one in 11 horses. Work load and use of horses differed to a degree and included racing (17 horses), show jumping (18 horses) and hobby rides (5 horses).

Light sedation of all horses was necessary to enable examination (xylazine hydrochloride; 0.3-0.4 mg/kg of body weight; i.v.; Rometar 2%, SPOFA, Czech Republic). After injecting xylazine, *n. auriculopalpebralis* block anaesthesia (bupivacaine hydrochloride; 2 ml s.c.; Marcaine 0.5%, AstraZeneca, France) and topical corneal anaesthesia (oxybuprocaine chloride; Novesin 0.4%, CIBA Vision AG, Switzerland) were performed. Mydriasis was induced (tropicamide; Mydriacyl 1%, Alcon laboratories, Belgium) in cases where the pupil responded to the application of mydriatics.

Sterile ultrasound gel (BOVIVET gel, KRUUSE, Denmark) was applied directly onto the cornea for transcorneal approach or on the upper eyelid for transpalpebral scanning. When using the transpalpebral method, the eyelid hairs had to be moistened prior to applying the gel. Ophthalmoscopy was performed using a direct ophthalmoscope Beta 200, Heine, Germany.

Two ultrasound devices were used for the examination. The mobile Dynamic Imaging Concept/SV equipped with a 10 MHz sector transducer was used until August 2005. Later, we changed to stationary Hitachi EUB-6500 (Hitachi Medical Corporation, Japan) equipped with an electronic 5 to 10 MHz linear transducer. The results of examinations using the first device were recorded on thermal sensitive paper while the second one provided the possibility of digital recording. The examined eyes were photo-documented.

Both eyes in all horses were examined using direct ophthalmoscopy on a routine ophthalmologic basis. The examination comprised a systematic evaluation of all ocular structures. Healthy eyes, enabling examination of retina and the optic disc by direct ophthalmoscopy, were excluded from our collection. ERU affected eyes were examined using direct ophthalmoscopy to the extent limited by the translucency of ocular parts.

Two-dimensional ultrasound examination (B-mode imaging) was employed in all eyes on two planes, i.e., vertical (sagittal) and (frontal). All ocular structures were evaluated one by one from the anterior segment to the posterior segment and retrobulbar space containing the optic nerve, vessels and fat tissue. Both examination methods were employed in all eyes. Firstly, the transpalpebral approach gentlest to the patient was used. The transcorneal method was used only when the patient tolerated contact of the cornea with the transducer. The examination began in the axial vertical plane with a continual increase in gain. After that, the gain level was decreased and the examination continued by slowly turning the transducer 90° into the axial horizontal plane. Then, the gain was increased again. Finally, oblique scanning through the sclera was performed.

Evaluations of the observed clinical symptoms and their imaging characteristics were performed at the end of each examination for both eyes simultaneously in order to exclude individual differences.

Chi-square and McNeumara tests were employed for a statistical comparison of methods and their diagnostic yield in separate ocular clinical symptoms.

Results and discussion

Only 10 (18.9%) of the 53 affected eyes were amenable, at least partly, to examination by direct ophthalmoscopy including the fundus and the optic nerve. The remaining 43 eyes (81.1%) could not be examined using direct ophthalmoscopy because of severe opacity in the anterior ocular segment and ultrasound had to be employed. Causes of loss of translucency of anterior ocular structures included common sequels to ERU.

Corneal oedema was discovered in 15 eyes (28.3%) and in all cases was a condition which presented itself as a focal or diffuse steamy opacity disabling examination of further ocular structures. There were, however, no cases of complete loss of corneal translucency. Changes were most severe in the limbal area and diminished towards the corneal centre. Ultrasound findings included enlargement of the hypoechogenic space within the corneal stroma lying between two parallel lines of the anterior and posterior epithelium. Corneal oedema was amenable to examination to the same extent using both direct ophthalmoscopy and ultrasound (fig. 1, tab. 1).

Corneal vascularization, present in 8 cases (15.1%), was always accompanied by corneal oedema. In all cases vessels grew into the epithelium or surface stromal area from around the whole limbus. The most prominent changes, however, were in the ventral or ventromedial area. Ultrasound B-mode imaging of this lesion was insignificant, in contrast to direct ophthalmoscopy ($p < 0.01$) (fig. 1, tab. 1).

Effusions within the anterior chamber, present in 8 eyes (15.1%), were mostly associated with both the above findings. Purulent or blood-purulent effusions formed crescent shaped sediments in the ventral part of the anterior chamber. Ultrasound revealed effusions as masses of varying echogenicity in the anterior ocular chamber. In contrast to direct ophthalmoscopy, it was not possible to distinguish between hypopyon and hyphaema using ultrasound. We were, however, able to evaluate the degree of organization of the effusion. Both methods of examination were equal in their diagnostic value (fig. 1, tab. 1).

Extreme miosis was found in 10 examined eyes (18.9%). Miosis manifested as a complete iris contr-

Tab. 1. Diagnostic yield of both examination methods expressed as numbers and percentage of clinical symptoms confirmed by direct ophthalmoscopy and ultrasonography

Symptom	n	Direct ophthalmoscopy n (%)	Ultrasonography n (%)
Corneal oedema	15	15 (100%)	15 (100%)
Corneal vascularization	8	8 (100%)	0
Effusions within AC	8	8 (100%)	8 (100%)
Miosis	10	10 (100%)	0
Anterior synechiae	6	6 (100%)	6 (100%)
Posterior synechiae	23	23 (100%)	23 (100%)
Cataract	32	5 (15.6%)	32 (100%)
Lens dislocation	5	2 (40%)	5 (100%)
Vitreal opacities	29	6 (20.7%)	29 (100%)
Retinal detachment	17	0	17 (100%)
Phthisis bulbi	17	17 (100%)	17 (100%)

Abbreviations: AC – anterior chamber

action due to inflammatory irritation in acute cases or fixation by synechiae between iris and lens in chronic cases. Miosis accompanied all the above listed clinical signs in all cases. Ultrasound imaging of miosis was insignificant. The diagnosis of this finding relied totally on direct ophthalmoscopy ($p < 0.001$) (fig. 1, tab. 1).

Synechiae was evident between the iris and corneal endothelium (anterior synechiae) or iris and lens (posterior synechiae). The former were present in 6 eyes (11.3%) while the latter in 23 eyes (43.4%). Pigmentary fibers between the iris and cornea were the signs of anterior synechiae. Posterior synechiae with the anterior lens capsules originated in the iris as well, but were attached to the lens. Both kinds of synechiae contorted the pupil and focal opacities were visible in the area of their attachment. Ultrasound revealed synechiae as echogenic or even hyperechogenic lines or masses found within the anterior or posterior ocular chamber. Both methods of examination were equal in their diagnostic yield (fig. 1, tab. 1).

Cataracts were present in 32 (60.4%) of the eyes examined and all of them were in chronic stages of progression with mature or hypermature changes (lens of greyish-white colour). A cataract with capsule affection is visible through ultrasound as a smooth, curved, hyperechogenic line. Depending on their location of opacity within the lens, either cortical and nuclear intralenticular echogenicity or hyperechogenicity were found. All cases of changes in the lens translucency could be diagnosed by ultrasound ($p < 0.001$). Only 5 eyes (15.6%) were amenable to direct ophthalmoscopy due to translucent anterior ocular segments (fig. 1, tab. 1).

Lens dislocation was found in 5 eyes (9.4%). There was subluxation of a mature cataract (*cataracta matura*) in 4 cases and one case of luxation of a hypermature cataract into the vitreous (*cataracta hypermatura*). In posterior luxation the pupillary margin was fragmented into fibers and the iris was trembling as the globe moved. Subluxations showed a typical aphakic crescent. Lens luxation on ultrasound manifested as a hyperechogenic mass with not clearly demarcated margins, which freely floated in the vitreous chamber. Ultrasound imaging of subluxation appeared as an echogenic or hyperechogenic structure, clearly demarcated and partly fixed in its normal position. All cases of lens dislocation could be diagnosed by ultrasound ($p < 0.05$), while only 2 (40%) of them were visible on direct ophthalmoscopy (fig. 1, tab. 1).

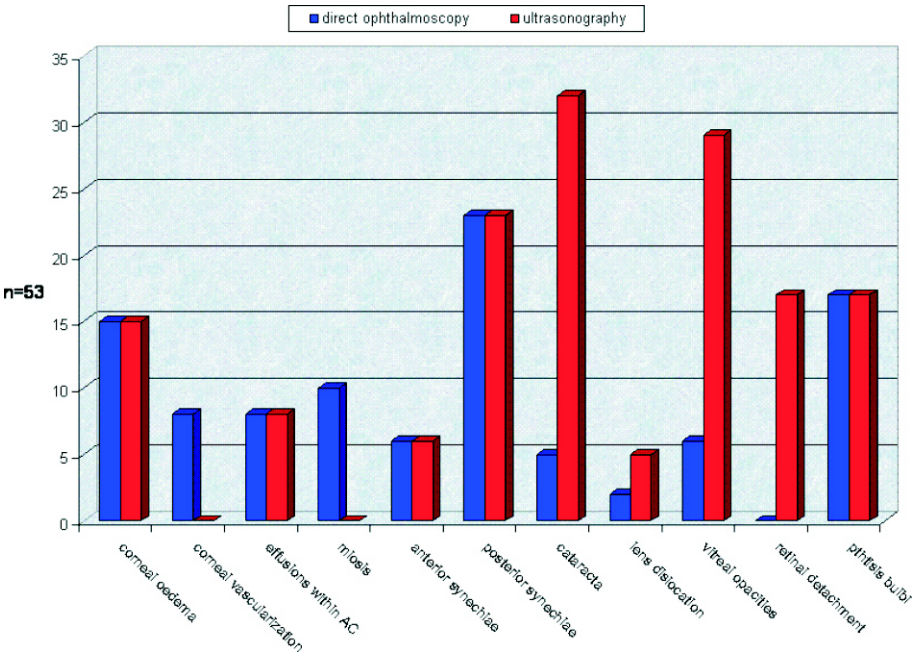

Fig. 1. Frequency of individual pathological findings diagnosed by direct ophthalmoscopy and ultrasonography
Explanation: AC – anterior chamber

Vitreous opacities were present in 29 cases (54.7%). With ophthalmoscopy they looked like greyish-white objects such as flakes, fibers and membranes of different size and shape floating freely in the vitreous. Membranes visible as echogenic lines of various shapes were most common in ultrasound detection. All cases could be diagnosed by ultrasound ($p < 0.001$) and only 6 (20.7%) by direct ophthalmoscopy (fig. 1, tab. 1).

Retinal detachment occurred in 17 eyes (32.1%) and was always accompanied by deterioration in the translucency of the anterior ocular segment or vitreous. With ultrasound it looked like membranous echogenic or hyper-

echogenic lines. The echogenicity of the detached retina was higher enough compared to that of membranes within the vitreous to enable distinction. Complete retinal detachment was shaped as a classic „V" or „Y" with clearly visible anchorage of its base at the site of the optic disc. Ultrasound was of crucial importance for diagnosing this finding ($p < 0.001$) (fig. 1, tab. 1).

Phthisis bulbi was found in 17 eyes (32.1%). This globe, when compared to the other one, was smaller, shrunken and deeper seated within the orbit. There was third eyelid protrusion and entropion of various degrees. When using ultrasound the globe could be characterised by a decrease in the anterior-posterior diameter and deformations in the anterior ocular chamber as well as the chamber of the vitreous. All cases of atrophic globes showed other pathological changes of ocular structures. Both methods of examination were equal in their diagnostic yield (fig. 1, tab. 1).

Equine recurrent uveitis is a serious ocular disease of horses common both in the Czech Republic as well as worldwide (25, 26). It has recently been discovered that ERU patients are difficult to manage when using conservative methods of treatment, that they quickly loose vision despite specific and early therapy and within a short period suffer from afflictions in both eyes. Modern surgical methods of treating this disease (13, 27) which considerably improve their long-term prognosis, require an exact evaluation of all ocular structures.

On condition that it is possible to achieve mydriasis, direct ophthalmoscopy represents a standard examination technique for eyes with translucent ocular media because it enables careful evaluation of all ocular structures including the posterior segment and the optic disc (6). Its diagnostic application, however, is hindered by obstacles posed by opacities of structures that are normally translucent (5).

Since the first published echogram in 1956, (9) ultrasound has become the preferred tool in examination procedures in human ophthalmology and has developed into a multifunctional diagnostic method. Opacities of parts of the eye are the main indication for ultrasound examinations in veterinary ophthalmology (14, 15).

Only 10 eyes (18.9%) of the 53 affected ones could thoroughly be examined using direct ophthalmoscopy. Symptoms limiting the use of direct ophthalmoscopy presented themselves as changes characteristic for the acute stage of ERU (1). Corneal oedema decreased the translucency of cornea in 15 eyes (28.3%). There was not, however, any case of a complete loss of corneal translucency. Despite varying extents of the greyish-white opacity, it was always possible to transilluminate the cornea by a direct source of light in a dark room. Corneal oedema was found near the limbus, which is typical for the ERU disease (18). Corneal vascularization, present in 8 cases (15.1%), participated in the decrease in its translucency together with corneal oedema. This change also predominated around the limbus (7). The course and length of vessels provided information on the duration of the process, but precluded the use of direct ophthalmoscopy. Effusions within the anterior chamber, present in 8 eyes (15.1%), lay in its ventral half and, depending on their degree of organization, limited the use of direct ophthalmoscopy. In all cases purulent or blood-purulent effusions formed a horizontal level at the bottom of the anterior chamber. There was, however, no case of fibrin formation that totally blocked the pupil like a membrane (28). Miosis, as a cardinal sign of acute cases of ERU, completely prevented the use of direct ophthalmoscopy for evaluating deeper-lying structures in 10 eyes (18.9%). The pupil was fully contracted in these eyes and there was no light response (21). The remaining eyes showed at least partial light response and their several-millimetres-in-diameter pupil allowed only minimum use of direct ophthalmoscopy. Synechiae between the iris and corneal endothelium (anterior synechiae) resulted in focal corneal opacities at the site of their attachment, deterioration in the function of the pupil as well contortions in its shape (2). In our collection the combination of the above three mechanisms limiting the use of direct ophthalmoscopy could be observed in 6 eyes (11.3%). Synechiae between the iris and lens (posterior synechiae), which occurs more frequently, also deforms the pupil or even may fix it in permanent miosis, and is responsible for the opacity of the anterior lens capsule at the attachment site (17). Depending on the extent that this occurred, they disabled direct ophthalmoscopy of 23 eyes (43.4%) in our collection. Cataracts occur most commonly as a sequel to ERU in horses ERU (23) and were present in 32 (60.4%) of the eyes examined. Ophthalmoscopy revealed 5 cases in which it was not possible to examine structures lying beyond the affected lens. Chronic uveitis may lead to disintegration of the ciliary zonule and subsequent lens dislocation (3). Of a total of 5 cases of lens dislocation (9.4%), ophthalmoscopy revealed 1 subluxation and 1 luxation into the vitreous. In terms of the diagnostic possibility of direct ophthalmoscopy, the effect of subluxation of a completely opaque lens was the same as that of a nonluxated mature cataract. In one finding, a hypermature lens which had luxated into the vitreous did not block the use of direct ophthalmoscopy at the level of lens, but the level moved further back to the vitreous chamber. Less pronounced changes in the vitreous even allowed an examination of the ocular fundus (19). In our collection, however, dense membranous lesions disabled direct ophthalmoscopy evaluation in 6 of a total of 29 eyes (54.7%) and, therefore, ultrasound examinations had to take over. Retinal detachment as a clinical entity may easily be diagnosed using direct ophthalmoscopy due to its typical appearance. In horses suffering from ERU it

is, however, one of many complex changes in the eye which mostly result in opacity of some other structures (4). In our collection retinal detachment occurred in 17 eyes (32.1%) and all cases had to be confirmed using ultrasound examinations. Phthisis bulbiis was the final result of ERU (11). All 17 atrophied eyes (32.1%) in our collection had been affected in other structures such as in the iris and lens (posterior synechiae and cataract). These changes totally disabled the use of direct ophthalmoscopy for evaluating the posterior ocular segment.

The most common cause of decrease in transparency was due to obstacles at the level of the pupil and lens (miosis, anterior and posterior synechiae, and cataract) in our collection of eyes affected by ERU. This corresponds quite well with characteristics of equine recurrent uveitis and therefore results in the impossibility of evaluating of structures lying beyond this barrier by using direct ophthalmoscopy. Contrary to this method, ultrasound proved to be irreplaceable in evaluating intraocular structures beyond the iris (23).

Clinical signs of ERU depend on the site of inflammation within the uveal tract. The classic form of ERU may be characterised by rather dramatic changes in the anterior uvea (iris, ciliary body). There are no reports concerning quantification of changes caused by ERU. The disease develops on an individual basis and ocular structures are irregularly affected and their progression cannot be predicted. There are differences in relation to the workload of horses, seasons of the year and type of housing. Ocular structures are not affected as separate units, but always as part of several ocular components (24). It is, therefore, hard to quantify to what extent individual pathological lesions limit the use of direct ophthalmoscopy.

Due to the fact that in this study veterinary surgeons lacked subjective pieces of information obtained from the equine patient concerning its visual abilities, ultrasound proved to be an irreplaceable ophthalmologic examination method and added new data to that obtained by direct ophthalmoscopy and was helpful in evaluating intraocular structures abd, thus providing a prognosis in horses affected by equine recurrent uveitis (20).

Conclusions

The clinical manifestation of ERU is variable, but in most cases presents itself as anterior uveitis. Both examination methods, i.e., direct ophthalmoscopy and ultrasound are easy to perform and have unquestionable importance for diagnosing ERU. Direct ophthalmoscopy is reliable in determining the acute nature of the problem and the extent to which the anterior ocular segment as far as the iris is affected. Structures beyond the iris are less amenable to be examined by direct ophthalmoscopy. Thus, inn the posterior ocular segment ultrasound becomes of major diagnostic importance due to its ability to evaluate the variety as well as extent of sequels to ERU.

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