From the Department of Surgery, College of Veterinary Medicine, Helsinki and the Department of Ophthalmology, University of Helsinki, Finland.

FLUORESCEIN ANGIOGRAPHY OF THE CANINE OCULAR FUNDUS IN KETAMINE-XYLAZINE ANESTHESIA

By

B. Kommonen and *L. Koskinen*

KOMMONEN, B. and L. KOSKINEN: *Fluorescein angiography of the canine ocular fundus in ketamine-xylazine anesthesia.* Acta vet. scand. 1984, 25, 346—351. — Fluorescein fundus angiography was performed on 30 dogs with no pathologic fundus findings using a Canon CF 60 Z wide angle camera. In serial photography of the dye passage 4 different circulatory phases could be distinguished: choroidal, retinal anteriolar, capillary and venous phase. The dye passage in the retinal vessels was described in detail. For aesthesia the combination of ketamine and xylazine proved to be suitable.

staining; retinal blood vessels; dog.

Fluorescein angiography has been used for several years to study retinal circulation before being used in clinical work. *Bellhorn* (1973) described fluorescein fundus photography in animals. *Gelatt et al.* (1976) compared restraint, different types of films and various doses of fluorescein in the dog.

The fluorescein injected intravenously appears in the eye in a few seconds in the dog, as in most animals. Sodium fluorescein is excited by blue light of 490 nm and after excitation emits light at a wave-length of 520 nm. By using a blue filter over the strobe light and a yellow filter in front of the film it is possible to observe the dye as it passes through the choroid and retinal vessels. Defects in the blood retinal barrier and choroid-retinal barriers are seen as dye leaks into the retina and vitreous *(Gelatt* 1981).

In this study fluorescein angiography of ophthalmologically healthy dogs was performed using a photographic unit which

gives a wide angle (60°) wiew of the fundus. Previous reports have not described the passage of the dye in the retinal capillaris in the dog in detail.

MATERIAL AND METHODS

A total of 30 clinically healthy dogs of both sexes and different breeds (Table 1), age ranging from 6 months to 8 years, were examined at the Department of Ophthalmology, University of Helsinki.

T a b l e 1. Breeds and numbers of the dogs examined.

Breeds	Number of dogs
Toy Poodle	14
Miniature Poodle	5
Giant Poodle	5
Beagle	4
Labrador Retriever	1
Chesapeake Bay Retriever	1

At the general examination none of the dogs showed signs of an ophthalmological or general disease. Prior to angiography the dogs were examined by direct and indirect ophthalmoscopy. Slit lamp biomicroscopy was performed in order to detect possible lens and vitreous opacities. None of the dogs had pathologic findings. The dogs were electroretinographically tested and were all found to be normal.

For mydriasis cyclopentolate 5 mg/ml (Oftan Syklo®, Star) and tropicamide 5 mg/ml (Oftan Tropicamid®, Star) eyedrops were given approximately 20 min prior to photography.

After an overnight fast the dogs were anesthesized using a combination of ketamine hydrochloride 9 mg/kg (Ketalar® 5 mg/ml, Parke Davis) and xylazine hydrochloride 1.4 mg/kg (Rompun vet.® 20 mg/ml, Bayer) given intramuscularly in the biceps femoris muscle or slowly intravenously in the cephalic vein. Within 10 min of administration of the anesthetics the dogs were placed in lateral recumbency on their right side on a table in front of a Canon CF Z fundus camera.

The camera was focused on the fundus and control photographs on Kodak Tri-X pan 400 ASA film or Kodak ektachrome 64 film were taken. Sodium fluorescein 10 % aquaeous solution

(Fluorescite® 10 % inject, Alcon) was rapidly injected in the left cephalic vein using a dosage of 12 mg/kg. Photography was started prior to appearance of the dye in the retinal arterioles, and was continued at 1.0 s intervals for 15—30 s. During anesthesia the cornea was frequently moistened with 0.9 % saline solution.

Angiography pictures were taken on Kodak Tri-X pan 400 ASA film. The camera had build-in excitatory and barrier filters so no extra filters were needed during angiograhy. For the control photographs a Kodak Wratten 58 filter was used. The black and white films were developed in Agfa Refinal® according to the method used at the Department of Ophthalmology. The developing time was 7 min at 20°C.

RESULTS

During the initial phase of angiography some of the dogs showed autofluorescence of the tapetum. The dye appeared approximately at the same time in the choroidal circulation as in the 10—20 cilioretinal arterioles. The choroidal filling was first seen as a patchy fluorescence in the nontapetal region (Fig. 1).

In the early arteriolar phase the 10—20 cilioretinal vessels emerging from the optic disc periphery seemed to fill almost simultaneously Fig. 1). Differences in the filling velocity of individual arterioles were noted; the filling of those in the tapetal and nontapetal parts of the fundus was simultaneous.

The dye first appeared in the retinal capillaries surrounding the arteriolar branches near the optic disc region (Fig. 3). The capillaries were poorly visualized in the early venous phase (Fig. 2). The fluorescence of the capillary bed was most obvious during the mid-venous phase in the majority of the dogs (Figs. 3 and 4). A narrow capillary free zone along the arterioles was observed (Figs. 4 and 8). In the periphery the capillary bed clearly became less dense (Figs. 4 and 7), and close to the ora serrata the network was totally lacking. The capillaries were not visualized in the tapetal area because of autofluorescence (Fig. 4). The background fluorescence reached its maximum approximately at the same time as the capillary fluorescence was seen in the mid-periphery of the fundus (Fig. 4).

The first branches to fill during the venous phase were the veins of the area centralis region. The dye laminated against the
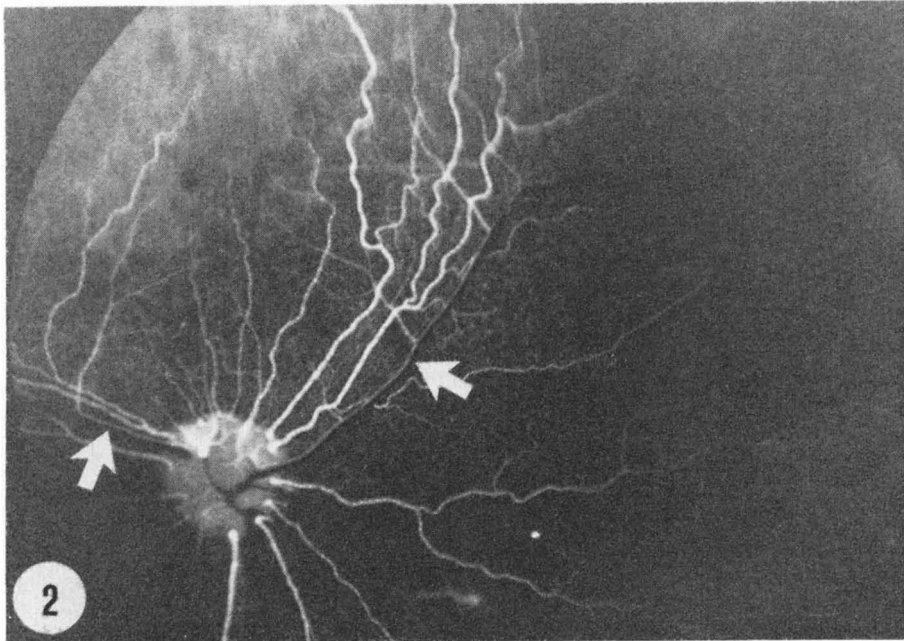
Figure 1. Dog A. The fundus of a 4 year old Miniature Poodle bitch photographed in the early arteriolar phase. Fluorescein shows up in different shades of whithe. Empty vessels appear as black lines. The arterioles are filling at slightly different times. Choriocapillaris has started to fill in a patched pattern (white arrow).

Figure 2. Dog A. Early venous phase. Most of the cilioretinal arterioles are fulorescing. The optic disc shows some fluorescence. Two large vein stems show laminated dyeflow (white arrows). Choriocapillaris fluorescence is more diffuse due to the masking effect of the pigment epithelium.
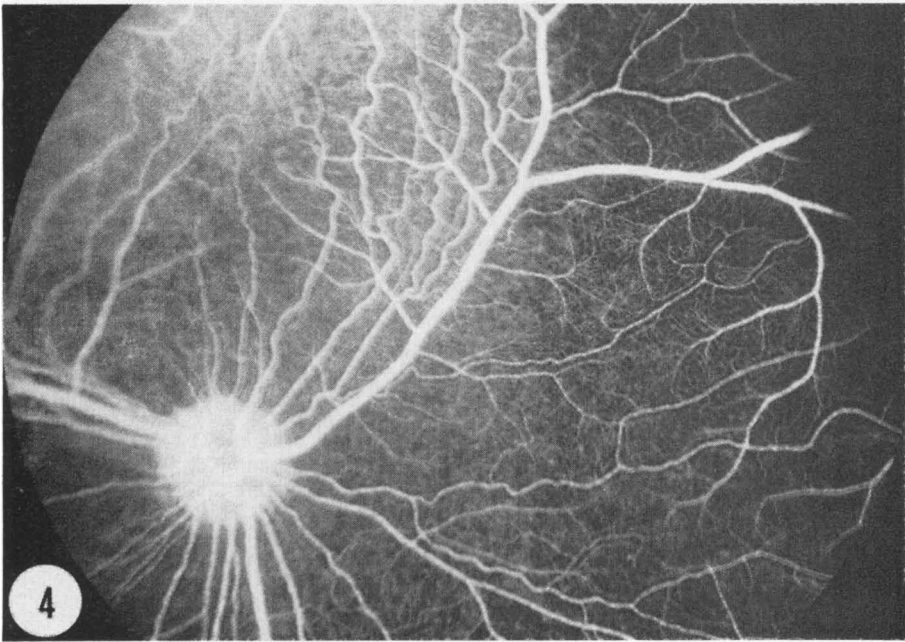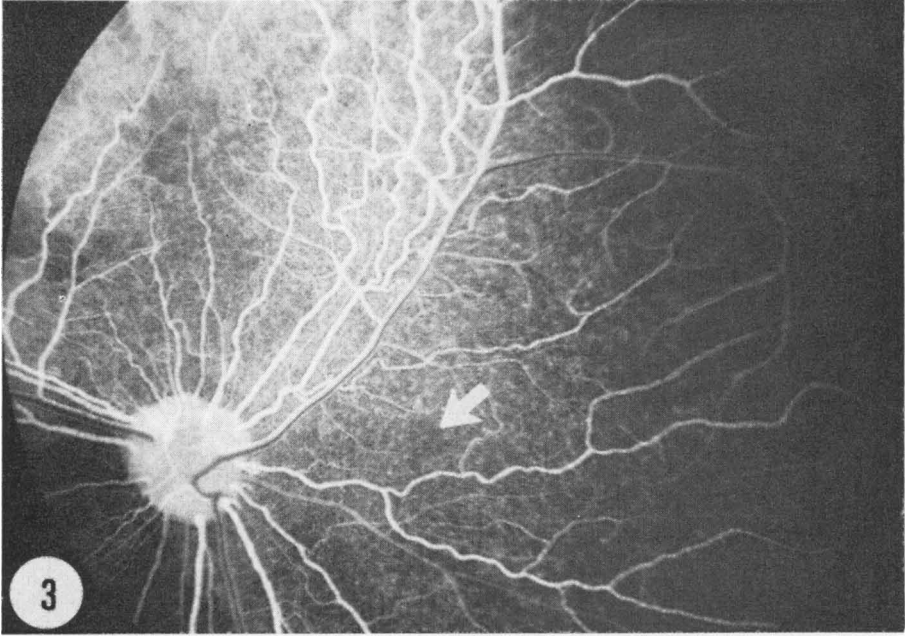
Figure 3. Dog A. Mid venous phase. Patches of choriocapillaris layer still remain unfilled (white arrow). The lamination of fluorescein in the large veins is now clearly visible. The arterioles are fluorescing intensely. The capillaries near the optic disc have started to fill.

Figure 4. Dog A. Late venous phase. All the veins are filled with dye. The peripherial capillary network shows vivid staining
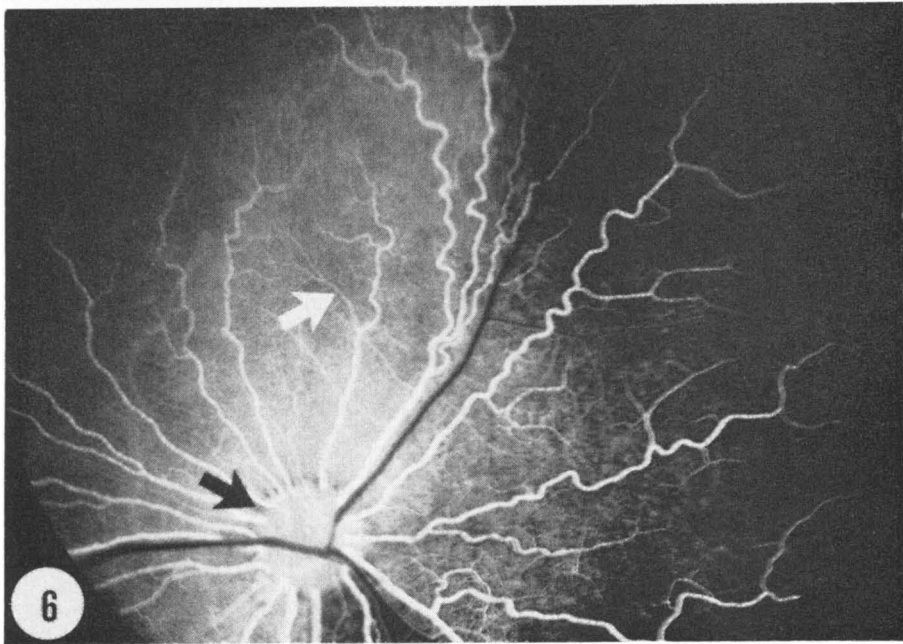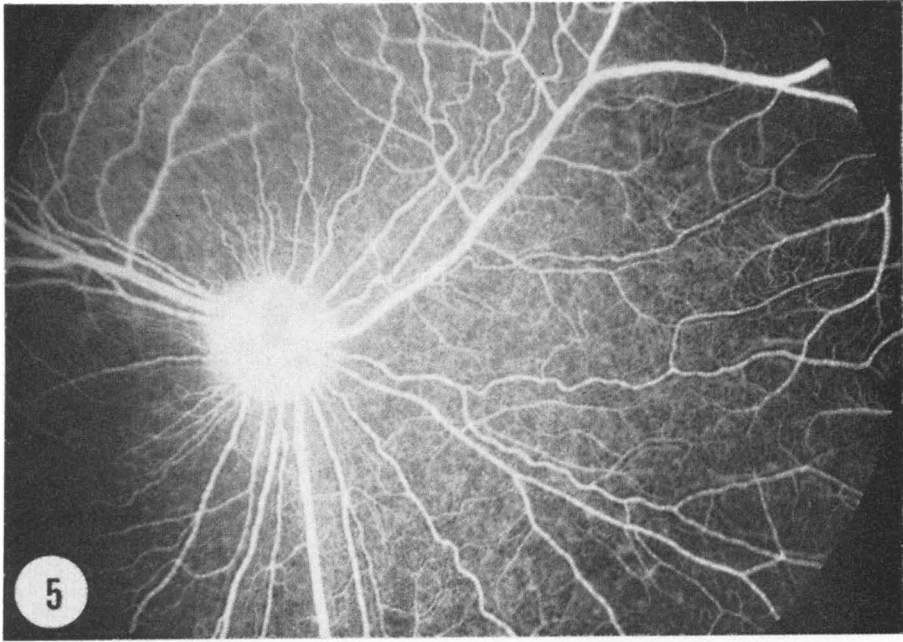
Figure 5. Dog A. Late phase of angiography. No dye leakage is seen.

Figure 6. Dog B. The fundus of a 2 year-old Miniature Poodle bitch photographed in the very early venous phase. The tertiary and secondary branches of the veins from the central area have already filled (white arrow). The optic disc is surrounded by a narrow hypofluorescent ring due to peripapillary pigment aggregation (back arrow). Two kinds of arterioles are fluorescing: 16 long tourtuous cilioretinal vessels reaching throughout the retina, and shorter and thinner arterioles leading to the peripapillary region.
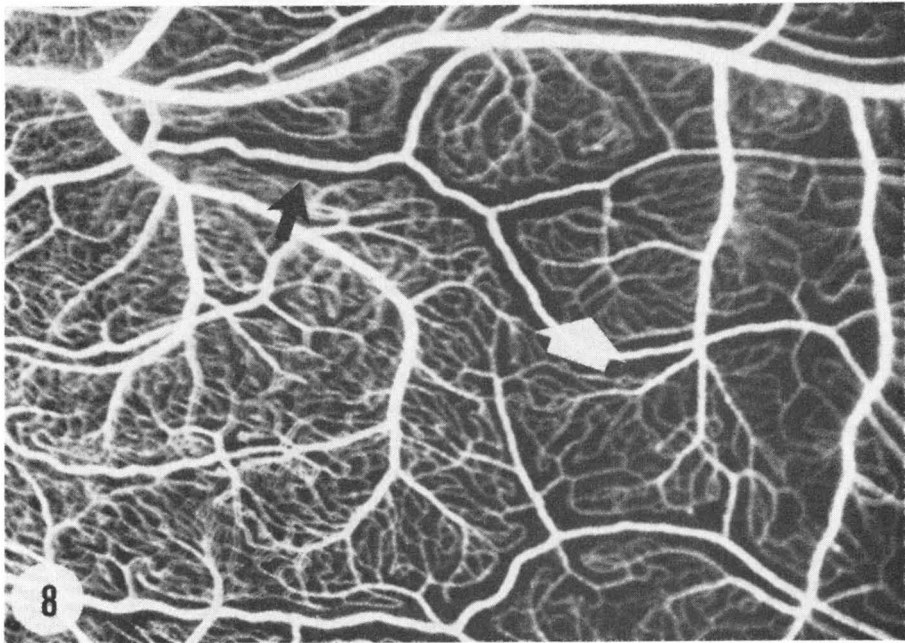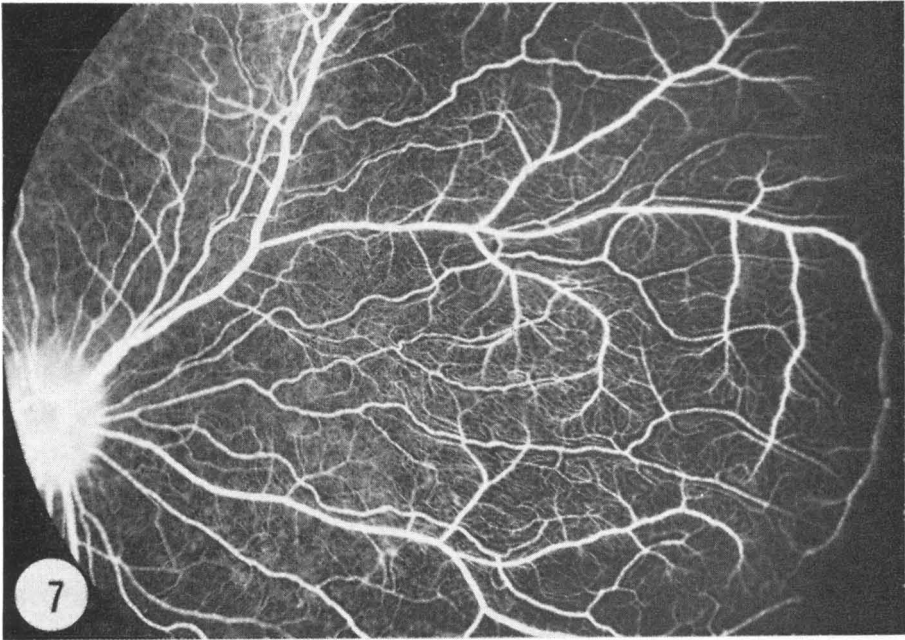
Figure 7. Dog C. The fundus of a 4 year old Toy Poodle bitch photo-
graphed in the late venous phase. The decrease in the density
of the capillary network towards the periphery is obvious.
No arteriovenous shunt formation is seen.

Figure 8. An enlarged segment from Fig. 7 showing the midperipheral
fundus of dog C. The fine capillary meshwork is clearly vis-
ible. The capillaries form freely anastomosing loops. The
capillaries are arranged in a lobulated pattern with indistinct
margins (white arrow). A single arteriolar branch seems to
feed each lobulus which is drained by a small venular branch.
A capillary free zone is evident along the arterioles (black
arrow).

vessel walls in major vein stems (Figs. 2 and 3). This phenomen
was not seen in the small venules which were completely filled
with dye (Fig. 3). The laminated pattern was not disturbed where
2 veins joined (Fig 3). The laminated flow of the dye was main-
tained all the way to the optic disc (Fig. 3). In the late-venous
phase the whole lumen of the larger veins were filled with dye
(Fig. 4). No dye leakage from retinal vessels was observed during
the whole angiography.

With the use of a combination of ketamine and xylazine for
anesthesia the dogs were easily handled and positioned for photo-
graphy. In most of the dogs the globe remained straight during
the whole procedure, which was an advantage of this anesthesia
compared to halothane. Only in 2 dogs did the globe slightly
rotate ventronasally in the beginning of the angiography, but the
globe was easily straightened with a muscle hook. The duration
of the anesthesia was 30—40 min, which was obtained with a
single dose of anesthetics. For longer duration an extra injection
of 4 mg/kg ketamine was needed. This proved to be unnecessary
because most of the dogs remained sufficiently sedated for ex-
amination although they showed signs of recovery from anes-
thesia. In 3 dogs rapid horizontal hystagmus appeared at the
beginning of the anesthesia. Three Poodles, 2 Labrador Retrievers
and 1 Chesapeake Bay Retriever developed epileptiformic seizures
of short duration during the first 5 min after injection of the
anesthetics.

Complications

One 2 year-old Giant Poodle with no previous signs of respira-
tory or circulatory disease died of pulmonary edema 2 days after
angiography; necropsy revealed a myocardial degeneration.

DISCUSSION

A detailed study of the retinal vessels and the way they
filled with fluorescein was possible with the use of a fundus
camera with a wide angle lens and Kodak Tri-X pan 400 ASA
film. The dosage of 12 mg/kg sodium fluorescein, which is the
dosage used for humans, proved to be adequate for dogs. With
this dosage all the different phases of the angiography were well
visualized. After injection of the fluorescein side effects such as
vomiting were rare. The use of control photographs, taken prior

to the injection of the dye, allowed for easier topographic orientation when evaluating fundus angiograms. The evidence of tapetal autofluorescence during angiography indicates that the tapetum emits wave-lengths in the same range as fluorescein. The tapetal autofluorescence combined with choroidal fluorescence inhibits the visualization of dye filled capillaries in the tapetal region. The choriocapillaris fluorescence was diffuse due to dye leakage starting from the early venous phase. The capillaries were easily distinguished in dogs with a darkly pigmented fundus. The more clearly defined capillaries in the peripheral fundus could result from a combination of their lesser density and a stronger pigmentation of the pigment epithelium. The avascular zone was angiographically seen to lineate only the retinal arterioles and not the venules. This corresponds to observations made in humans (*Nowotny & Alvis* 1960, 1961). The fluorescein filled arterioles and veins seemed larger in diameters when compared to the nonfluorescent vessels in the control photographs. The phenomen has been previously reported in man (*Meyer & Schwickerath* 1968). This is explained by the binding of the dye to the peripheral plasmacolumn. Blood plasma is ophthalmoscopically invisible. No specific sex, age or breed differences were observed in our results.

For angiographic procedures the use of a combination of ketamine and xylazine proved to be very useful due to the limited effects on the globe and sufficient duration of sedation. The authors believe that the anesthesia could be a contributory factor to the fatal disorders of 1 Giant Poodle mentioned previously. Therefore ketamine in dogs should be used with caution.

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SAMMANFATTNING

Fluorescein angiografi av hundens ögonbotten i ketamin-xylazin anestesi.

Fluorescine fundus angiografi med en Canon CF 60 Z vidvinkel kamera gjordes på 30 hundar som icke visade patologiska förändringar i ögonbottnen. I bilder tagna i serie kunde fyra skilda cirkulationsfaser av fluoresceinflödet åtskiljas: den choroidala, näthinnas arteriola, den kapillära och den venösa fasen. Färgämnets genomflöde i näthinnans kärl beskrevs i detalj. Kombinationen av Ketamin och Xylazin visade sig vara lämplig för anestesin.