HISTOMORPHOLOGICAL STUDY OF THE TRACHEA IN ALBINO RAT

THESIS

SUBMITTED FOR PARTIAL FULFILMENT

OF THE MASTER DEGREE OF (M.Sc.) IN

(ANATOMY)

BY

NAGLA'A YAHIA MOHAMED EL-CHAFEY

SUPERVISORS

Prof. Dr. FAKHRY AMIN ISKANDER
Prof. of Anatomy
Faculty of Medicine
Ain Shams University

Prof. Dr. SAWSAN AHMED ABDEL-RAHMAN
Prof. of Anatomy
Faculty of Medicine
Ain Shams University

Dr. HANY EL HESSY
Lecturer of Anatomy
Faculty of Medicine
Ain Shams University

FACULTY OF MEDICINE
AIN SHAMS UNIVERSITY

1987

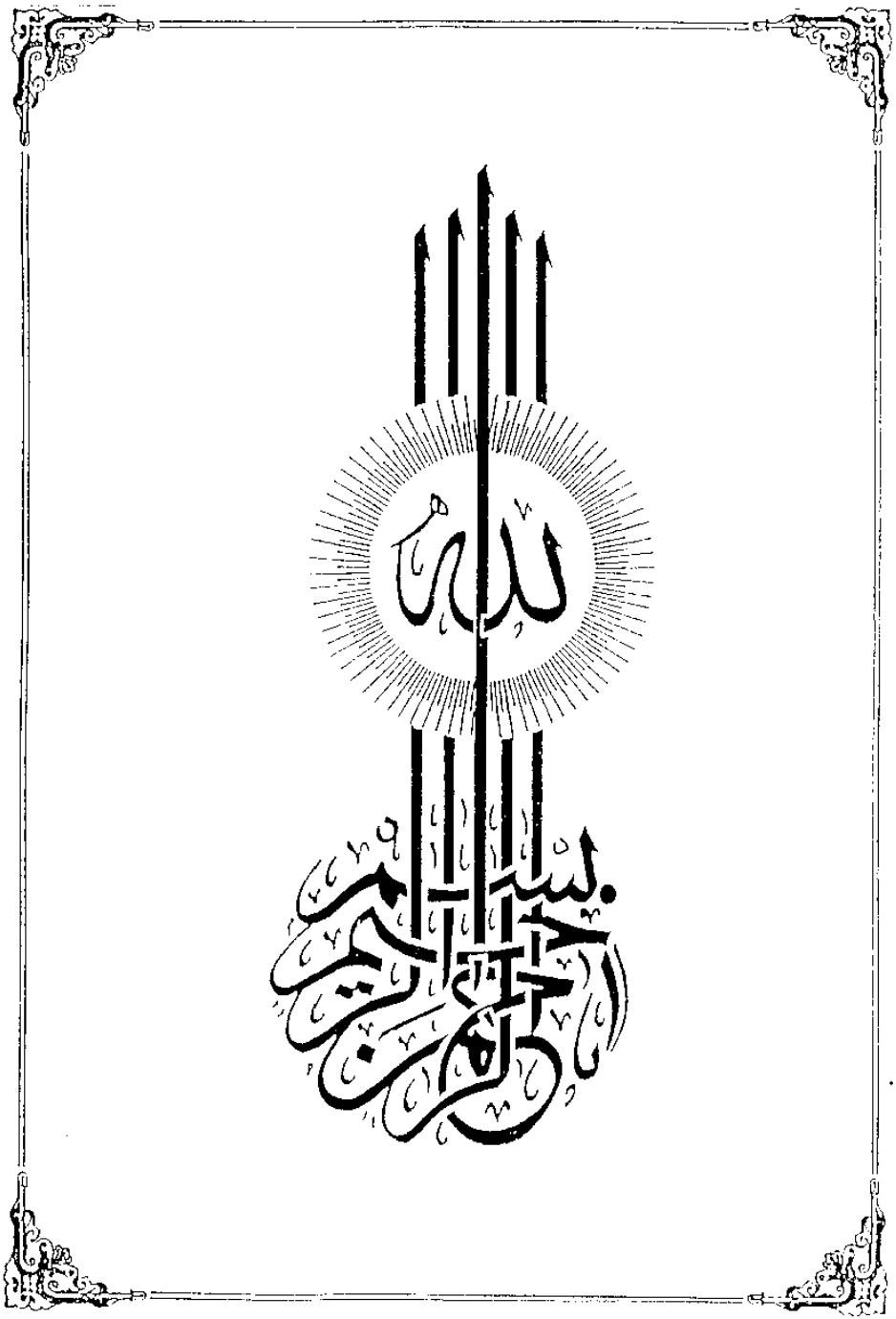
A C K N O W L E D G E M E N T

I would like to express my deepest thanks and gratitude to Prof. Dr. Fakhry Amin Iskander , Anatomy Department, Faculty of Medicine, Ain-Shams University, for his supervision of this work, sincere help and encouragement.

I am very much obliged to the kindness of Prof. Dr. Sawsan Ahmed Abd-ElRahman , Professor of Anatomy, Faculty of Medicine, Ain-Shams University, who suggested the topic of this research and assisted me throughout the work by her helpful discussion, criticism, and encouragement. To her I am specially endebted.

My deepest thanks and gratitude are due to Dr. Hany El-Hessy , Lecturer of Anatomy, Faculty of Medicine, Ain-Shams University, for his kind help and encouragement.

Finally, I would like to express my thanks and gratitude to all my professors and colleagues in the Anatomy Department.



CONTENTS

		Page
I.	INTRODUCTION AND AIM OF THE WORK	1
II.	REVIEW OF LITERATURE	2
III.	MATERIAL AND METHODS	25
IV.	RESULTS	29
V.	DISCUSSION	35
VI.	SUMMARY	47
VII.	REFERENCES	50
VIII.	APPENDIX	57
IX.	ARABIC SUMMARY	

Introduction and Aim of the Work

I N T R O D U C T I O N

Reviewing the anatomy and histology of the trachea in adult albino rat, it was found that the anatomy was described by Greene (1963).

Moreover, the histological aspects of the trachea were revised by Bloom and Fawcett (1966) and Ham and Leeson (1969).

The intrinsic innervation of the trachea was studied by Larsell (1922), Larsell and Dow (1933), Graylor (1934), Elftman (1943) and Spencer and Leof (1964), Jeffery and Reid (1973) and Abd-ElRahman and Iskander (1974).

However, little attention was paid to the histochemical picture of the trachea.

The aim of the present investigation was to study the histochemical activity of the trachea in adult albino rat. The work was planned to visualize the cholinesterase activity using a specific inhibitor for the pseudocholinesterase. Demonstration of alkaline phosphatase, polysaccharides, mucopolysaccharides and glycoproteins was also performed. Moreover, silver impregnation techniques were performed in addition to the ordinary histological studies as correlative measures to assess the histochemical results.

Review of Literature

REVIEW OF LITERATURE

Elftman (1943) studied the ganglia, nerve fibres and terminal endings in the trachea of dog. He noticed two types of afferent nerve endings in the tracheal wall of four days old dogs. One of these types appeared within the smooth muscle which in the trachea was found to lie peripheral to the cartilage. The endings arose from a course fibre which branched palmately. The branches showed many varicosities and terminated in swellings or reticulations among the smooth muscle cells.

The other type of afferent ending in the trachea showed subepithelial branches with swellings at their intersections and a ring termination. In addition, some of the branches continued up between the epithelial cells. The tracheal nerve endings were, in general much less numerous than those of any other part of the respiratory tree. They were confined chiefly to the dorsal wall, although there were few exceptions.

In addition to the coarse afferent fibres, there were some fine deeply staining fibres with occasional small swellings which ran between the muscle fibres. These were very likely efferents but their terminations were not apparent.

The nerve plexus was much denser and the ganglia more numerous in the dorsal wall of the trachea than in the ventral wall.

He also noticed multipolar nerve cells in the ganglia. The afferent endings in the smooth muscle were seen more frequently in the region of bifurcation of the trachea and at the hilus than elsewhere, but the amount of muscle was also much greater in these regions. They differed from muscle spindles of striated muscles.

As regard the acini of the tracheal glands, the majority of fibres supplying them were sympathetic and only few were of parasympathetic origin.

Hojin (1954) studied the ganglia and nerves of the lower respiratory tract of the mouse. He described a large number of small ganglia, serially connected by nerves and embedded in the adventitial tissues of the dorsal wall of the trachea. He pointed out the complete absence of ganglia in the ventral walls.

Hojin (1956) studied the nerve supply of the lung of the mouse. He noticed fine twigs arising from the posteriorly situated tracheal plexus and passing forwards, between the cartilages,

to the ventral surface. He also observed axons of the ganglion cells passing to the smooth muscle and myelinated nerves forming endings in the muscle and epithelium.

Rhodin (1959) studied the electron microscopic picture of the normal rat trachea to understand the mechanisms involved in the formation of mucous, ciliary activity and the transport of mucous on the tracheal lining as well as cell regeneration. He noticed that the tracheal epithelium in the rat was of the simple columnar type as compared to the pseudostratified epithelium of the human trachea. The epithelium was formed of four types of cells : ciliated cells, brush cells, mucous cells in different stages of secretion and lastly basal cells.

He also noticed that the mucous blanket was formed by secretion from mucous cells as well as serous cells which were encountered both in the epithelial layer and in the subepithelial glands.

Fisher (1962) studied the trachealis muscle in monkeys, human foetuses and adults. He observed that the trachealis muscle was bridging the posterior gap in the trachea with transversely running fibres attached to the internal aspect of the tracheal cartilages. Some of the fibres curved downwards from the cartilages to form a definite longitudinal layer situated

between the transverse fibres and the submucosa. This longitudinal layer of smooth muscle extended in some cases as high as the cricoid cartilage and passed downwards to become attached to the posterior aspect of the carina.

Sections of trachealis muscle, therefore, exhibited transverse, oblique and longitudinal bands of smooth muscle fibres broken up by the ducts of tracheal glands.

Greene (1963) observed that the vagus nerve in rat gave the right recurrent laryngeal nerve in the neck. On the right side, the recurrent nerve made a loop around the beginning of the subclavian artery. On the left side, the left recurrent nerve arose in the thorax. It ran through the aortic arch, turned anteriorly along the boundary between the oesophagus and trachea, to both of which it supplied branches. It finally ended as the inferior laryngeal nerve to supply the intrinsic muscles of the larynx.

Fisher (1964) studied the intrinsic innervation of the trachea in rats, guinea pigs, monkeys and human subjects. He noticed that nerves entered the trachea mainly through its posterior wall, via a longitudinal ganglionated chain. They formed primary, secondary and tertiary plexuses in the muscle, between and internal to the cartilage plates and in the submucous

regions. He also observed a profuse supply of predominantly unmyelinated fibres innervating the muscle, glands and blood vessels. The plexuses supplying these structures apparently communicated with each other. No evidence of either free nerve endings or a syncytium was observed.

He noticed that multipolar parasympathetic effector neurons occurred predominantly in the posterior wall, the larger ganglia containing over 20 cells. Small ganglia were found anteriorly between the cartilages and occasionally at nodes of the muscular plexus. Scattered neurones occurred in the submucosa and in the internal longitudinal elastic lamina.

Afferent endings were identified in the trachealis muscle. The sensory supply to the mucosa was via free nerve endings and no other type of endings was observed. The tracheal arteries possessed profuse vascular nerve plexuses while the corresponding veins had a poorer supply.

Rhodin (1966) analyzed the structure of the mucosa of the human trachea by means of electron microscopic studies. He classified the cells of the pseudostratified ciliated columnar epithelium of the human trachea into ciliated cells, mucous producing goblet cells, basal cells, and intermediate cells. The basal cells represented the layer from which the other cells

differentiated; while the intermediate cells were transformed into either ciliated cells or goblet cells.
At the same time, he could not find an indication of a goblet cell being transformed into a ciliated cell or vice versa. The goblet cells went through secretory cycles. The ciliated cells were seen to slough more frequently than the mucous cells. The structure of the cilium and the basal body was not as complex as in the invertebrates. In spite of that, sufficient evidence had been obtained from this study that also in man, in the respiratory epithelium, the cilia and their submicroscopic fibrils were provided with numerous devices for regulating the conduction and synchronization of the ciliary beat.

Luciano and Reale (1970) used the electron microscope to clarify whether the innervation of the epithelium of airways was sensory, motor or both. By electron microscopy, both afferent and efferent fibres were distinguished within the rat surface epithelium. Axons rich in mitochondria were considered afferent and those containing microtubules, microfilaments, mitochondria, vesicles and ß-glycogen were efferent.

Jeffery and Reid (1973) in their quantitative electron microscopic study investigated the intraepithelial nerves in normal rat airways. They analysed the types of axons seen, their frequency at various airway levels, and their relation

to various cell types. They noticed that, in young rats, intra-epithelial nerves were detected only in the extrapulmonary air-way epithelium and not in the intrapulmonary epithelium. There was a greater concentration of nerves in the upper than in the lower trachea or main bronchi. In the lower trachea and main bronchi, there were more axons in the anterior than in the posterior wall.

They observed that, most of the axons (87%) were close to the basement membrane and were particularly associated with basal cells. From the ultrastructural features, 50% of axons were considered sensory, 33% efferent and adrenergic, and 17% efferent and possibly cholinergic.

Abd-ElRahman and Iskander (1974) studied the trachealis muscle in the dog, albino rat and desert rodent Gerbillus gerbillus. They noticed that in the albino rat, it was formed of transversely arranged smooth muscle fibres splitting to enclose the posterior ends of each tracheal ring. In the dog and Gerbillus gerbillus the muscle fibres were attached to the perichondrium covering the outer surface of the tracheal ring and in Gerbillus gerbillus few additional bundles of longitudinal muscle fibres were found to lie external to the transverse ones. In all the examined species there were no tendons for insertion of the muscle.

The intrinsic innervation of the muscle and its mucosa was also studied and intraepithelial fibres as well as submucosal and periacinar nerves were detected. The muscle was richly supplied by both intramural, extramural nerve trunks and nerve fibres. Small pyramidal, pyriform and spindle shaped nerve cells were detected in the muscle. The nerve fibres either ran in a transverse direction between the individual muscle fibres or they were perpendicular to them. Parasympathetic ganglion cells were found to lie in the adventitia covering the trachealis muscle in addition to thick bundles of nerve fibres. These ganglia were probably the site of relay of fibres arising from cell bodies in the dorsal vagal nucleus. Sympathetic innervation reached the trachea on the inferior thyroid artery from cell bodies in the middle cervical ganglion.

As regard the mucous membrane, they noticed that the part covering the trachealis muscle only was thrown into longitudinal folds in albino rats and dogs. The epithelium in all examined species was of the pseudostratified columnar ciliated type with goblet cells. The epithelium showed fine intraepithelial nerve fibres which were more numerous in the anterior than in the posterior wall of the trachea.

Monkhouse and Whimster (1976) studied the macroscopic, microscopic and ultrastructural features of the longitudinal