Innervation of the feline and canine cornea in correlation to corneal sensitivity

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Introduction

The purpose of our study was to determine the basic architecture of the corneal neural network, the relative nerve density and the corneal touch threshold (CTT) in healthy dogs and cats. The obtained data were screened for correlation between the nerve density and corneal touch threshold.

Material and Methods

For microscopic and morphometric investigations 40 corneas of adult, mesaticephalic dogs and 26 corneas of domestic shorthair cats were examined, which had been obtained from animals euthanised by pentobarbital overdose for reason unrelated to this project. The CTT were determined in a second group of 22 healthy, adult, mesaticephalic dogs (Fig. 1) and 24 domestic shorthair cats. The corneal nerves were stained using a modified silver impregnation technique. The morphometric evaluation was focused on the quantification of the subepithelial and basalepithelial nerve plexus. In total 360 images of corneal sections were analysed morphometrically. The points of intersections of nerve fibers with a square grid (hits) were counted as morphometric primary parameter of relative nerve density and afterwards converted into into square millimeter.

Fig.1 Measurement of the corneal touch threshold (CTT) by using a Cochet-Bonnet aesthsiometer (12/10mm; Luneau Ophthalmology , Chartre Cedex , France).

Morphometric and aesthesiometric results

The relative nerve density of the subepithelial nerve plexus was 5943 ± 939 hits/mm² in the central (Fig. 2), 6447 ± 877 hits/mm² in the dorsal, 6351 ± 1228 hits/mm² in the ventral region in dogs, 5432 ± 1229 hits/mm² in the central, 5538 ± 659 hits/mm² in the dorsal and 5200 ± 576 hits/mm² in the ventral region in cats. There were no statistically significant differences when comparing the regional values of the subepithelial nerve plexus.

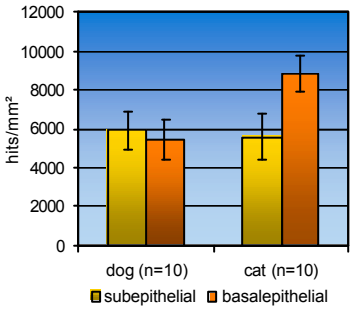

Fig. 2 The relative nerve density of the subepithelial and the basalepithelial nerve plexus in the central region in dogs was approximatly the same (P= 0,143), in contrast to cats having a significantly higher relative nerve density of 8838 ± 916 hits/mm² in the central region (P<0,003).

The mean CTT values (in mm filament length) for dogs were 28,80 ± 7,40 in the central (Fig. 3), 25,95 ± 7,17 in the dorsal and 23,33 ± 7,47 in the ventral region. The mean CTT values in cats were 42,82 ± 2,94 in the central, 37,82 ± 3,31 in the dorsal and 35,43 ± 3,34 in the ventral region. A significant difference in CTT values within both groups was found in the central region, being the most sensitive, followed by the dorsal and ventral region (P<0,001).

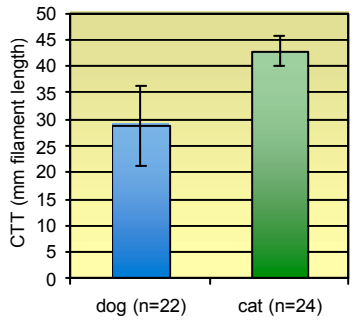

Fig. 3 The central cornea of dogs were significantly less sensitive than in cats (P<0,001).

Microscopic results

The periphery was innervated by a conjunctival nerve plexus (Fig. 4) entering at the superficial level, branching in a disorganized pattern and ending after a short distance. Corneal stromal nerve trunks (Fig. 5) entered the anterior third of stroma from various perilimbal sites, continued centrally and gave off collaterals in horizontal and vertical plane. Most of the smaller nerve fibers extended in anterior direction forming the subepithelial (Fig. 6) and basalepithelial nerve plexus (Fig. 7), expanded into the wing cell layer and ended there as free nerve endings.

Peripheral Cornea

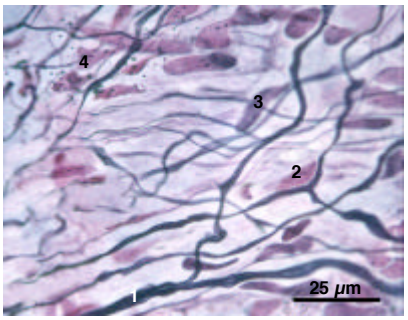

Fig. 4 Superficial conjunctival nerve plexus with (**1**) entering nerve fiber bundles of varying diameter (0,5-3,5 µm), (**2**) fibrocyte, (**3**) Schwann's cell, (**4**) pigment of the corneal margin

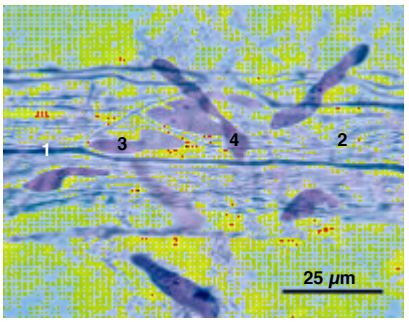

Fig. 5 Deep corneal stromal nerve trunk near the corneal limbus (diameter approx. 50 µm), contains one (**1**) thick axon bundle (3 µm), (**2**) several fine nerve fibers (1-0,6 µm),single axons, (**3**) Schwann-cells (approx. 25 µm); above the nerve rests a fibrocyte (**4**) with its cytoplasmic processes

Central Cornea

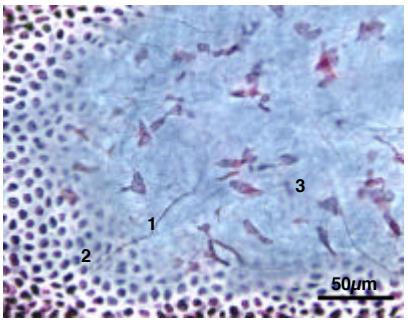

Fig. 6 Subepithelial nerve plexus with nerve fibers (**1**) expanded through the basal lamina between the basal cells (**2**); anterior corneal stroma (**3**)

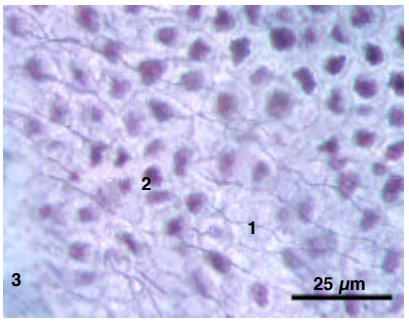

Fig. 7 Basalepithelial nerve plexus with criss-crossing, predominantly straight running nerve fibers (**1**) in a horizontal orientation (diameter 0,5-1µm), basalepithelial cell layer (**2**), subepithelial plane (**3**)

Conclusion

The higher relative nerve density of the cats basalepithelial nerve plexus and the higher corneal sensitivity indicated a functional connection. No correlation was found between the subepithelial relative nerve density and the CTT values.

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