

Some Histological and Histochemical Study of the Esophagus in One-Humped Camel (*Camelus dromedarius*)

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Abstract: The aim of this research has been described some histological and histochemical changes of muscle fiber of normal esophagus of the one-humped camel (*Camelus dromedarius*). Twenty camels were used for the present studies. The mucosal epithelium was keratinized stratified squamous and there were abundant submucosal glands throughout the esophagus. The tunica muscularis of the esophagus showed stratified muscle in two general layers. The results of the esophageal histochemistry in this study revealed that the type 2 muscle fibers predominated in both cervical and thoracic portions of the esophageal musculature and the proportion of type 1 muscle fiber was low in the cervical esophagus and increased in the thoracic esophagus. This study provides some details about histological description of the normal esophagus in dromedary camel that can be used as a basis for further studies of esophageal malfunction in this species.

Key words: One-Humped Camel • Esophagus • Histochemical • Microscopic • Muscle Fiber Anatomy

INTRODUCTION

The esophagus plays an important role to transferring of ingested bolus from mouth cavity to stomach because of anti peristaltic action of its musculature. The anatomy and microanatomy of the camel esophagus has been described [1-3], there is no histological and histochemical esophagus information in dromedary camel. This study described the microscopic anatomy and muscle fiber type of the camel esophagus.

MATERIALS AND METHODS

Twenty camels (10 females and 10 males) with clinically normal condition were selected from the slaughterhouses in Yazd province, Iran and used for the microscopic studies. The mean rang of camel ages were 5.5 years old (from 2 to 10 years old).

Histological Examination: The esophagus of each camel were removed and a complete esophagus cross-section, were took from each region (cervical, thoracic and

abdominal) and placed in 10% buffered formalin. The specimens of each region were dehydrated in graded alcohol series, cleared in methylbenzoate, embedded in paraffin and 5- μ m-thick sections were cut by microtome. The sections prepared and stained with haematoxylin and eosin (H&E) for histological study.

Histochemical Examination: A specimen was cut from each defined region of the esophagus and the mucosal layer of these removed. The specimens were viewed by a dissection microscope to determine the orientation of muscle fibers and to ensure preparation of transverse sections. The specimens were mounted on a labeled cork disc with viscous embedding compound (OCT, Tissue Tek, Elkhart, IN) and frozen rapidly in isopentane cooled with liquid nitrogen. Specimens were stored at -70°C until sectioning. A sample of quadriceps muscles was processed in the same method for use as a control section. The muscle sections were prepared by a cryostat microtome at -19°C that four serial sections, 8 μ m thick transverse muscle fiber sections were cut. The sections were stained with Gomori trichrome and H&E to evaluate

tissue orientation and general appearance of muscle fibers. The sections were stained for myosin ATPase activity using standard methods with pre-incubation at pH 10.0, 4.65 and 4.35 for qualitative myofibrillar histochemistry [4]. These were examined visually by light microscopy for high, intermediate and low enzyme activity as judged with according to intensity of intracellular staining. Muscle types were determined by matching the observed enzyme activity to the profile of muscle types in quadriceps muscle. The serial sections were photographed with a digital camera attached to the microscope. Type 1 and Type 2 fibers were identified by the myosin ATPase reaction after re-incubation at pH 10.0 and type 2A, 2B and 2C fibers were identified by the myosin ATPase reaction after pre-incubation at pH 4.65 and pH 4.359 [5]. Fiber type proportions were determined using color micrographs of serial sections with 100 randomly selected fibers counted at each esophageal level.

RESULTS

Histological Examination: The esophagus of dromedary camel consisted of three regions, cervical, thoracic and abdominal regions. The structure's of all esophagus regions was similar and their walls composed of three layers: tunica mucosa, tunica muscularis and tunica adventitia (serosa) (Fig. 1, 2). The mucosal epithelium was a keratinized stratified squamous epithelium throughout the length of esophagus. The epithelium was separated of lamina propria by a basal lamina. The lamina propria consisted of connective tissue, scattered lymphocytes and vascular structure. The muscularis mucosa was located between lamina propria and submucosa and it was identifiable only in distal esophagus. It was consisted of a few thin scattered strand's of smooth muscle. The submucosa layer consisted of submucosal glands that observed in each region of the esophagus. The glands were ovoid or elliptical and composed of large and small cluster or lobules of tubuloalveolar mucous glands (Fig. 1). Esophagus glands in cross-section throughout observed around the circumference of the wall. The tunica muscularis composed of striated muscle and consisted of two layers, the inner (circular) and the outer (longitudinal) throughout the length of the esophagus (Fig. 2). The myenteric plexus was observed between two layers of the tunica muscularis. The tunica adventitia was located outer layer of cervical and thoracic region of the esophagus that composed of loose connective tissue. The tunica serosa



Fig. 1: Transverse section of the esophagus wall in one-humped camel. Keratinized stratified squamous epithelium (E); submucosal gland (G); tunica muscularis (inner layer) (M). (H&E)X40.

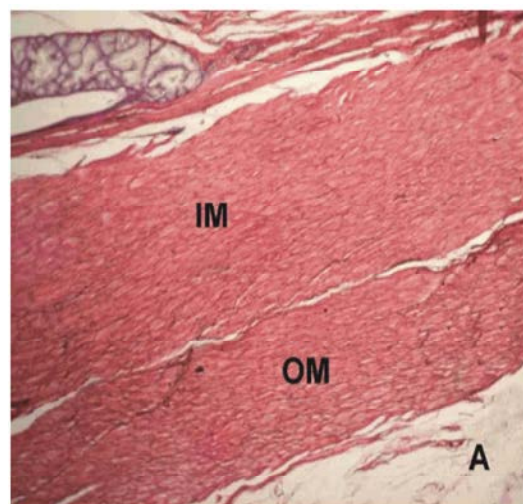


Fig. 2: Transverse section of the esophagus wall in one-humped camel. The inner (circular) layer of tunica muscularis (IM); the outer (longitudinal) layer of tunica muscularis (OM); adventitia layer (A). (H&E)X40.

composed of loose connective tissue and a mesothelium layer and was observed in outer layer of abdominal region.

Histochemical Examination: Histochemical examination were carried out in cervical and thoracic muscle regions. The differentiated between the Type 1 and Type 2 tunica

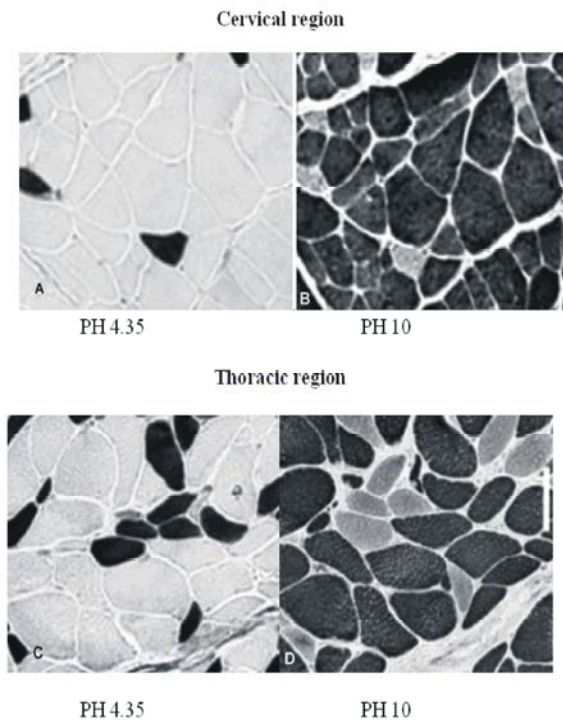


Fig. 3: The sections of the camel esophageal muscle that stained by myosin ATPase. The proportion of type 1 muscle fiber is low in cervical esophagus and increase in the thoracic esophagus. Cervical esophagus; myofibrillar ATPase reaction at PH=4.35 (A). Cervical esophagus; myofibrillar ATPase reaction at PH=10.0 (B). Thoracic esophagus; myofibrillar ATPase reaction at PH=4.35 (C). Thoracic esophagus; myofibrillar ATPase reaction at PH=10.0 (D). Type 1 muscle fibers are light staining at PH=10.0 and dark staining at PH=4.35. Type 2 muscle fibers are dark staining at PH= 10.0 and light staining at PH=4.35.

muscularis fibers in both esophagus regions was identified by myosin ATPase reaction in control quadriceps muscle. After pre-incubation at pH 4.35 observed reverse of fiber type staining. Type 2 fibers in the cervical and thoracic esophagus regions were observed obviously more than the Type 1 fibers in the both region (Fig. 3). The distinction between Type 1 fiber and Type 2 fiber of tunica muscularis in the segments of the esophagus was increased gradually from the cranial cervical region to caudal thoracic region. Type 2 fibers in quadriceps muscle were identified uniform population. This study not capable to identification of the various subtypes of Type 2 fibers with the methodology employed.

DISCUSSION

The histological structure of the esophagus in one-humped camel is largely similar to the structure of cow, sheep and horse, but differs from the human, dog and cat [6-8]. Esophagus in all ruminants and animals, present stratified squamous epithelium in mucosal layer. The thick heavily keratinized mucosal epithelium present in ruminants and camel that it helps to prevent injury from ingestion of coarse and dry foods. The presence of the muscularis mucosa in the caudal segment of esophagus with the form of a few scattered strands of smooth muscle is contrary to histological esophagus structure in ruminants. The muscularis mucosa found only in the most distal part of esophagus in camel, but in the ruminant is through esophagus's length [6]. The submucosal glands presence abundant and found throughout the length of the camel esophagus that is similar to the llama [2] but in ruminants, horses and cats, the submucosal glands were observed only in the proximal part of esophagus [6]. The mucous secreted of submucosal glands plays important role in the passage of rough and forage foods through the long esophagus. On the other hand, the secretions of these glands may also contribute for the providing a suitable chemical environment for digestive function and increasing buffering capacity of the first compartment of the camel compared to the rumen of ruminants [9]. The tunica muscularis of camel esophagus composed of entirely striated muscle fibers and divided into two layers: the inner (circular) and outer (longitudinal) and is similar to the ruminants [6]. The proportion of striated and smooth muscle varies greatly among species. For example, in the horse, the tunica muscularis of the cranial two-third of the esophagus consists of striated muscle and the caudal third is of smooth muscle [6].

Tunica adventitia having loose irregular connective tissue contained with fine blood capillaries, small blood vessels and fatty tissue in cervical and thoracic region, the tunica serosa possessing a mesothelium covered the above structure in abdominal region of camel esophagus as reported in ruminants [6].

In the cervical region of camel esophagus, muscle fiber type is more predominantly than Type 2 that it is similar to the ruminants. The Type 1 fibers increase gradually in the thoracic region. The percentage of Type 1 fibers in thoracic region of sheep esophagus is 30% and in cow is 36% [10]. The secondary peristaltic movement observes mostly in the thoracic esophagus in camel after a burp and rarely in the cervical esophagus. The

differences in physiological action between the two regions of the esophagus may be due to the difference proportions of fiber types.

REFERENCES

1. Smuts, M.M.S. and A.J. Bezuidenhout, 1987. Anatomy of the Dromedary. Oxford, Clarendon Press: pp: 119-123.
2. Jamdar, M.N. and A.N. Ema, 1982. The submucosal glands and the orientation of the musculature in the esophagus of the camel. *J. Anat.*, 135: 165-171.
3. Dellman, H.D., P.C. Blin and M.F.A. Fahmy, 1968. Contribution à l'étude de l'anatomie microscopique du tube digestif chez le chameau. *Rev. Elve. Méd. Pays. Trop.*, 21(1): 1-32.
4. Dubowitz, V. and M.H. Brooke, 1973. Muscle Biopsy: a Modern Approach. London, W.B. Saunders.
5. Brooke, M.H. and K.K. Kaiser, 1970. Muscle fiber type: how many and what kind? *Arch. Neurol.*, 23: 369-379.
6. Schummer, A., R. Nickel and W.O. Sack. 1979. The alimentary canal. In: *The Viscera of Domestic Mammals*. New York, Springer-Verlag, pp: 99-202.
7. DeNardi, F.G. and R.H. Riddell, 1991. The normal esophagus. *Am. J. Surg. Pathol.*, 15: 296-309.
8. Fawcett, D.W. and E. Raviola, 1994. The esophagus and stomach. In: Fawcett, D. W. (Ed). *A Textbook of Histology*. 12th Ed. New York, Chapman and Hall, pp: 593-616.
9. Vallenar, A., L. Llerena, A. Valenzuela, D. Chauca, J. Esquerre and E. Candela, 1973. Concentración de ácidos grasos volátiles a lo largo del tracto gastrointestinal de alpacas y llamas (Volatile fatty acid concentrations in the length of the gastrointestinal tract of alpacas and llamas). *Rev. Inv. Pec. (IVITA)*, 2(1): 3-14.
10. Mascarello, F., A. Rowleson and P.A. Scapolo, 1984. The fiber type composition of the striated muscle of the esophagus in ruminants and carnivores. *Histochemistry*, 80: 277-288.