Cairo University
Faculty of veterinary medicine
Anatomy and Embryology Department

"Anatomical studies on the spinal cord of the domestic cat (*Felis domesticus*)"

Thesis presented by

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Under the supervision of

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Title of Thesis

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Abstract

Part I: The morphological and morphometric studies

The study was applied on the spinal cord of ten cats and addressed its beginning and termination levels, enlargements, segmentation, the relationship between the medullary segments and the corresponding vertebrae, in addition to the morphometric studies including its total length and the length of its indices in different regions, the segment measurements as well as the root and interroot lengths of both dorsal and ventral spinal nerve roots.

Part II: The vascular studies revealed that:

The study was applied on fifteen cats injected with colored Neoprene latex. And revealed that the spinal cord received blood from five longitudinal trunks: an unpaired ventral spinal artery and a pair of lateral dorsal spinal arteries and another pair of medial dorsal spinal arteries. These vessels were reinforced by 20-23 pairs of radicular arteries. The superficial veins accompanied with the spinal cord were the ventral and dorsal median spinal veins which were drained through 12 -18 ventral and 6-13 dorsal radicular veins.

Key words: Spinal cord, Anatomy, Blood supply, cat.

Dedication

Dedicated to my family

….Father,

….Mother

….Sister

. . . Brothers

. . .and my uncle

And to my Faithful Friends

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First and foremost, all praise is due to ALLAH to whom every success should be attributed.

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Contents

Introduction

Knowledge of the topography of the spinal cord is indispensable in clinical practice for the diagnosis, prognosis and treatment of vertebromedullary injuries, and it is sometimes necessary to locate injuries of the central nervous system at a vertebral level, a method that is possible by associating specific sensory and motor deficiencies in a given spinal segment **(Machado, 2003 and Dyce *et al*, 2004)**, especially in anesthesiology, in order to block specific spinal nerves **(Dyce *et al*, 2004).**

The spinal cord was early studied in the cat by **Hopkins (1935), Thomas and Combs (1962) and Camara-Filho *et al*., (1998)** but there is a paucity of the anatomical information about this organ particularly its vascularization. The anatomical studies of the spinal cord received also attention of many anatomical researchers, In this respect, in humans **(Willians *et al*., 1995)**, monkeys **(Carvalho-Barros *et al*., 2003),** sheep **(Rao, 1990),** coatis **(Gregores *et al*., 2010),** freshwater dolphins **(Machado *et al*., 2003),** sea lion **(Fettucia and Simoeslopes,2004)** and rabbit **(Farag *et al*., 2012).** Moreover**, Mansour (1980), Abu-zaid (1982) and Abd El-ghany (1995)** gave valuable studies on the anatomy of the spinal cord in donkey, buffalo, and goat respectively.

Considering the importance of detailed knowledge about the comparative anatomy of the nervous system of vertebrates and its use in veterinary medicine, the purpose of this investigation was to give adequate information about the anatomy of the spinal cord of the cat specially referring to its segments and the vertebromedullary relationships as well as its vasculature.

MATERIAL AND METHODS

For morphological study, ten adult cats of different ages, sex and weights were selected. The animals were clinically examined to be free from any deformities or diseases that could affect the vertebral column or its contents.

The animals were prepared, scarified and bled through the common carotid arteries. The blood vessels were thoroughly washed by worm normal saline solution then injected by an amount of 150-180 cc formalin (10%). The specimens were then preserved in a suitable tank containing 10% formalin solution for a duration ranged between 10-15 days. For exposing the spinal cord and the spinal nerve roots, we used fine dissecting tools and bone cutter to remove the skin, epaxial muscles, vertebral arches and epidural fatty tissue. The morphometric study was measured by the aid of a dissecting microscope and **Vernier caliper (Fig.1).**

The total length of the spinal cord as well as the length of its cervical, thoracic, lumbar and sacrocaudal regions and the medullary cone were measured and the indices of each portion of the spinal cord were then calculated, in percentage, by the routine mathematical ratio. Other measurements comprised, the segment measurements as well as the root and interroot lengths of both dorsal and ventral spinal nerve roots.

The methods of measurements were estimated according to the basis adopted by **Farag *et al.* (2012)** as follow :-

1- The root attachment length was estimated as the distance of the cord surface between the rostral most and the caudal most rootlet of the same spinal nerve root.

2- The inter root length was considered as the distance of the cord surface between the caudal most rootlet of one spinal nerve root and the rostral most rootlet of the succeeding spinal nerve root.

3- The segment length was considered as the length of the cord surface extending from the rostral most attachment of one spinal nerve root to the rostral most attachment of the succeeding spinal nerve root.

4- The total length of the cord was estimated as the distance between the rostral most rootlets of the first cervical spinal nerve root to the end of the medullary cone**.**

5- The morphometric records were then tabulated and interpreted into charts and curves.

For the arterial studies ten animals were used. The animals were prepared and bled by direct puncture to the left ventricle after anesthesia. The blood vessels were thoroughly washed by worm normal saline solution then injected by injected by an amount of 150-180 cc of Neoprene latex colored red with Rotring ® Ink through the left ventricle.

For the venous studies another five animals were used. The animals were prepared and bled by direct puncture to the right ventricle after anesthesia. The blood vessels were thoroughly washed by worm normal saline solution then injected by injected by an amount of 150-180 cc of Neoprene latex colored blue with Rotring ® Ink through the right ventricle.

The nomenclature used during this study was adopted according to **Nomina Anatomica Vetrinaria- N.A.V. (2012)** as well as some nomenclatures used in previous recent publications when missed in the N.A.V (2012).

REVIEW OF LITERATURE

The morphological studies of the spinal cord in different species of animals were made by many authors. **Dellmann and Mc Clure (1975)** the spinal cord was generally defined as that part of the central nervous system caudal to the brain and contained within the vertebral canal. It was revealed in different species of domestic animals that the cranial end of spinal medulla laid on a level of the foramen magnum. On other hand the level of termination of the caudal end of the cord showed species variation, from the last two lumbar vertebrae to the middle of the sacrum.

Abu-zaid (1982) in the Egyptian buffalo revealed that the rostral limit of the spinal cord was indicated by the point of emergence of the rostral most rootlets that form the first cervical nerve and added that it extended on a level with the middle of the occipital condyles. **Noor (1995)** in goat, reported that the beginning limit of the spinal cord in some cases was displaced either cranially up to the level of the cranial third of the occipital condyles or caudally to a level with the rim of the foramen magnum.

Thomas and Combs (1962) and Camara-Filho *et al.*, (1998) in cat asserted that, the spinal cord ended on a level with the first sacral vertebra. **Hopkins (1935)** recorded its termination on a level with the middle of the sacrum in the same animal. In canine, the spinal cord extended caudally to the level of the junction between the sixth and seventh lumbar vertebra **(Miller *et al.*, 1964; Jenkins and Thomas, 1972; Dellmann and Mc Clure, 1975 and Dyce, *et al.*, 2010)** or at the cranial portion of the seventh lumbar vertebra **(Hopkins, 1935; Habel, 1951; Bradley and Grahame, 1959;Fletcher, 1979 and Ghoshal 1975)**. In the horse, **Hopkins (1935) and Habel (1951)** reported that the spinal cord is terminated at the junction between the first sacral and second sacral vertebra. However in adult cattle **(Deem *et al.*, ,2004)** at the second sacral vertebra but in buffalo **(Sharma and Rao , 1971** and **Abu-zaid ,1982)** at the third sacral vertebra but in ox it is either terminated at the first sacral vertebra **(Hopkins, 1935 and Habel, 1951)** or at the second sacral vertebra **(Clair and Hadenbrook, 1956)**. **Mansour (1983)** in the camel, observed its termination at the junction between the second and third sacral vertebra.

Thomas and Combs (1962) and Camara-Filho *et al.*, (1998) in cat asserted that the spinal cord ended on a level with the first sacral vertebra however **Hopkins (1935)** recorded its termination on a level with the middle of the sacrum in the same animal.

In pig, **Dellmann and Mc Clure (1975)** gave its termination between the cranial edge of the second sacral vertebra and middle third of the third one.