Morphological studies on lyssa in cats and dogs

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ABSTRACT: The aim of this study is to reveal the morphology of the lyssa in the cat and dog. Eight heads of adult healthy cats and eight heads of dogs of both sexes were used as materials. In the cat the lyssa, yellow coloured, had a helical appearance and its edge facing the oral cavity became sharp; in the dog the lyssa, pinkish white coloured, was more or less J-shaped. The whole body of the cat's lyssa was buried among the intrinsic lingual muscles. In the dog, although aboral, two thirds of the lyssa were squeezed among the intrinsic lingual muscles, its cranial third was placed just under the mucosa to protrude slightly into the oral cavity. In both species, the whole body of the lyssa was determined to have been formed by the nearly adipose tissue in which occasional striated muscles existed. Moreover, in the middle third of the dog's lyssa, dense striated muscle fibres were seen dorsally to the adipose tissue, and we also noticed with interest that the lyssa sheath embracing this part contained few muscle spindle-like structures. It was of interest that in the cat a pyramidal rod encircled by a fine capsule of connective tissue was attached to the ventral edge of the cranial third of the lyssa.

Keywords: lyssa; tongue; morphology; carnivore

In cats and dogs there is a firm cartilaginous, almost bony structure called the lyssa lying along the median ventral surface under the tip of the tongue. First described in a Mesopotamian tract dating from 1800 B.C., the illness was known to the ancient Greeks as lyssa, meaning "frenzy". But the Romans, adopting the Latin word that means "to rage", gave us the name by which the disease is known today: rabies. Moreover, since the lyssa was formerly considered to be a worm causing rabies, its removal was thought to help to prevent from rabies (Easley, 1999). In fact, the lyssa derived from the neuroectoderm was a morphological structure situated ventrosagittally at the apex of the tongue in carnivores, which can easily be demonstrated on a cross section (Budras et al., 1994; Capellari et al., 2001). This fusiform fibrous spicule shaped lyssa extends from the apex to the level of the attachment of the frenulum linguae (Evans and La Hunta, 1996). Budras et al. (1994) considered the adipose tissue of the lyssa as structural because no change appeared during life in its adipose tissue.

The authors (Capellari et al., 2001) claimed that the contraction of skeletal muscles located dorsally to the adipose tissue in the aboral half of the carnivore lyssa causes volume reduction and consequently stiffening, straightening and dorsal flexion of the lyssa according to the shape of its connective tissue sheath, and that its relaxation causes the lyssa to become soft and to take an undulating course.

Since previous anatomical descriptions concerning the lyssa in carnivores are rather superficial and/or conflicting, in the present study we aimed to describe a detailed morphology of the lyssa in the cat and dog.

MATERIAL AND METHODS

Eight heads of adult healthy cats and eight heads of dogs of both sexes were used as materials. The cats, mixed breeding, 2 to 3 years of age, were weighing between 2.5 and 3.5 kg each; the dogs, mixed breeding, 4 to 5 years of age, were weighing

between 25 and 30 kg each. All heads were obtained from the recorded cadavers used by students in an anatomy laboratory of Selcuk University, Veterinary Faculty, Konya, Turkey. The animals were intramuscularly anaesthetised with 2 mg/kg xylazine HCl (Rompun®, Bayer, Istanbul, Turkey) and 20 mg/kg ketamine HCl (Ketanez®, Alke, Istanbul, Turkey), and subsequently killed by exsanguination from the right common carotid artery without regaining consciousness. After the tongues of the animals were removed, the specimens were transferred into containers with 10% formaldehyde solution. Then, four cat (2 males, 2 females) and four dog (2 males, 2 females) tongues with lyssa were investigated both macroscopically and under a stereomicroscope (Nikon SMZ-2T, Nikon Corp., Tokyo, Japan). For routine histological examinations, the tissue samples of the remaining tongues were fixed in 10% buffered-formaldehyde (pH 7.4), dehydrated, cleared and embedded in paraffin blocks and cut in 6-µm thick transverse sections which were stained with Crossman's trichrome stain (Bradbury and Gordon, 1990). The histological preparations were examined using a light microscope (Nikon E-400 attached with DS-5M digital camera and DS-L1 Camera control unit). All measurements were performed using a digital calliper (Mitutoyo 500 171-1 Digimatic Calliper 150mm/6in, Japan).

RESULTS

Dissection findings

The lyssa was found to lie along the median plane on the ventral surface of the free tip of the tongue in both species (Figure 1). The body of the cat's lyssa, yellow coloured, had a mean length of 1.5 cm and diameter of 1 mm. Moreover, it was very interesting that in the cat the lyssa had a helical appearance and its edge that faced the oral cavity became sharp as a razor blade (Figure 2). In the dog the lyssa, more or less J-shaped and pinkish white coloured, was approximately 3.5 cm long and 3 mm in diameter. The whole body of the cat's lyssa was buried among the intrinsic lingual muscles. In the dog, although aboral, two thirds of the lyssa were squeezed among the intrinsic lingual muscles, its cranial third was located just under the mucosa to protrude slightly into the oral cavity. In the dog, therefore, its cranial portion was readily visible and was palpable on the median plane in the free tip of the tongue. The cranial extremity of the lyssa was about 3 mm or 2 mm away from the apex of the tongue in the dog and cat, respectively. In both species the sheath of the connective tissue of the lyssa was mixed with the lingual septum, by projecting from the oral extremity of the lyssa. In the cat the

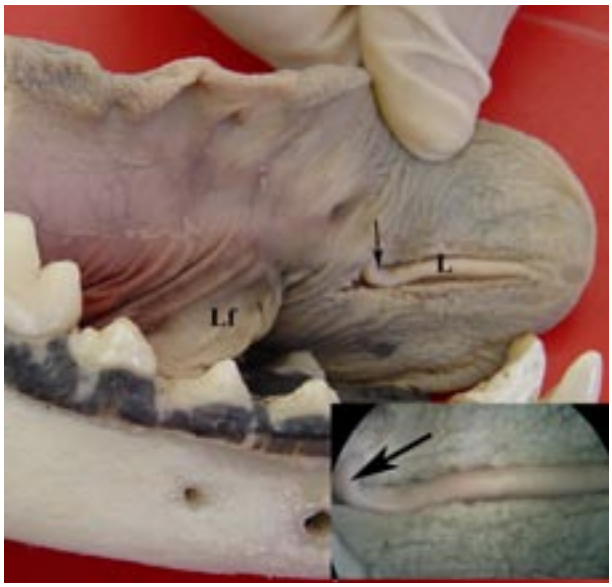

Figure 1. Location of the lyssa in dog's tongue, arrows show the J-shaped curving of lyssa

Abbreviations: L = lyssa; Lf = lingual frenulum

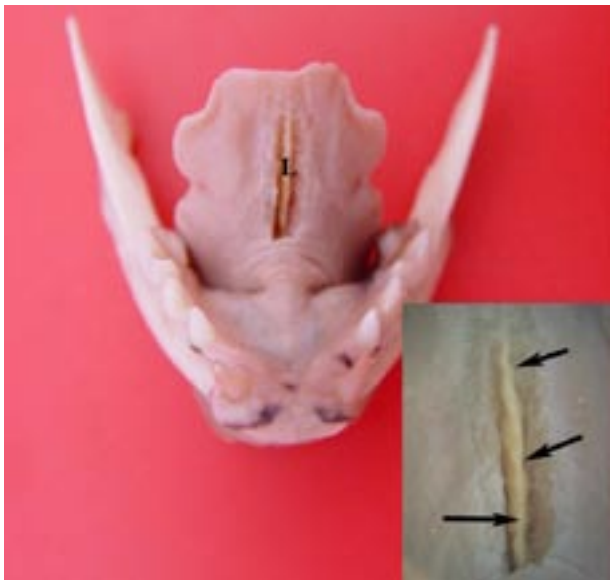

Figure 2. Location of the lyssa in cat's tongue, arrows show the helical structure of lyssa

Abbreviations: L = lyssa

Figure 3. Transverse section of the cranial third of the lyssa in dog

Abbreviations: Ct = connective tissue; Dlf = deep longitudinal fibres; L = lyssa; Ls = lingual septum; Tf = transverse fibres

sheath leaving the aboral extremity of the lyssa, about 10 mm away from the lingual frenulum, was mixed aborally with the rostral part of the vertical fibres of the genioglossus muscle. In the dog, however, it penetrated into the intrinsic muscles in the right half of the tongue immediately after turning sharp right at an approximate distance of 10 mm from the lingual frenulum to form a J-shaped bend with an aboral convexity.

Histological findings

In both species, the body of the lyssa was encircled by a thick connective tissue made from collagen fibres. The latter ones were mixed with those of *lamina propria* along the whole length of the lyssa (Figure 3). In both species, the entire body of the lyssa was found to have been formed by the nearly adipose tissue in which not only occasional striated muscle fibres but also blood vessels and nerve fibres were found. Moreover, in the middle third of the dog's lyssa, dense striated muscle fibres were seen dorsally to the adipose tissue (Figure 4), and we also noticed with interest that the lyssa sheath embracing this part contained few muscle spindle-like structures (Figure 5). In the cat it was interesting that a pyramidal rod encircled by a fine capsule of connective tissue was attached to the ventral edge of the cranial third of the lyssa (Figure 6). This rod was formed by the adipose tissue and seemed to support the lyssa ventrally.

In the light of the macroscopic and microscopic findings, we suggested that the lyssa of both species serves as an elastic limb and/or skeleton of the free portion of the tongue and its helical or J-shaped structures can possibly be straightened by the contraction of intrinsic lingual muscles.

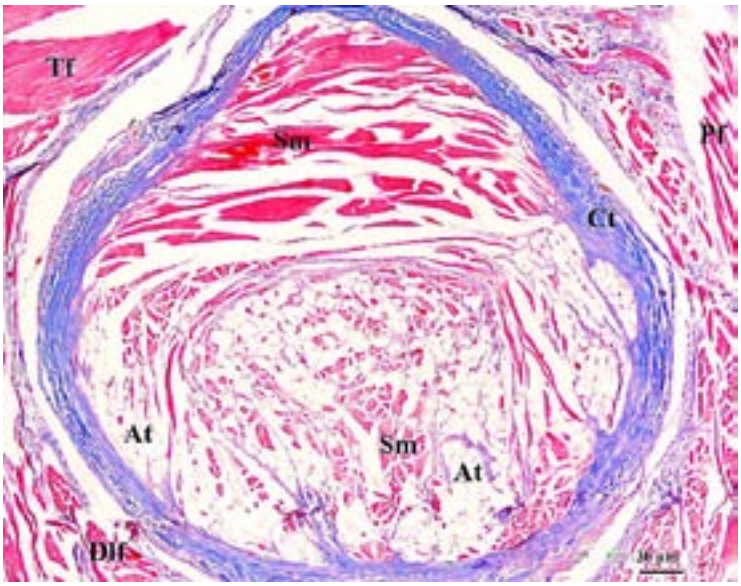

Figure 4. Transverse section of the middle third of the lyssa in dog

Abbreviations: At = adipose tissue; Ct = connective tissue; Dlf = deep longitudinal fibres; Sm = striated muscle; Pf = perpendicular fibres; Tf = transverse fibres

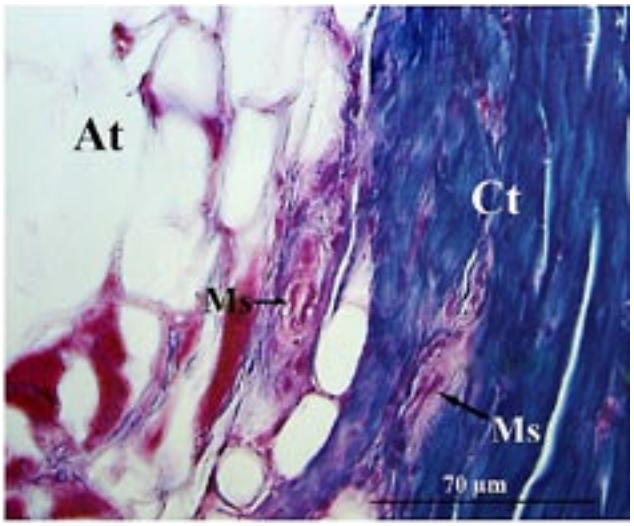

Figure 5. Muscle spindles in the connective tissue sheath of the middle third of the lyssa in dog

Abbreviations: At = adipose tissue; Ct = connective tissue; Ms = muscle spindle

DISCUSSION

Although some authors (Evans and Christensen, 1979; Nickel et al., 1979; Schaller, 1992; Budras et al., 1994; Frewein and Vollmerhaus, 1994) stated that the cartilaginous tissue existed in the structure of the lyssa in carnivores, in our study we found no cartilaginous tissue in both species as was reported by Capellari et al. (2001).

Although Capellari et al. (2001) reported that the lyssa had a rod-shaped appearance in the cat and dog, this study revealed that it was spiral-shaped in the cat and J-shaped in the dog. We proposed that the spiral structure of cat's lyssa makes its very quick and/or short-time lengthening possible, and therefore the cat can effectively use its tongue for speedy lingual movements. The authors mentioned above stated that although the oral half of the lyssa contained mainly the adipose tissue, its aboral half also had skeletal muscles placed dorsally on the adipose tissue. However, we found that the whole body of the lyssa in both species comprised the adipose tissue in which rare striated muscles dispersed sparsely, and that in the dog its middle third also had dense striated muscle fibres located just dorsally to the adipose tissue.

In the textbook (Gartner and Hiatt, 2001) it was stated that the muscle spindles, an important proprioceptor, lie among myofibres and are monitoring devices of the nervous system for body position, tactile input, joint movement, etc. We also saw that muscle spindle-like structures existed in the middle

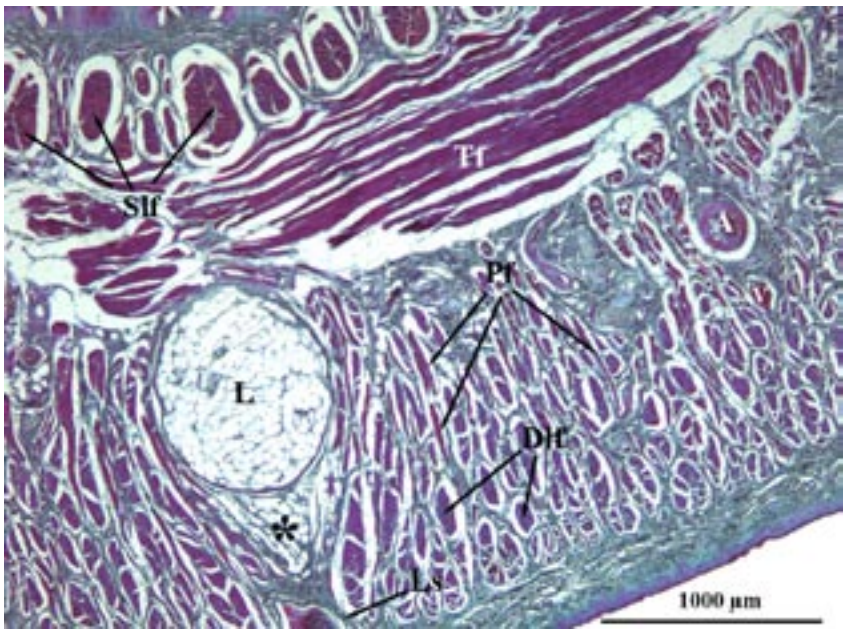

Figure 6. Transverse section of the cranial third of the lyssa in cat

Abbreviations: * shows a pyramidal rod of adipose tissue encapsuled by connective tissue; A = artery; Dlf = deep longitudinal fibres; L = lyssa; Ls = lingual septum; Pf = perpendicular fibres; Slf = superficial longitudinal fibres; Tf = transverse fibres

third of the dog's lyssa sheath. We proposed that they possibly detected and/or adjusted the threshold level of changes suitable for any lingual tension thus acting as a sort of potentiometer apparatus. However, since vertical fibres of the genioglossus muscle in the cat were connected with the aboral extremity of the lyssa, they possibly substitute for muscle spindles in order to regulate the lingual extending position.

Based on the findings of our study, it was concluded that the lyssa must be taken into consideration not only in operations on pathologic structures such as intermandibular and dermoid cysts found in the mouth and tongue (Liptak et al., 2000), but also in *frenulum linguae* operations such as partial or complete ankyloglossia and sublingual frenectomy (Eisenmenger and Zetner, 1985). The authors claim that further embryological and physiological studies are required to understand thoroughly the functional importance of the lyssa in carnivores. They also suggest that the results from this study shed light on the future experimental studies on the lyssa, and that they contribute considerably to the present anatomical knowledge regarding the lyssa in the cat and dog.

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