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Comparative histomorphometric study of the trachea between immature and mature domestic gazelle: *Gazella Subgutturosa*

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Abstract

The study involved five immature and five mature gazelles in order to define the characteristics of the trachea, the mucosa, submucosa, hyaline cartilage, adventitia, and muscle fibers make up the complex tissue of the trachea. The cervical portion of the trachea is home to many simple alveolar mucous glands, the thoracic part of trachea has goblet cells that form "intraepithelial glands" in place of the mucous glands. The mucosa was lined with ciliated pseudostratified columnar epithelium, which contained basal, goblet, and columnar cells. The goblet cells were more prevalent in the thoracic than in the cervical portions of the trachea, and the percentage of goblet cells was higher in mature than in immature ages. The incomplete cartilage rings were hyaline in nature and enclosed by perichondrium; the hyaline C shaped rings. The posterior ends of these cartilages are connected by a connective tissue and smooth muscle, and the external layer comprises of adventitia made of connective tissue alongside numerous blood vessels. The sub mucosa contains mucous glands, loose connective tissue, collagen fiber, and blood vessels. The ground substance-containing chondrocytes that make up cartilage. There are multiple mucous simple alveolar glands in the cervical epithelium, and goblet cells have replaced the mucous gland in thoracic epithelium. The skeletal muscle fibers of lateral tracheal on each side of tracheal rings were clearly visible. The perichondrium encased the flattened cartilaginous rings. The cartilage covered by the adventitia is composed of chondrocytes and ground material, with smooth muscle and dense fibroelastic tissue connecting the posterior ends of cartilages. Goblet cells and ciliated pseudo stratified columnar epithelial cells made up the epithelialis mucosa throughout immature ages. The lamina propria and epithelialis mucosa built up the tunica mucosa in adult ages. The trachealis muscle, which was situated on the posterior membranous region of the trachea, interlaces bundles of smooth fibers to join the free ends of cartilaginous crescents. The tiny bands of smooth muscles that sustain the posterior trachea wall are in place because it lacks cartilage. Conclusion. The number and kind of cells as well as the thickness of the histological layer varied amongst the ages of the trachea.

Keywords: Gazelle, cervical trachea, thoracic trachea, Histological, different ages

1. Introduction

The gazelles are graceful, herbivorous, ruminant, tiny, and herbivorous antelopes that are known as quick animals. They are primarily found in Africa's hot, deserts, arid savannas and grasslands. Their main habitats are the hot, arid savannas, deserts, and grasslands of Africa, the Indian subcontinent, and the regions of southwest and central Asia ^[1]. In addition to allowing gases to condense and exchange, the respiratory system also controls body temperature, creates and excretes a number of chemicals, including histamine, and helps produce voice, and linked to the sense of smell ^[2-4]. In ruminants, the trachea is a tube-like structure extends from the cartilage of the cricoids to the point where it splits into the bronchi. Its hyaline cartilage is divided into many rings that form an incomplete ring towards the dorsal aspect of the structure. Each ring-shaped cartilage is connected dorsally by the tracheal membrane, and externally by the trachealis ^[5-7]. Four distinct layers make up the very malleable trachea: the adventitial layer, cartilaginous, mucosa layer submucosa layers, and trachealis muscle. The trachea's main job is to supply the mechanical compliance required for variations in intraluminal pressure that occur during respiration, coughing, and swallowing. The trachea is

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composed of the adventitia, muscularis, mucosa, and submucosa. The lining is composed of well-developed adventitia, submucosa, and respiratory epithelium. The cartilaginous ring is incomplete [8-10]. Goblet cells, intermediate cells perched on the basement membrane, ciliated cells, basal cells, and goblet cells make up the tracheal epithelium [11-12]. The ciliated cells are completely gone from the distal respiratory bronchioles of calves and pups, while they are slightly present in the trachea and bronchi of newborn canines and cattle. A newborn dog's trachea has longitudinally directed folds across its dorsal walls and numerous cilia covering its ventral and dorsal surfaces [13-14]. There is relatively little material available on the characteristics of the gazelle trachea in Iraq, and our understanding of the microscopic structural organization of these parts of trachea and their function in influencing the mechanical response of the tissue is severely limited. The information on microstructure of the tracheal elements and how it affects the mechanical response of the tissue is the aim of this study, knowing the relationship between structure and function is crucial for creating tissue-engineered replacements that mimic the mechanical properties of native tissue. It also aids in understanding all other sciences and makes it possible to view the structure and any unique alterations that may have occurred at the tissue.

Materials and Methods

Ten healthy indigenous breeds of gazelles (*Gazella subgutturosa*), five at one year of age and five at two to three years of age, Between January and May 2023, the animals were taken alive from Sawa Station in Al-Muthanna City, which is connected to the Ministry of Agriculture. The animals were then given an overdose of ketamine and xylazine, and they were sacrificed. Samples were obtained from the cervical and thoracic regions of the trachea, and seven specimens from each location were preserved in 10% formalin for a full day before being processed histologically, the stains that were previously there; Periodic acid/Schiff (PAS) stain; Mallory and Masson's trichrome stain for the basement membrane, mucoprotein, glycoprotein, carbohydrates, and mucopolysaccharides; To the collagen fibers and smooth muscles [15]. An ocular micrometer was used to measure the thickness of the adventitia tunicae, mucosa, and submucosa of each tracheal segment in five sections at each age. The mean ($\bar{x}$) and standard error (S. E.) was calculated for thirty slides of each section. [16].

Results and Discussion

The mucosa, muscularis, adventitia, and submucosa comprised the layers of trachea's wall. the cervical portion of the tracheal epithelium has more mucous glands, while cervical portion of the tracheal epithelium has fewer glands and most of its regions are home to "intraepithelial glands," which have replaced mucous glands in the thoracic tracheal epithelium and are fewer developed in the cervical trachea than thoracic trachea in both ages, the trachea is lined by a respiratory epithelium alongside goblet and basal cells that lie on the basement membrane (Fig.1,2), Mucosa and submucosa layers thicknesses decreased gradually toward the thoracic section of the trachea (Table 1). The mucosa-associated lymphoid tissue, found on the surface of mucosal tissues like the respiratory tracts of horses, farm animals, and rodents, is crucial to the local immune response [6, 17]. Mature animals' trachea is made wholly of ciliated cells, while the trachea of

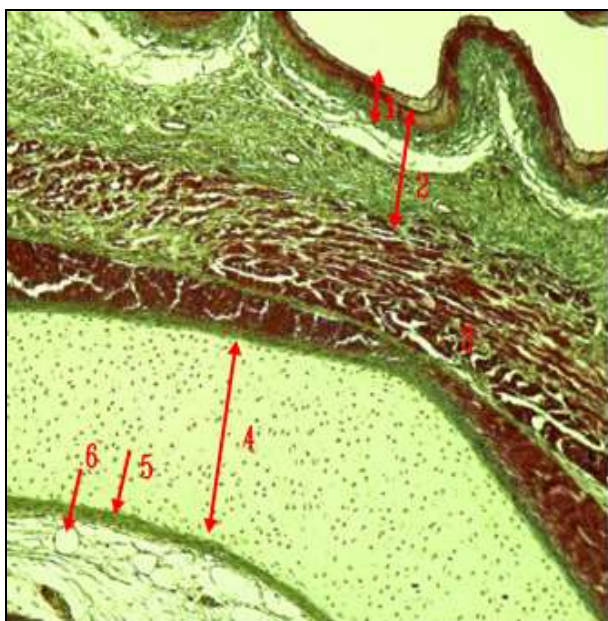
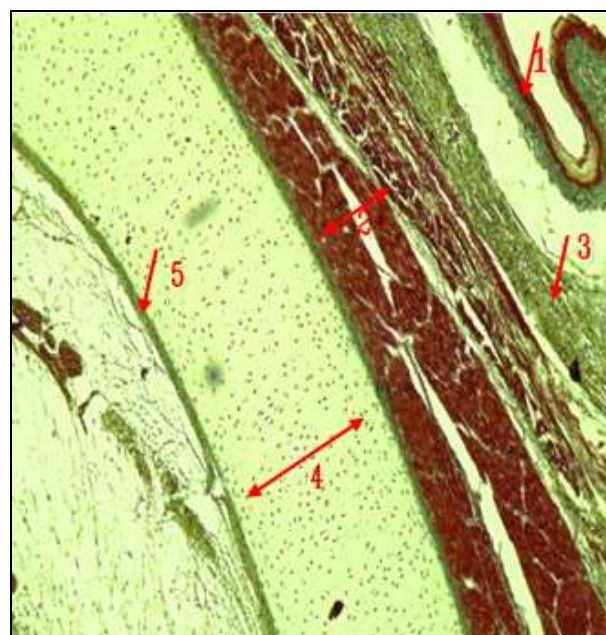
immature ages is made totally of non-ciliated columnar epithelium. This is in contrast to rodents' airways that are devoid of ciliated cells. At the microscopic level, a network of several kinds of fibers, including collagen and muscle fibers, make up each layer of the trachea (Fig.3, 4, 5). Experimental evidence has sufficiently established the role of the fiber networks in the mechanical behavior of soft tissues [3]. Goats, oxen, sheep, and dogs all have glands in the ventral rather than the dorsal section of their trachea. Specialized tracheobronchial glands protruded from the airway surface epithelium into the submucosa. Two distinct kinds of secretory cells exist in the tracheal [6].

The submucosa was made of loosely connected tissue and was made up of blood arteries, lymphocytes, and longitudinal groupings of elastic fibers. This layer's collagen was likewise arranged into dense bundles; it did not clump together into many orientated bundles. Rather, a single fiber family was seen in most of the cases throughout the thick and well-developed adventitia that wrap the respiratory epithelium and the goblet cells which make up the mucosal lining, covered incomplete cartilaginous rings, Early on, a greater percentage of goblet cells had neutral mucins; this improved goblet cells' protective (Fig.1-3), thickness of the mucosa in the cervical part of trachea in immature was ($97.5 \pm 1.3 \mu\text{m}$), in mature was ($111.7 \pm 1.4 \mu\text{m}$), and it thickness in the thoracic trachea in immature was ($92.4 \pm 1.2 \mu\text{m}$), in mature was ($103.4 \pm 1.5 \mu\text{m}$). Bundles of smooth fibers join the cartilaginous ends of the trachea through the trachealis muscle, which is located on the posterior membrane. The posterior trachea wall is held in place by the minuscule bands of smooth muscles that comprise its cartilage-free wall. These incomplete cartilaginous rings are hyaline in character and are encircled by perichondrium (Fig.7). Thickness of the submucosa in cervical and thoracic parts of the trachea in immature was (312.1 ± 2.4 , $295.2 \pm 1.1 \mu\text{m}$) respectively, in mature trachea was (363.2 ± 1.3 , $306.1 \pm 0.5 \mu\text{m}$) respectively. Thickness of adventitia in cervical and thoracic trachea in immature was (71.2 ± 0.6 , $74.2 \pm 0.4 \mu\text{m}$) respectively, in mature ages was (78.4 ± 0.1 , $81.3 \pm 0.2 \mu\text{m}$) respectively (Table 1).

The cartilage matrix exhibited a strong response to PAS, while the chondrocytes exhibited a mild reactivity similar to that of most mammals. The posterior ends of cartilages joined by smooth muscle and connective tissue, and the external surface are composed of adventitia composed of connective tissue with multiple blood vessels (Fig. 6, 10). The cartilage is made up of pulverized substance-containing chondrocytes. It was possible to see the skeletal muscle fibers of lateral trachea on both sides of the tracheal rings. Thick bundles of collagen were shown to be arranged in the adventitia (Fig. 8, 9, 10). The muscle fibers are directly connected to the perichondrium, in certain species (such dogs, cats, and rabbits) attaches to the outside of the crescent-shaped trachea ring. Some animals, such as guinea pigs [2, 18]. It should be noted that the purpose of the ciliated cells in the trachea is to transport secretions across the airways. It is these ciliated cells that transfer water and ions across epithelia [19]. The tracheal epithelium in animals is thought to consist of three distinct cellular types: serous cells, secretory mucous cells, and non-ciliated bronchiolar epithelial cells. Mucus produced by the goblet cells coats the ciliated cells, and the weather mean spreads it. Mucus from respiratory system sticking to the cells of the cilia [2, 19]. Basal cells pushed goblet cells between them in the trachea, where they are found in domestic mammals and were involved in the production of mucus [2, 17, 20].

Table 1: Dimensions and thickness of the wall layers and number of goblet cells (X200) in portions of trachea of the gazelle (μm)

Part / Measure	Tunica mucosa	Submucosa	Adventitia	Number of goblet cells
Cervical portion in immature in mature	97.5 ± 1.3	312.1 ± 2.4	71.2 ± 0.6	33 ± 1
	111.7 ± 1.4	363.2 ± 1.3	78.4 ± 0.1	40 ± 2
Thoracic portion in immature in mature	92.4 ± 1.2	295.2 ± 1.1	74.2 ± 0.4	32 ± 3
	103.4 ± 1.5	306.1 ± 0.5	81.3 ± 0.2	38 ± 1

**Fig 1:** Microscopic section of the cervical portion of trachea of immature gazelle; mucosa (1), submucosa (2), cartilage (3), smooth muscle (4), adventitia (5), esophagus (6), masson trichrome, 100X**Fig 3:** Microscopic section of the thoracic portion of trachea of immature gazelle; mucosa (1), goblet cells (2), submucosa (3), cartilage (4), chondrocyte (5), perichondrium (6), Mallory stain, 200X**Fig 2:** Microscopic section of the cervical portion of trachea of mature gazelle: mucosa (1), submucosa (2), muscles (3), cartilage (4), perichondrium (5), adipose tissue (6), masson trichrome 200X**Fig 4:** Microscopic section of the thoracic portion of trachea of mature gazelle; epithelium (1), muscle (2), fibers (3), cartilage (4), perichondrium (5), Masson stain, 100X

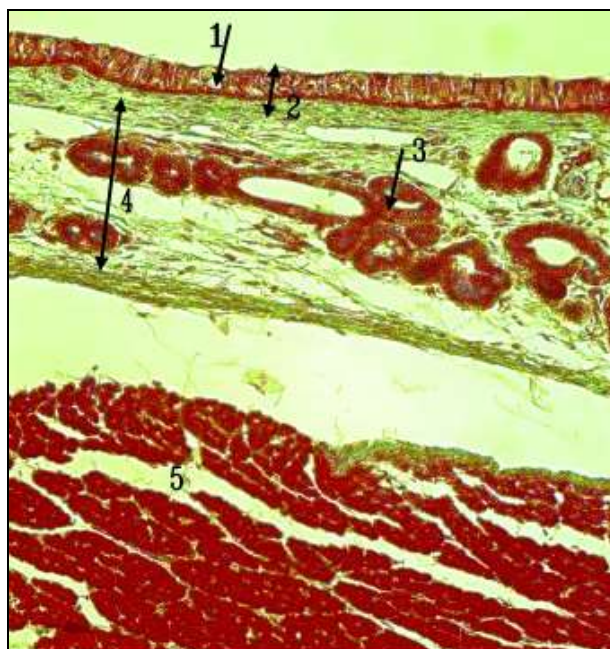


Fig 5: Microscopic section of the cervical portion of trachea of immature; goblet cell (1), mucosa (2), glands (3), submucosa (4), smooth muscle (5), Masson stain, 100X

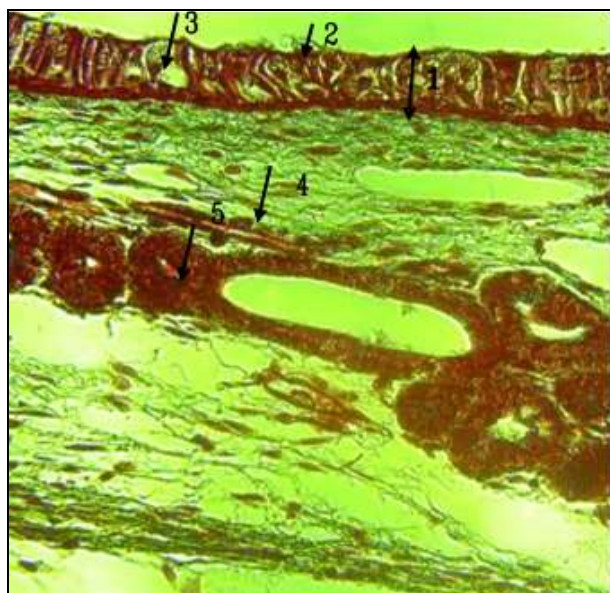


Fig 6: Cross section of the cervical trachea of mature; mucosa (1), cilli (2), goblet cell (3), connective tissue (4), gland (5), Masson stain, 400X

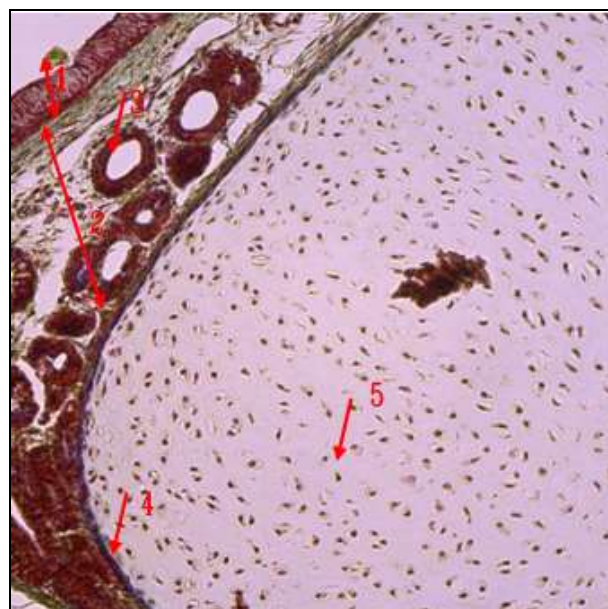


Fig 7: Microscopic section of the thoracic portion of trachea of immature gazelle; mucoasa (1), submucosa (2), glands (3), perichondrium (4), chondrocyte (5), Mallory stain, 200X

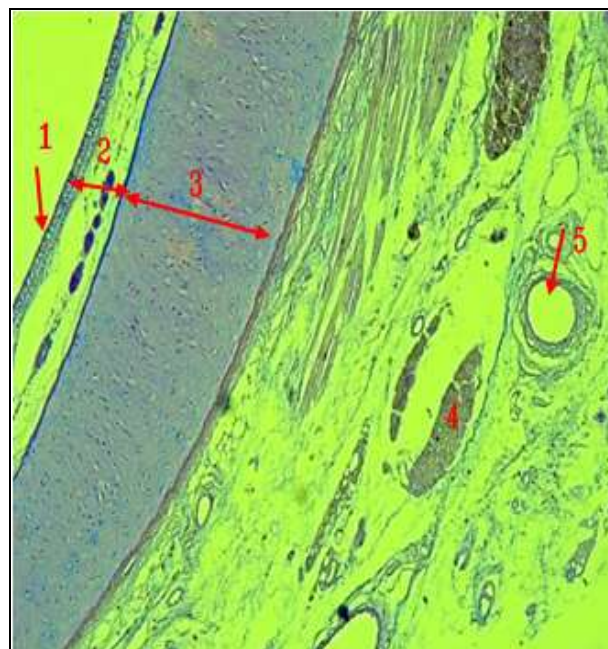


Fig 8: Microscopic section of the thoracic portion of trachea of mature gazelle; epithelium (1), submucosa (2), cartilage (3), smooth muscle (4), blood vessels (5), PAS stain, 100X

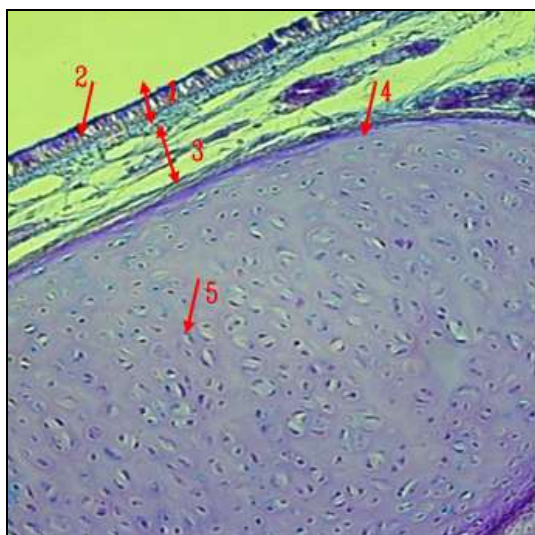


Fig 9: Microscopic section of the cervical portion of trachea of immature; mucosa (1), goblet cell (2), submucosa (3), perichondrium (4), chondrocyte (5), PAS200X

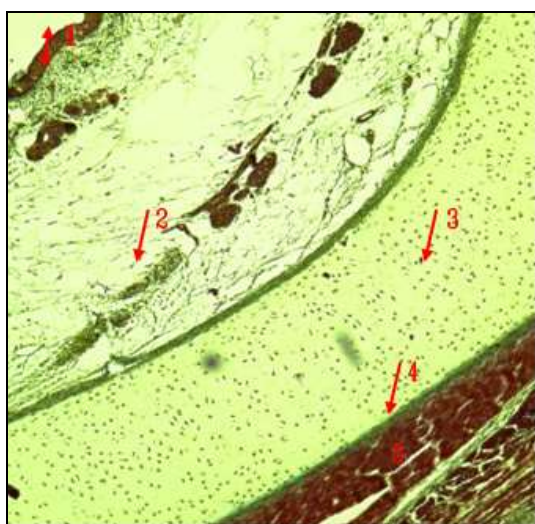


Fig 10: Microscopic section of the cervical portion of trachea of mature; mucosa (1), connective tissue (2), chondrocyte (3), perichondrium (4), Masson stain, 100X

Conclusion

Changes in the quantity and kind of goblet cells, as well as the thickness of the histological layer, were observed in trachea of varying ages.

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Conflict of interest

Regarding the writing process, authors of manuscript have declared that there was no conflict of interest.

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