Dept. of Anatomy and Histology
Fac. Vet. Med., Assiut University
Head of Dept. Prof. Dr. A. Hifny.

COMPARATIVE STUDIES OF THE NERVE SUPPLY OF THE LARYNX IN DOG, GOAT AND DONKEY

(With 3 Fig.)

By

YOUSRIA A. ABDEL-RAHMAN; A.K. AHMED and H. BADAWI

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دراسات مقارنة على أعصاب الحنجره فى الكلاب الماعز ، الحمير

يسريه عبد الغنى ، أحمد قناوى ، حلمى بدوى

تم إجراء هذا البحث بغرض دراسة أعصاب الحنجره وتوزيعها فى الكلاب والماعز والحمير. ولقد أوضحت الدراسة التشريحيه أن اعصاب الحنجره تأتى من الفرع الخارجى والداخلى للعصب الحنجرى الأمامى وكذلك من العصب الحنجرى الخلفى فى الثلاث حيوانات ، بالإضافه إلى العصب الحنجرى الوسطانى وكذلك المصاحب للعصب الراجع فى حالة الكلب.

وقد أظهرت النتائج أنه يوجد إتصال بين الفرع الداخلى والعصب الحنجرى الخلفى فى الحيوانات موضع الدراسه وكذلك إتصال الفرع الداخلى للعصب الحنجرى الأمامى أيضاً بالعصب المصاحب للعصب الراجع فى حالة الكلاب وقد لوحظ أيضاً إتصال العصب الحنجرى الخلفى بنظيره فى الحمار وكذلك بين العصب السابق ذكره والفرع الموصل بنظيرهما من الناحيه الأخرى فى الكلاب.

SUMMARY

The pattern of innervation of the larynx was carried out on fresh and formalin preserved materials of 36 adult male and female dogs (12), goats (12) and donkeys (12). The external, internal, and caudal laryngeal nerves are constant in the 3 studied species. In addition, the larynx of dog receives also the median and the pararecurrent laryngeal nerves. This study revealed the presence of anastomosis between the internal branch of the cranial laryngeal nerve and the caudal laryngeal one through a R. communicans in the 3 dissected animals as well as between the former branch and the pararecurrent nerve in the dog. Also in dog another communication takes places in the form of a plexus at the median plane between a twig of the R.communicans and of the caudal laryngeal nerve in one side with the homonymous structures of the opposite side. In the donkey a simple anastomosis between the caudal laryngeal nerves of both sides was demonstrated caudal to the median raphe of the M.arytenoideus transversus. The R.externus supplies the M.cricothyroideus in goat and donkey while, in dog it supplies the same muscle after joining the median laryngeal nerve. The R.internus innervates the mucosa of the laryngeal vestibule and the ventral part of the glottis. The caudal laryngeal nerve innervates all the internsic laryngeal muscles except the M.cricothyroideus. In addition, it supplies also the mucosa of the infraglottic cavity and that of the dorsal part of the glottis.

INTRODUCTION

In domestic animals little was mentioned concerning the laryngeal nerves by several authors *(BOWDEN & SCHEUER, 1961; GODINHO, 1973; GODINHO & GETTY, 1975; SEIFERLE, 1984; DYCE, SACK & WENSING, 1987; BERG, 1988).*

The aim of this study is to throw a light on the laryngeal nerves and their termination within the larynx of dog, goat and donkey

MATERIALS and METHODS

Dissection of the laryngeal nerves on both sides of the larynx was done under the dissecting and surgical microscopes on fresh and 10% formalin fixed materials from 12 dogs, 12 goats and 12 donkeys and also the pattern of innervation were recorded. Special attention was given for the existence of any communication between the different branches of the laryngeal nerves. The nomenclature used here is adopted by the *N.A.V. (1983).*

RESULTS

Generally, the larynx of dog, goat and donkey receives its innervation from the cranial and caudal laryngeal nerves which are branches of the vagus nerve . However, in dog the larynx recieves in addition to the above mentioned nerves the median and the pararecurrent Laryngeal nerves. In dog, goat and one dissected case of the donkey the cranial laryngeal nerve is divided into an external and internal branches. Ramus externus N. Laryngeus cranialis:

In dog and goat the external branch arises from the N. Laryngeus cranialis at about 1-2 cm before its entering the larynx. In donkey it originates often from the pharyngeal plexus and in 3 cases it arose directly from the vagus. However, in one specimen this branch was detached from the cranial laryngeal nerve as in dog and goat.

In all examined animals, the R. externus runs caudoventrally on the lateral aspect of the M. thyropharyngeus then passes undercover the M. sternothyroideus to terminate in the M. cricothyroideus. In the dog and before its termination it receives the median laryngeal nerve. The latter originates mainly from the pharyngeal plexus and only in one case it arose from the cranial laryngeal nerve directly after its origin from the nodose ganglion. Along its course, the R.externus detaches 1-2 twigs to the Mm. thyropharyngeus and cricopharyngeus as well as the thyroid gland in case of dog and donkey. In the goat it detaches a branch which anastomses with the esophageal twig of the pharyngeal plexus, and gives off another anastomotic branch to the caudal laryngeal nerve just before the latter enters the larynx.

Ramus internus N. Laryngeus cranialis.

The internal branch (Fig. 1, 2, 3/1) of the cranial laryngeal nerve enters the larynx through the thyrohyoid membrane in case of dog or through the thyroid foramen in case of goat and donkey. About 0.5-1 cm before its entrance it detaches the R. communicans cum N. laryngeo caudali and

terminates by dividing into 3-7 twigs in dog (Fig. 1/2 and 3-6 twigs in goat (Fig 2/2). In the donkey and about 1 cm dorsal to the thyroid foramen the internal branch divided into a cranial and a caudal twigs. The caudal twig gives off a R. communicans about 1 cm after its entering. After that both main branches divide several times to give 7-12 twigs (Fig 3/2).

In the 3 studied species, the above mentioned twigs supply the mucous membrane of the lingual surface of the epiglottis, the corniculate process, ary- or lateral epiglottic fold, the laryngeal vestibule and the ventral part of the glottis as well as the epiglottic and corniculate cartilages. Moreover, in the donkey and dog they innervate the median laryngeal recess and/or the laryngeal ventricles in addition, to the caudal part of the pharyngeal mucosa in case of goat and donkey.

The R. communicans cum N. laryngeo caudali (Fig 1, 2, 3/4) From its origin from the R. internus it runs caudally medial to the thyroid cartilage. In goat, donkey and 20% of dog, it joins the caudal laryngeal nerve above the cricothyroid joint. While, in the rest of the dissected dogs it runs in a fibrous sheath with the latter nerve until the second or the third tracheal rings and then ends by joining the pararecurrent nerve.

Throughout its course, the R. communicans cum N. laryngeo caudali in dog detaches 2 twigs, the first twig (Fig. 1/3) passes dorsally to the overlying pharyngeal mucosa. The second twig (Fig. 1/10) runs together with a branch (Fig. 1/11) from the caudal laryngeal nerve towards the median plane of the larynx and rostral to the M. cricoarytenoideus dorsalis to join the homonymous twig of the opposite side forming a plexus (Fig. 1/12). This plexus detaches 3 groups of twigs, the rostral group (Fig. 1/13,14) innervates the corniculate cartilage, the Mm. arytenoideus transversus and ventricularis and the caudal one (Fig. 1/15) terminates in the M. cricoarytenoideus dorsalis. While, the ventral group passes in the space between the arytenoid and cricoid cartilages to terminate in the mucous membrone of the infraglottic cavity and the dorsal part of the glottis. However, in the three out of the dissected goats the R. communicans gave off a twig to the lateral epiglottic fold, corniculate cartilage, pharyngeal mucosa and the esophagus. While, in donkey it detaches 2 twigs (Fig. 3/5) to the M. vocalis and the laryngeal ventricle.

The pararecurrent nerve (Fig. 1/8) of the dog springs either from the vagus in half of the dissected cases or from the recurrent laryngeal nerve in the rest of specimens, directly near the latter's origin, then passes parallel to it.

Along its course, it makes an anastomoses with the recurrent laryngeal nerve at a variable distance and gives off several rami to the esophagus and trachea.

N. Laryngeus caudalis

In the three dissected species, the caudal laryngeal nerve (Fig. 1,2,3/6) runs between the M. cricopharyngeus and M. cricoarytenoideus dorsalis to enter the larynx between the thyroid and cricoid cartilages above the cricothyroid joint. Thenafter it runs rostroventrally on the lateral aspect of the M. cricoarytenoideus latralis and terminates in the M. vocalis in dog, Mm. vocalis and ventricularis in donkey and M. thyroarytenoideus in goat. However, in two cases of the later animal, it penetrated firstly the texture of the M. cricoarytenoideus lateralis before its termination.

Throughout its course, the N. laryngeus caudalis detaches variable number of muscular branches, ranged from 1-3 in dog (Fig. 1/9), 3-6 in goat (Fig. 2/9, 16) and 5-11 in donkey(Fig. 3/9, 16) ,to the Mm. cricoarytenoideus dorsalis and lateralis. Moreover, the caudal laryngeal nerve gives off another branch in the 3 dissected animals (Fig. 1/11; 2, 3/18)that passes rostromedially undercover the M. cricoarytenoideus dorsalis to terminate in the M. arytenoideus transversus in goat and donkey and also in a part of the M. ventricularis which lies over it in the later animal. In dog this branch passes towards the median plane of the larynx to share in the formation of the already described plexus. The above mentioned branch (Fig 2,3/18) gives off a further twig (Fig. 2/18) in goat which runs towards the median plane of the larynx to pass between the cricoid and arytenoid cartilages and terminate in the mucous membrane of the infraglottic cavity and the dorsal part of the glottis. In donkey it gives off further 2 twigs, one of them (Fig. 3/18) has the same course as that of goat. While, the other (Fig. 3/18') anastomoses with homonymous of the opposite side at the raphe of the M. arytenoideus transversus.

Moreover, in two dogs and one goat the caudal larynageal nerve gave also another twig. In the former animal it passes between the caudal border of the arch of the cricoid cartilage and the first tracheal ring and in the goat it runs medial to the M.cricoarytenoideus Lateralis and the cricoid cartilage in the Latter. It terminates in the mucous membrane of the infraglottic cavity in addition to the caudal part of the M. thyroarytenoideus in goat.

DISCUSSION

In the present investigation the cranial laryngeal nerve in dog and goat is divided into an external and internal branches similar to that recorded in dog (*MILLER et al., 1964, JENKINS, 1972, EVANS and DelAHUNTA, 1980*), in bovine (*McLEOD, 1958*), in ox (*RAGHAVAN and KACHROO, 1964*), in horse (*BRADLEY and GRAHAME, 1947*) and in domestic animals (*GODINHO and GETTY, 1975; SEIFERLE, 1984*).

However, in the most investigated donkeys the cranial laryngeal nerve is absent as the external and internal branches arise separately, the internal branch emerges directly from the vagus as observed in horse (*QUINLAN et al., 1982*) and bovine (*GODINHO and GETTY, 1975*). While, the external branch arise mainly from the pharyngeal plexus or directly from the vagus. These findings are greatly in accordance with those given by *SISSON and GROSSMAN (1968)* in horse, *GODINHO and GETTY (1975)* in some bovine specimens. *SEIFERLE (1984)* stated that when the R. externus arises from the vagus trunk is called N. Laryngeus medius.

The present work proved that the external branch innervates the M. cricothyroideus in the 3 studied species. In additon, it supplies also the thyroid gland in dog and donkey as stated by *JENKINS (1972), GODINHO and GETTY (1975)* in dog and the Mm. cricophayngeus and thyropharyngeus in the same mentioned animals as descrided by *GODINHO and GETTY* (1975) in ruminants and horse.

Our results indicated that the M. cricothyroideus in dog received the median laryngeal nerve in addition to the above mentioned ramus externus which anastomose with each other before entering the muscle. This observations is supported by *ELLENBERGER and BAUM (1891), LIVON (1891), LEMERE (1932 a), SHIN et al. (1969) and IBRAHIM et al. (1980)* in dog and *HUNT* and *KUFFLER (1954)* in cat. While, *MARTENSSON (1966)* could not provide the existance of the double innervation of the M. cricothyroideus of the dog. However, *COMPBELL and MURTAGH (1956)* in goat and *ONODI (1902)* in man found that the M. cricothyroideus may receive motor innervation from both the R. externus and the recurrent nerve. On the other hand ,and by electromyography *RUDOMIN (1966)* recorded in feline that the reminant activity of the M. cricothyroideus after sectioning the external branch is due to the existence of very few fibers that perform this activation other than the R. externus.

In agree with *BRADLEY and GRAHAME (1947)* in horse, *McLEOD (1958)* in bovine and *HARE (1975)* in ruminant and horse the

internal branch enters the larynx through the thyroid foramen in goat and donkey. while, in dog it enters the larynx through the thyrohyoid membrane as mentioned by *VOGEL (1952) and HARE (1975)* in the same animal.

Our results provide that the R. internus supplies the laryngeal mucosa until the glottis as stated by *MILLER* et al. *(1964)* in dog, *HARE (1975), DYCE* et al. *(1987) and BERG (1988)* in domestic animals. However, in dog *(VOGEL, 1952; BRADLEY and GRAHAME, 1959; JENKINS, 1972; EVANS and DeLAHUNTA, 1980)* , in bovine *(McLEOD, 1958)*, in ox *(RAGHAVAN and KACHROO, 1964)*, in horse *(BRADLEY and GRAHAME, 1947; SACK and HABEL, 1977)* and in domestic animals *(GODINHO and GETTY, 1975; SEIFERLE, 1984)* the R. internus innervates the whole laryngeal mucosa. *Moreover, NEW (1923), GREENE (1924), BERLIN and LAHEY (1929), NEW and CHILDREY (1932), ZIEGELMAN (1933) and VOGEL (1952)* added that in man the R. internus contains motor Fibers innervating the M. arytenoideus transversus. The present investigation revealed that this Ramus supplies also the mucous membrane covering the epiglottis and the corniculate process as well as the epiglottic and corniculate cartilages and the caudal part of the pharyngeal mucosa in goat and donkey. *SEIFERLE (1984)* mentioned that the R. internus carries taste Fibers to the epiglottis and the aryepiglottic fold as a parasympathetic fibers for the laryngeal gland.

Through the R. communicans, the internal laryngeal branch anastomoses with the caudal laryngeal nerve in the 3 dissected animals as stated in dog *(LEMER, 1932 b; VOGEL, 1952; BRADLEY and GRAHAME, 1959 ; BOWDEN and SCHEUER, 1961; MILLER* et al., *1964; JENKINS, 1972)*, in sheep *(MAY, 1970)*, in horse *(QUINLAN* et al., *1982)*, and in domestic animals *(GODINHO and GETTY, 1975; SEIFERLE, 1984). However, BOWDEN and SCHEUER (1961)* recorded that this anastomtic branch is absent in all artiodactyle species except the pig.

Our results revealed the presence of a plexus only in dog at the median plane rostral to the cricoid lamina, which is formed by joining of two twigs from the R. communicans and the caudal larygeal nerve at one side to the homonymous of the opposite one. This indicate possibly a bilateral innervation of the supplied structure at both sides of dog larynx. However, in donkey another anastomosis is observed caudal to the median raphe of the M. arytenoideus transversus between the right and left caudal laryngeal nerves. *QUINLAN* et al. *(1982)* in horse have not observed the crossover of nerve Fibers from one side of the larynx to the other. Consequently they stated that, the nerve supply of the larynx in the horse is strictly unilateral.

In agree with *LEMER (1932 a, b), BOWDEN and SCHEUER (1961) and PIERARD (1963)* in dog, the R. communicans Joins the so called pararecurrent nerve. The former authors stated that the pararecurrent nerve supplies the infraglottic mucosa.

As stated by *MILLER et al. (1964)* in dog, *HARE (1975) and DYCE et al. (1987)* in domestic animals, the recurrent laryngeal nerve in dog, goat and donkey supplies all the intrinsic laryngeal muscles except the M.cricothyroideus, in addition to the mucous membrane of the infraglottic cavity and the dorsal part of glottis which indicates that the caudal laryngeal nerve is not purely motor. The system of layngeal nerves is really a plexus *(DILWORTH, 1921:* in man).

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LEGENDS

Fig 1: Nerves of the larynx of the dog. Dorsal view.

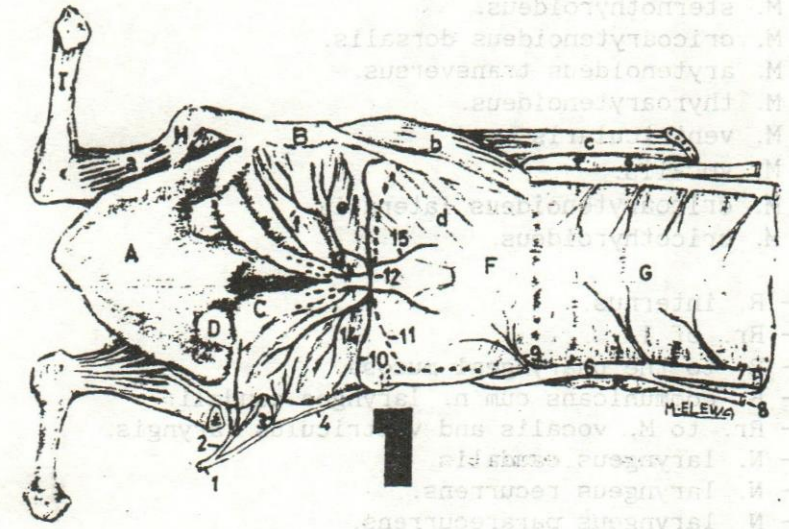
Fig 2: Nerves of the larynx of goat. Left lateral view. Deep dissection.

Fig 3: Nerves of the larynx of donkey. Left lateral view. Deep dissection.

A- Epiglottis.
B- Cartilago thyroidea.
C- Processus corniculatus.
D- Processus cuneiformis.
E- Plica aryepiglottica.
F- Cartilago cricoidea.
G- Trachea.
H- Thyrohyoideum.
I- Epihyoideum.
J- Ventriculus laryngis.
a- M. ceratohyoideus.
b- M. thyrohyoideus.

c- M. sternothyroideus.
d- M. cricoarytenoideus dorsalis.
e- M. arytenoideus transversus.
f- M. thyroarytenoideus.
f- M. ventricularis.
f- M. vocalis.
g- M. cricoarytenoideus lateralis.
h- M. cricothyroideus.

1 - R. internus.
2 - Rr. of 1.
3 - R. to the pharyngeal mucosa.
4 - R. communicans cum n. laryngeo caudali.
5 - Rr. to M. vocalis and ventriculus laryngis.
6 - N. laryngeus caudalis.
7 - N. laryngeus recurrens.
8 - N. laryngeus pararecurrens.
9 - Rr. muscularis to M. cricoarytenoideus dorsalis.
10- R. from 4.
11- R. from 6.
12- Plexus formed of 4 and 6 of both sides.
13,14- Rostral group to processus corniculatus and Mm. arytenoideus transversus and ventricularis.
15- Caudal group to the M. cricoarytenoideus dorsalis.
16- Rr. musculares to M. cricoarytenoideus lateralis.
17- Rr. musculares to the M. thyroarytenoideus.
18- R. to M. arytenoideus transversus.
18- R. to the cavum infraglotticum and the dorsal part of the glottis.
18- R. to anastomose with the homologous of the opposite side at the raphe of the M. arytenoideus transversus.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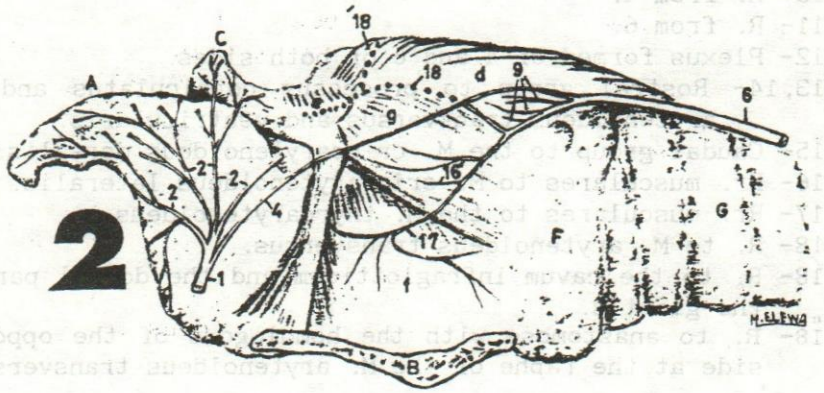
M.ELEWA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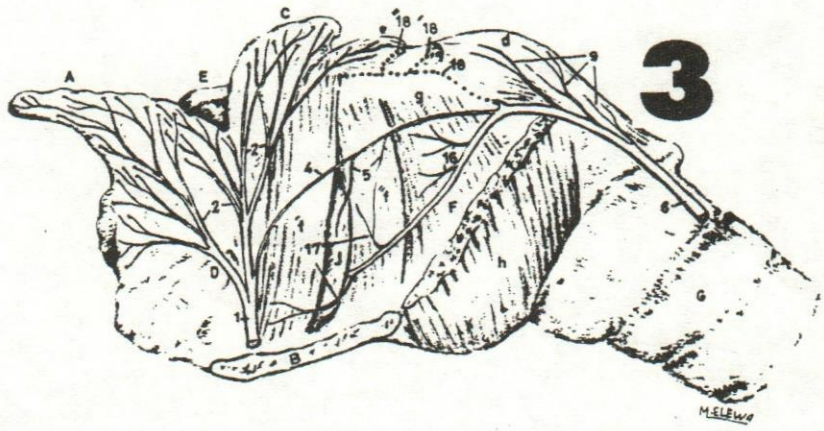
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