International Journal of Zoological Research

ISSN 1811-9778

Academic Journals Inc.

www.academicjournals.com

International Journal of Zoological Research 8 (2): 90-97, 2012
ISSN 1811-9778 / DOI: 10.3923/ijzr.2012.90.97

Gross Anatomical Studies on Duodenum of one Humped Camel (*Camelus dromedarius*)

T. Althnaian, K.M. Alkhodair, I.F. Albokhadaim, R.O. Ramdan and A.M. Ali
Department of Anatomy, College of Veterinary Medicine and Animal Resources, King Faisal University, Al-Ahsa 31982, Kingdom of Saudi Arabia

Corresponding Author: T. Althnaian, Department of Anatomy, College of Veterinary Medicine and Animal Resources, King Faisal University, Al-Ahsa 31982, Kingdom of Saudi Arabia

ABSTRACT

The main objective of this research was to study the morphological characters of the camel duodenum. The general features of the camel duodenum were studied macroscopically. The camel duodenum was grayish to white in color. It was divided into two parts i.e., ampulla and thin part which form the long part. The thin part was divided into three parts i.e., descending part, caudal duodenal flexure (transverse part) and ascending part. The duodenum began at the pylorus and ended at the beginning of jejunum. Its mucosa was pink to grayish in color with crossed circular and longitudinal fold at the ampulla and longitudinal fold at the thin part. The length of the duodenum ranged between 1.2-3.1 m. In conclusion, the camel duodenum has distinctive morphological characters. The study provided an excellent potential for further physiological studies on camel duodenum under an arid environment.

Key words: Divisions, length, duodenum, small intestine, jejunum, caudal duodenal flexure, camel

INTRODUCTION

The camel (*Camelus dromedarius*) is a main source of milk, meat, wool and hides for people especially who were live in the desert. The adult camel can produce 9.1-14.1 kg of milk per day and 400-600 kg of meat (Williamson and Payne, 1978). Camels are well adapted to life in the desert because of their unique metabolic pathways which enable them to survive without food and water for few days (Haghkhah and Madjlesi, 1999). The mechanism used is not well understood, but probably involves several organ systems including the gastrointestinal system which is well known for fluid and electrolytes transport (Ali *et al*., 2008). The duodenum is responsible for further processing of the material from the stomach by secreting enzymes which are vital for digestion. It also mixes the digesta with these enzymes within its lumen (Weisbradt, 1987; Guyton, 1988; Dellmann and Eurell, 1998).

The morphology of the gastrointestinal tract has been reported for sheep, cattle, pig, horses, dogs (Sisson *et al*., 1975), man (Ellis 1992), birds (Devyn *et al*., 2000), monk seal (Gwen *et al*., 2001) and rodent (Perez *et al*., 2008a; Ali *et al*., 2008). The average length of small intestine is 40 m in camel (Smuts and Benzuidenhout, 1987), about 22 m in horse (Sisson *et al*., 1975), 5 m in pampas deer (Perez *et al*., 2008a), 11 m in monk seal (Gwen *et al*., 2001), 1.3 m in wild African giant pouched rat (Ali *et al*., 2007) and 5 m in human (Nakshabendi *et al*., 1999). The cranial part of the camel duodenum comprised of the first division of the duodenum called *Ampulla duodeni* which lies against the visceral surface of the liver followed by sigmoid flexure curve *Ansa sigmoidea* is present in nutria (Perez *et al*., 2008b; Sisson *et al*., 1975). In sheep, the cranial part of duodenum

passes near the umbilical fissure of the liver and forms sigmoid flexure on the caudate lobe of the liver (May, 1977). In the horse, the cranial part of the duodenum form a sigmoid flexure and it is in contact with the quadrate and right lobe of the liver and presents two ampullae with constriction between them. Also the descending duodenum passes dorsal and caudal on the right dorsal part of the colon and ventral to the right lobe of the liver. On reaching to the right kidney and the base of the caecum it curves toward the median plane opposite the last rib (Sisson *et al*., 1975; Dyce *et al*., 2002). In the pampas deer, the cranial part of the duodenum presented sigmoid flexure. While, the descending duodenum is situated in the dorsal part of the right flank. Also, in pampas deer after a caudal flexure, the ascending part of the duodenum ran in parallel to the descending part and was accompanied by the first portion of the descending colon (Perez *et al*., 2008a). Ventrally to the caudal pole of the right kidney the duodenum of camel turns medially as transverse duodenum *Pars transversa* which is attached to the last part of the ascending colon and passes cranially between the latter and the angle formed by the transverse and descending colon forming ascending duodenum then bend ventrally at the *Flexura duodenojejunalis* (Smuts and Benzuidenhout, 1987) while in sheep the descending part of the duodenum turns forward at tuber coaxe again to form iliac flexure. The third part of the duodenum forms second sigmoid flexure curve at the caudal extremity of the right kidney (May, 1977). In the horse, the ascending part of the duodenum passes from right to left caudal to the attachment of the base of the caecum (Sisson *et al*., 1975; Dyce *et al*., 2002). In most ruminants the cranial, the descending parts and the caudal flexure of the duodenum are only parts of the intestine that are exposed when the peritoneal cavity is opened from the right side (Sisson *et al*., 1975).

In camel the descending duodenum is suspended by a short mesoduodenum which contains the right lobe of the pancreas (Smuts and Benzuidenhout, 1987) while in pampas deer the right lobule of the pancreas which was located within the mesoduodenum, adhered to the cranial portion of the descending duodenum (Perez *et al*., 2008a). In horse, the mesoduodenum fixes the cranial part of the duodenum closely to the liver and ascending part of the right dorsal colon (Sisson *et al*., 1975; Dyce *et al*., 2002). In other ruminants, the cranial part of the duodenum is attached along its cranial surface to the lesser omentum and along its caudal surface to the superficial wall of the omental bursa. The descending part and caudal flexure are attached dorsally to the mesoduodenum which contains the extended right lobe of the pancreas, while the ascending part is attached to the descending colon caudally by duodenocolic ligament (Sisson *et al*., 1975; May, 1977; Dyce *et al*., 2002). The small intestine mucosa is characterized by permanent folds of the mucous membrane, plicae circulares (Junqueira *et al*., 1995).

Further information is required about the anatomy and histology of an important part of the gastrointestinal tract i.e., "the duodenum". The term duodenum is a Latin derivation from greek dodekadaktulon (12 fingers). The present study was undertaken to study the macroscopic structure of the camel duodenum including its position, shape and mucosa. Also, to discuss the information obtained about camel duodenum in the light of what is known about the duodenum of other domestic animals.

MATERIALS AND METHODS

Experimental camels: Eleven dromedary camels (*Camelus dromedarius*) of both sexes were taken from Al-Ahsa slaughterhouse and the camel research center, college of veterinary medicine and animal resources, King Faisal University, Hofuf, Al-Ahsa for study during 2009-2010. The animals and specimens were apparently healthy and free from gross pathological changes. The age of animals ranged between 2-12 years (Ramadan, 1994).

Methodology: Gross anatomical features and measurement of duodenum were studied in eleven fresh duodenums of experimental camels. The length of the ampulla and the thin part of the duodenum were measured in cm. Mean of each part of duodenum was calculated. The topography of the camel duodenum and the duodenal mucosa were examined.

The fresh specimens of dromedary camel duodenum were examined in the slaughter's house and in the Department of Anatomy, college of veterinary medicine and animal resources, King Faisal University, Hofuf Al-Ahsa.

RESULTS

The color of the specimens was grayish to white. The duodenum was divided into two main portions namely the ampulla and the thin part which formed the long part of the duodenum (Fig. 1). The thin part was divided into three parts such as the descending part, caudal duodenal flexure (transverse part) and ascending part (Fig. 2). The duodenum coils (festoon like coils) were

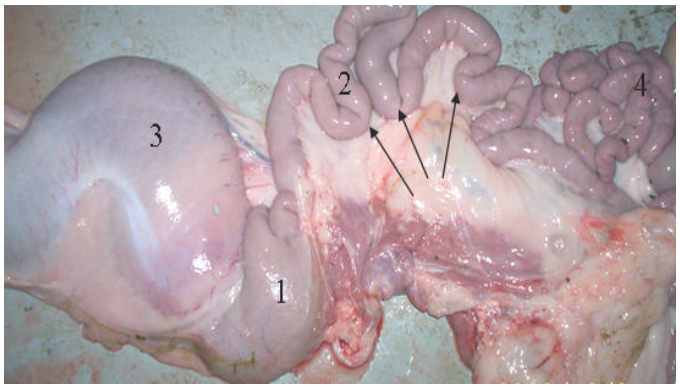

Fig. 1: Two parts of the camel duodenum. 1: Ampulla of duodenum, 2: Thin part of duodenum, 3: Abomasum, 4: Jejunum. Arrows are showing the duodenal coils

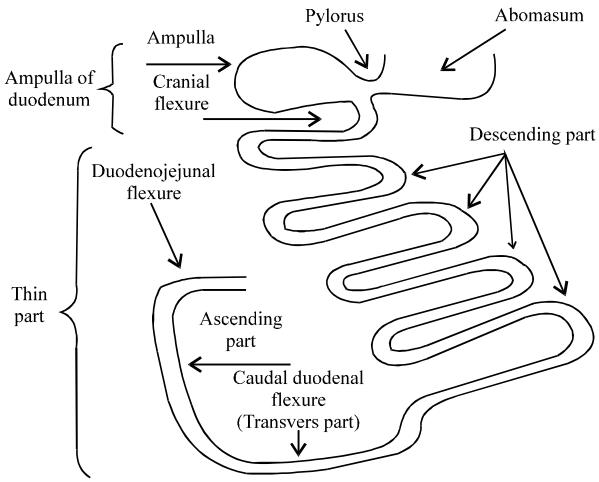

Fig. 2: The schematic diagram explains the different parts of the camel duodenum

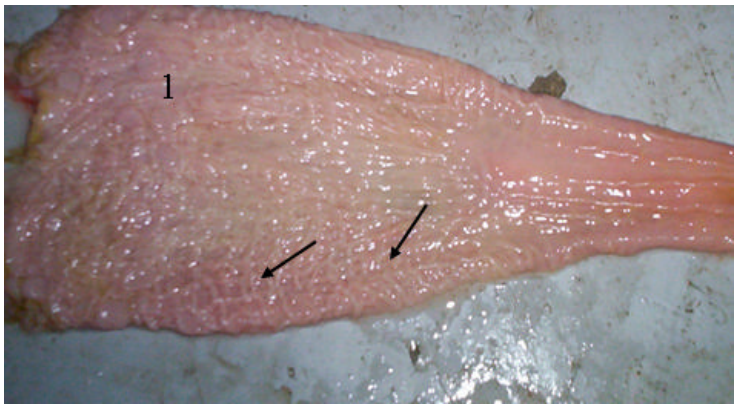

Fig. 3: Longitudinal section of the ampulla of the camel duodenum. Arrows are pointing the crossed longitudinal and circular folds. 1: The ampulla

Fig. 4: Longitudinal section of thin part of the camel duodenum. 1: Longitudinal folds, 2: Circular folds. Arrow is showing the end of the duodenum and beginning of the jejunum

ranged between 4-6 coils (Fig. 1, 2). The shape of duodenum was rounded in the upper part (ampulla) and cylindrical with many curvatures at the thin part. However, the duodenum was covered by the peritoneum and the mesentery attached to the duodenum by high amount of fat and blood vessels.

The duodenum began from the pylorus and ended at the beginning of jejunum. The beginning of the duodenum was very obvious as denoted by its ampulla while the end of the duodenum was not obvious especially at the junction between the duodenum and jejunum. On palpation, the duodenum was soft and thin while the jejunum was stiff and thick. The internal mucosa was pink to grayish in color with thin longitudinal folds at thin part and crossed circular and longitudinal folds at ampulla (Fig. 3). While the jejunum mucosa was thick and had circular folds (Fig. 4).

The length of the ampulla of duodenum was 5 cm in young camel and up to 20 cm in the adult. The length of thin part of duodenum was 1.15 m in young camel and up to 2.9 m in adult. The total length of camel duodenum ranged between 1.2 to 3.1 m. The average length of duodenum was 2.17±m (Fig. 5).

The duodenum was located under the tenth costocondral junction. The cranial part of the duodenum (ampulla and beginning of thin part) was located against the visceral surface of the liver (Fig. 6). The duodenum was directed craniodorsally to forms the cranial flexure. At this flexure the convoluted descending part of the duodenum passed caudally suspended by mesoduodenum which contained the right lobe of the pancreas which attached cranially to the ampulla of duodenum. Internally, at the junction of ampulla and thin part, a shelf like partition projects into the lumen as the walls of two portions were attached to each other. Ventrally the caudal duodenal flexure

Fig. 5: The length of the camel duodenum

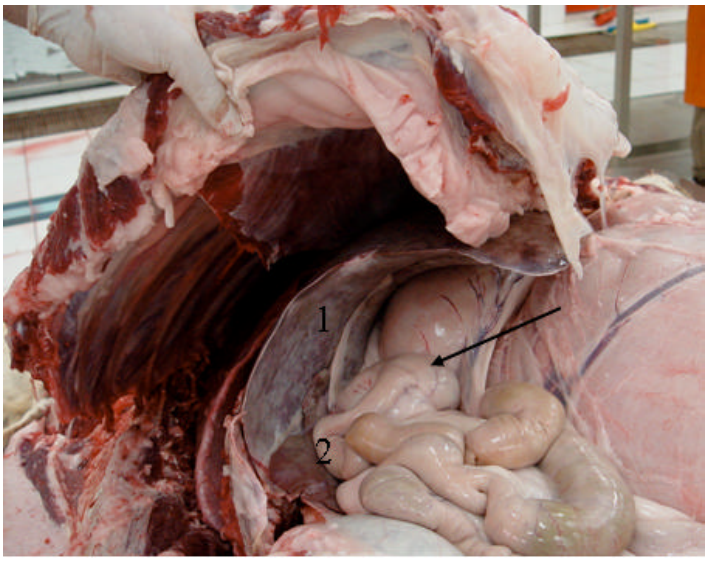

Fig. 6: The duodenum against the visceral surface of the liver. 1: Visceral surface of the liver, 2: Thin part of duodenum, Arrow is pointing the ampulla of the duodenum

(transverse part) of the duodenum passed caudal to the pole of right kidney and attached to the distal loop of ascending colon. The ascending part of the duodenum passed cranially between the angle formed by the transverse and descending colon and then bended ventrally to form the duodenojejunal flexure.

DISCUSSION

This study showed further contribution to the anatomical structure of the camel duodenum. The fresh camel duodenum was grayish to white in color. The camel duodenum was divided into two main portions, the ampulla and thin part. Similar findings were reported on the color and divisions of duodenum of various animals such as camel (Smuts and Benzuidenhout, 1987) and nutria (Perez *et al*., 2008a). On the other hand, the ampulla was not found in sheep (Sisson *et al*., 1975), cattle (Dyce *et al*., 2002) and pampas deer (Perez *et al*., 2008a). While in horse, there were two ampullae with constriction between them (Sisson *et al*., 1975). The thin part of the duodenum of the camel was divided into three parts, descending part, caudal duodenal flexure (transverse part) and ascending part. This findings agreed with previous work on camel (Smuts and Benzuidenhout,

1987), pampas deer (Perez *et al*., 2008a), sheep (May, 1977) and cattle (Dyce *et al*., 2002). The length of the camel duodenum reaches up to 1.2 m in young camel and up to 3.1 m in the adult. The average length was 2.17±m. Similar findings were not reported in camel earlier. Only the average length of the small intestine of the dromedary camel was reported to be 40 m (Smuts and Benzuidenhout, 1987). Whereas, the length of the duodenum was 1 m in the horse and most ruminants (Sisson *et al*., 1975), 29 cm in pampas deer (Perez *et al*., 2008a) and 20-30 cm in human (Lin *et al*., 1999). The internal mucosa of the duodenum of the camel was pink to grayish in color with thin longitudinal folds at the thin part and crossed longitudinal and circular folds at the ampulla. Thick circular folds were found in the jejunum. Therefore, the duodenum on palpation was soft while the jejunum was tough. This is one of the characteristic differences between the duodenum and the jejunum. Such findings were not reported in the literature. Some of the investigators reported that the internal mucosa of small intestine of other domestic animals had circular folds "Plicae Circulares" (Junqueira *et al*., 1995; Dellmann and Eurell, 1998).

The duodenum of the camel was located under the tenth costochondral junction of the right side. However, in sheep, the duodenum was situated opposite the ventral end of eighth intercostals space of right side (May, 1977). The ampulla of the duodenum was prominent, large and rounded in shape followed by thin part. The thin part was directed craniodorsally forming the cranial flexure. The study findings agree with those reported in camel by Smuts and Benzuidenhout, (1987) who concluded that the duodenum begins at the pylorus which is situated on the right side below the tenth costochondal junction in camel. The study results agree with those of Perez *et al*. (2008a) and Sisson *et al*. (1975) who stated that the cranial part of the duodenum forms sigmoid flexure in pampas deer and horse, respectively. In sheep, the duodenum was situated opposite the ventral end of eighth intercostal space of right side. Also, the duodenum passed cranially near to the umbilical fissure of the liver to forms sigmoid flexure on the caudal lobe of the liver (May, 1977). The convoluted descending part of the duodenum passed caudally, suspended by mesoduodenum to which the right lobe of the pancreas was attached cranially to the ampulla of duodenum. Similarly findings were reported in camel by Smuts and Benzuidenhout (1987) who found that the descending duodenum is suspended by a short a short mesoduodenum which contains the right lobe of the pancreas. In pampas deer, the descending part of the duodenum was situated in the dorsal part of the right flank and the right lobe of the pancreas was located within the mesoduodenum, adhering to the cranial portion of the duodenum (Perez *et al*., 2008a). In horse, the mesoduodenum fixes the cranial part of the duodenum closely to the liver and ascending part of the right dorsal colon (Sisson *et al*., 1975; Dyce *et al*., 2002). In most ruminants, the descending part of the duodenum runs dorsocaudally, near to the tuber coxae (Sisson *et al*., 1975; May, 1977; Dyce *et al*., 2002). The caudal duodenal flexure (transverse part) of the duodenum passed caudally to the pole of the right kidney and the ascending part passed cranially, then bended ventrally to form the duodenojejunal flexure. Identical findings were reported in camel by Smuts and Benzuidenhou, (1987) who stated that at the cranial duodenal flexure of the camel, the strongly convoluted descending duodenum commences, passing in a caudal direction. In sheep, the duodenum turned forward at the tuber coxae again to form iliac flexure, then the third part of the duodenum formed second sigmoid flexure (May, 1977). In pampas deer after caudal flexure, the ascending part of the duodenum ran parallel to the descending part (Perez *et al*., 2008a). In horse, the ascending part of the duodenum passed from right to left caudal to the attachment of the base of the caecum (Sisson *et al*., 1975).

CONCLUSIONS

Morphologically the duodenum of the camel has distinctive characters. It has a prominent large ampulla and thin part which constituted the long part of the duodenum. Longitudinal folds were also found in the thin part of the duodenum which makes its palpation thin and soft.

ACKNOWLEDGMENTS

The authors would like to thank the Camel Research Center, College of Veterinary Medicine and Animal Resources, King Faisal University and his members for providing the experimental animals, laboratory facilities and other help during the study.

REFERENCES

Ali, M.A., F. Nyberg, S.I. Chandranath, S. Dhanasekaran and S. Tariq *et al.*, 2007. Distribution of neuroendocrine cells in the small and large intestines of the one-humped camel (*Camelus dromedarius*). Neuropeptides, 41: 293-299.

Ali, M.N., O. Byanet, S.O. Salami, J. Imam, S.M. Maidawa, A.D. Umosen, C. Alphonsus and J.O. Nzalak, 2008. Gross anatomical aspects of the gastrointestinal tract of the wild African giant pouched rat (*Cricetomys gambianus*). Sci. Res. Essay, 3: 518-520.

Dellmann, H.D. and J.A. Eurell, 1998. Textbook of Veterinary Histology. 5th Edn., Lippincott Williams and Wilkins, Baltimore, USA.

Devyn, M.S., C. Rayetta, N. Grast, C.J. Theodosio, J.T. Clifford and M.N. Nanette, 2000. Evolution relationships between the amphibian, avian and mammalian stomachs. Evolut. Develop., 2: 348-359.

Dyce, K.M., W.O. Sack and C.J.G. Wensing, 2002. Textbook of Veterinary Anatomy. 3rd Edn., UUB Saunders, Philadelphia, London, pp: 258.

Ellis, H., 1992. The Gastrointestinal Tract. In: Clinical Anatomy: A Revision and applied Anatomy for Clinical Students, Ellis, H. (Ed.). 8th Edn. Bailliere Tindall, London, UK., pp: 73-97.

Guyton, A.C., 1988. Secretory Functions of the Alimentary Tract. In: Textbook of Medical Physiology, Guyton, A.G. (Ed.). Saunders WB, Philadelphia, pp: 801-815.

Gwen, D.G.L., S. Atkinson and J.R. Carpenter, 2001. Gross anatomy of the digestive tract of the Hawaiian Monk seal (*Monachus schauinslandi*). Pacific Sci., 55: 399-407.

Haghkhah, M. and F. Madjlesi, 1999. Normal microflora of eye of camel (*Camelus dromedarius*). J. Camel Pract. Res., 17: 79-82.

Junqueira, L.C., J. Carneiro and R.O. Kelley, 1995. Basic Histology. 8th Edn., Prentice-Hall International Inc., Appleton, Lange.

Lin, J.H., M. Chiba and T.A. Bailhe, 1999. Is the role of the small intestine in first-pass metabolism overemphasized?. The Am. Soc. Pharmacol. Exp. Therapeutics, 51: 135-158.

May, N.D.S., 1977. The Abdomen. In: The Anatomy of The Sheep: A Dissection Manual, May, N.D.S. (Ed.). 3rd Edn., University of Queensland, Queensland, pp: 67-101.

Nakshabendi, I.M. R. Mckee, S. Downie, R.I. Russell and M.J. Rennie, 1999. Rates of small intestinal mucosal protein synthesis in human jejunum and ileum. Am. J. Physiol. Endocrinol. Metab., 277: 1028-1031.

Perez, W., M. Clauss and R. Ungerfeld, 2008a. Observations on the macroscopic anatomy of the intestinal tract and its mesenteric folds in the pampas deer (*Ozotoceros bezoarticus*, Linnaeus 1758). Anat. Histol. Embryol., 37: 317-321.

Perez, W., M. Lima1 and A. Bielli, 2008b. Gross anatomy of the intestine and its mesentery in the nutria (*Myocastor coypus*). Folia Morphol., 67: 286-291.

Ramadan, R.O., 1994. Surgery and Radiology of the Dromedary Camel. Al-Jawad Printing Press, Kingdom of Saudi Arabia, ISBN-13: 9789960270241, Pages: 360.

Sisson, S., J.D. Grossman and R. Getty, 1975. The Digestive System. In: Sisson and Grossman?s The Anatomy of the Domestic Animals, Sisson, S., J.D. Grossman and R. Getty (Eds.). 5th Edn. Vol. 1, 2, WB Saunders Company, Philadelphia, USA, Pages: 2095.

Smuts, M.M.S. and A.J. Benzuidenhout, 1987. The Anatomy of the Dromedary. Clarendon Press, Oxford, Pages: 230.

Weisbradt, N.W., 1987. Motihty of the Small Intestine. In: Physiology of the Gastrointestinal Tract, Johnson L.R., J. Christense, M.J. Jackson, E.D. Jacobson and J.H. Walsh (Eds.). Vol. 2. Raven Press, New York, USA., pp: 631-663.

Williamson, G. and W.J.A. Payne, 1978. An Introduction to Animal Husbandry in the Tropics. 3rd Edn., Longman, London, UK., ISBN-13:9780582468139, pp: 484-498.