



Review Article

Anatomical Variations of the Celiac Trunk in Ruminants

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Abstract | The celiac trunk was the first branch originating at different levels from the abdominal aorta in ruminants. In most cases, the celiac artery originated independently, while in few cases it originated by a celiacomesenteric trunk with the cranial mesenteric artery. The branches of the celiac trunk in ruminants varied and originated either directly or indirectly according to the species. The right ruminal artery originated either from the splenic, left gastric or celiac arteries. The epiploic branch detached either from the splenic, celiac or right ruminal arteries. The left ruminal artery arose either from the celiac, splenic or left gastric arteries. The reticular artery originated either from the left ruminal, splenic, celiac or left gastric arteries. The left gastric artery originated either from the celiac or hepatic arteries. Knowledge of the variations of the celiac trunk branches is important for veterinary surgeons during surgical procedures in the abdominal region in ruminants.

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Introduction

Ruminants can successfully accommodate to different environmental conditions, which can include hot climatic conditions as well as low nutritional level. Ruminants are of great economic value providing a good source of meat, milk and some industrial substances. The study of the pattern of the blood supply is important to gain information in the interest of pharmacology and toxicology and from a surgical perspective in ruminants (King, 1974) to avoid bleeding such as in rumenotomy (Mohamed et al., 2016). Variability of the celiac trunk in ruminants has been described by many authors. Therefore, the current work aimed to review variability of the celiac trunk and its branches in small and large ruminants which can be used for possible correlating surgical interferences and

in possible future publications in ruminants.

Material and Methods

The data from 32 research papers (8 on goat, 5 on sheep, 3 on goat and sheep, 5 on ox, 2 on goat and ox, 2 on buffalo and 7 on camel) including full text original articles, theses, textbooks and abstracts were collected either via hard copies or electronic search. The origin of the celiac trunk and pattern of its branches in the goat, sheep, ox, buffalo and camel were reviewed, organized and discussed.

Results and Discussion

The results were presented by using Tables 1, 2, 3, 4, 5, 6, 7, 8 and 9 which included animals (goat, sheep,

Table 1: *The level of the origin of the celiac trunk in the goat, sheep, ox, camel and buffalo.*

Species	Author and year of publication	Main findings (A, B, C and D)
Goat	Horowitz and Venzke (1966), Youssef (1991), Mohamed et al. (2017)	A. At the level of the first lumbar vertebra.
Sheep	Habel (1975) and Mohamed et al. (2016)	
Ox	Wilkens and Munster (1981)	
Camel	Hegazi (1945), Youssef (1973) and El-Gaafary and Youssef (1979)	B. At the level between the first and second lumbar vertebra.
Goat	Habel (1975), El-Gendy (2007) and Alsafy (2009)	
Buffalo	Barnwal et al. (1980)	C. At the level between last thoracic and first lumbar vertebra.
Camel	Attia (1980)	D. At the level of the second lumbar vertebra.

Table 2: *The occurrence of the celiacomesenteric trunk in the goat, sheep, ox and buffalo.*

Species	Author and year of publication
Goat	Nayar et al. (1983), Youssef (1991) and Alsafy (2009)
Sheep	Anderson and Weber (1969), May (1970) and Kardage (1988)
Ox	Habel (1975).
Buffalo	Barnwal et al. (1980) and Machado et al. (2002)

Table 3: *The branches of the celiac trunk in the goat, sheep, ox, buffalo and camel.*

Species	Author and year of publication	Main findings (A, B, C, D, E, F, G, H, I and J)
Goat	Scupin (1960) and Koch and Berg (1985)	A. A common stem for the splenic and right ruminal arteries, a stem for the left ruminal and reticular arteries, hepatogastric trunk for the hepatic and left gastric arteries, and as well as an epiploic artery
	Horowitz and Venzke (1966), Nayar et al. (1983), Youssef (1991), Constantinescu (2001), Alsafy (2009) and Mohamed et al. (2017)	B. Splenic, hepatic and left gastric arteries
Sheep	Mohamed et al. (2016)	C. Common stem for the splenic and right ruminal arteries and another one for left ruminal and reticular arteries, in addition to a hepatic and left gastric arteries
Ox	Habel (1975)	
Camel	Youssef (1973), EL-Gaafary and Youssef (1979) and Smuts and Bezuidenhout (1987)	D. Splenoruminal trunk for splenic and right ruminal arteries as well as left ruminal, common hepatic and left gastric arteries
Sheep	Happich (1961) and Koch and Berg (1985)	
Ox	Sisson and Grossman (1969), Habel (1975) and Koch and Berg (1985)	E. Splenic, right ruminal, left ruminal, left gastric and hepatic arteries
	Raghavan and Kachroo (1964)	F. Omasoabomasal artery and collateral branches, namely splenic, right ruminal, left ruminal, and hepatic arteries
Buffalo	Barnwal et al. (1980)	G. Splenic, hepatic and ruminogastric arteries. The ruminogastric divides into right ruminal, left ruminal and left gastric arteries
	Machado et al. (2002)	H. Splenic, right ruminal, left ruminal, reticular, epiploic, left gastric and hepatic arteries
Camel	Lesbre (1903)	I. Hepatic and gastrosplenic arteries
	Hegazi (1945)	J. Celiac artery terminates by dividing into the superior and inferior branches of the omasum and abomasum and its collateral branches are the superior and inferior arteries of the rumen, in addition to reticular, hepatic and splenic arteries

Table 4: *Branches of the splenic artery in the goat, ox, sheep and buffalo.*

Species	Author and year of publication	Main findings (A and B)
Goat	Horowitz and Venzke (1966), Youssef (1991) and Constantinescu (2001)	A. Right and left ruminal arteries as well as an epiploic branch
Ox	McCarthy (1984) and Habel (1975)	
Goat	Alsafy (2009) and Mohamed et al. (2017)	B. Right ruminal artery and an epiploic branch
Sheep	Mohamed et al. (2016)	
Buffalo	Barnwal et al. (1980) and Machado et al. (2002)	

Table 5: *Origin of the right ruminal artery in the goat, sheep, ox, buffalo and camel.*

Species	Author and year of publication	Main findings (A, B, C and D)
Goat	Horowitz and Venzke (1966), Nayar et al. (1983), Youssef (1991), Alsafy (2009) and Mohamed et al. (2017)	A. Splenic artery
Sheep	Mohamed et al. (2016)	
Ox	Seilder (1966), Habel (1975) and McCarthy (1984)	
Buffalo	Machado et al. (2002)	
Goat	Kardage (1988)	B. left gastric artery
Sheep		
Ox	Koch and Berg (1985)	C. Coeliac artery
Camel	Youssef (1973), EL-Gaafary and Youssef (1979) and Smuts and Bezuidenhout (1987)	D. The right and left ruminal arteries arise together by a common stem from the left gastric artery

Table 6: *The origin of the epiploic artery in the goat, sheep, ox, buffalo and camel.*

Species	Author and year of publication	Main findings (A, B, C and D)
Goat	Horowitz and Venzke (1966), Youssef (1991), Constantinescu (2001), Alsafy (2009) and Mohamed et al. (2017)	A. Splenic artery
Sheep	Mohamed et al. (2016)	
Ox	Habel (1975) and McCarthy (1984)	
Buffalo	Barnwal et al. (1980) and Machado et al. (2002)	
Sheep	Koch and Berg (1985)	B. Celiac trunk
Camel	Youssef (1973) and EL-Gaafary and Youssef (1979)	C. Right ruminal artery
Sheep	Happich (1961)	D. From the common trunk of the splenic and right ruminal arteries

Table 7: *Origin of the left ruminal artery in the goat, sheep, ox, buffalo and camel.*

Species	Author and year of publication	Main findings (A, B and C)
Goat	Scupin (1960), Koch and Berg (1985), Alsafy (2009) and Mohamed et al. (2017)	A. Celiac trunk
Sheep	Anderson and Weber (1969) and Mohamed et al. (2017)	
Ox	Raghavan and Kachroo (1964), Seilder (1966) and Sisson and Grossman (1969)	
Buffalo	Machado et al. (2002)	
Goat	Horowitz and Venzke (1966), Youssef (1991) and Alsafy (2009)	B. Splenic artery
Sheep	Mohamed et al. (2016)	
Ox	Habel (1975) and McCarthy (1984)	
Buffalo	Machado et al. (2002)	
Goat	Horowitz and Venzke (1966) and Nayar et al (1983)	C. Left gastric artery.
Sheep	May (1970)	
Ox	Habel (1975)	
Buffalo	Machado et al. (2002)	
Camel	Youssef (1973), EL-Gaafary and Youssef (1979) and Smuts and Bezuidenhout (1987)	

Table 8: Origin of the reticular artery in the goat, sheep, ox, buffalo and camel.

Species	Author and year of publication	Main findings (A, B, C and D)
Goat	Youssef (1991), Constantinescu (2001), Alsafy (2009) and Mohamed et al. (2017)	A. Left ruminal artery
Sheep	Happich (1961), Anderson and Weber (1969), May (1970) and Mohamed et al. (2016)	
Ox	Habel (1975), Sisson and Grossman (1969) and Koch and Berg (1985)	
Goat	Horowitz and Venzke (1966)	B. Splenic artery
Sheep	Kowatscheve (1968)	
Goat	Scupin (1960) and Koch and Berg (1985)	C. Celiac artery
Ox	Raghavan and Kachroo (1964)	
Goat	Horowitz and Venzke (1966) and Nayar et al (1983)	D. Left gastric artery
Sheep	Kowatscheve (1968) and Mohamed et al. (2016)	
Buffalo	Machado et al. (2002)	
Camel	Smuts and Bezuidenhout (1987)	

Table 9: Origin of the left gastric artery in the goat, buffalo, sheep and ox.

Species	Author and year of publication	Main findings (A, B, C, E. and D)
Goat	Scupin (1960), Horowitz and Venzke (1966), Nayar et al. (1983) and Koch and Berg (1985)	A. Celiac artery
Buffalo	Machado et al. (2002)	B. Represents the direct continuation of the celiac artery
Goat	Youssef (1991), Alsafy (2009) and Mohamed et al. (2017)	
Sheep	Anderson and Weber (1969), May (1970), Boccaletti and Borelli (1981) and Mohamed et al. (2016)	
Ox	Sisson and Grossman (1969)	C. Hepatic artery
Goat	Wilkens and Munster (1981) and Simoens et al. (1981)	
Sheep	Simoens et al. (1981)	
Ox	Miglino and Didio (1993)	D. Originates from the celiac artery by a way of common trunk with the splenic artery, namely gastrolinal trunk.
Buffalo	Barnwal et al. (1980)	
Buffalo	Barnwal et al. (1980)	E. A branch of the ruminogastric artery

ox, buffalo and camel), author, year of publication (1903–2017) and main findings (A, B, C, D, E, F, G, H and I) and Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11.

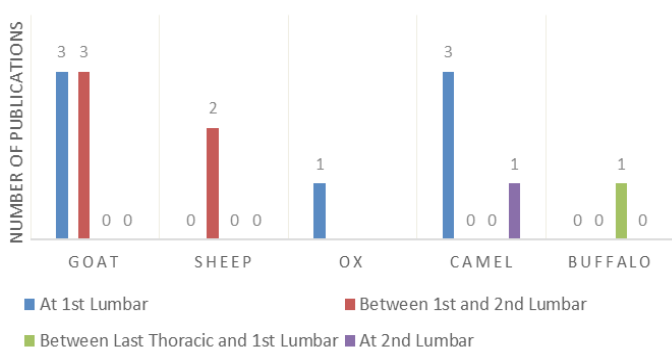


Figure 1: A graph showing the level of the origin of the celiac trunk in the goat, sheep, ox, camel and buffalo.

Comparison of the origin and branches of the celiac trunk in the goat, sheep, ox, buffalo and camel is given in Tables (1, 2, 3, 4, 5, 6, 7, 8 and 9), graphs (1-9)

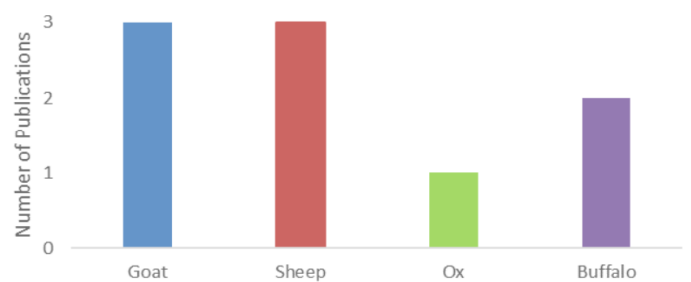


Figure 2: A graph showing the occurrence of the celiacomesenteric trunk in the goat, sheep, ox and buffalo.

and Figures 1 and 2. The celiac trunk originates independently from the abdominal aorta in the goat at either the first lumbar vertebra or between the first and second lumbar vertebrae, while it originates only at the first lumbar vertebra in the sheep and ox. However, it originates at the level between the last thoracic and first lumbar vertebrae in the buffalo and at either the level of the first or second lumbar vertebrae in the camel. Moreover, in some cases,

the celiac and cranial mesenteric arteries originate together from the abdominal aorta by a common trunk (celiacomesenteric trunk) in the goat, sheep, ox and buffalo.

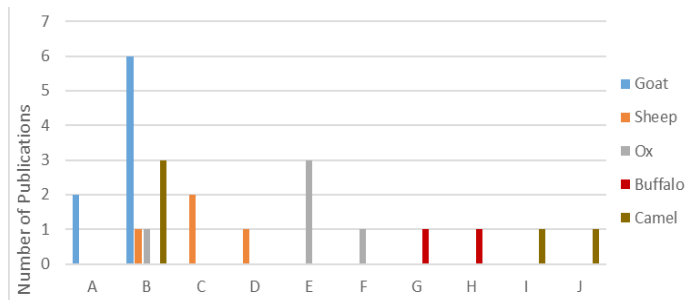


Figure 3: A graph showing the branches of the celiac trunk in the goat, sheep, ox, buffalo and camel.

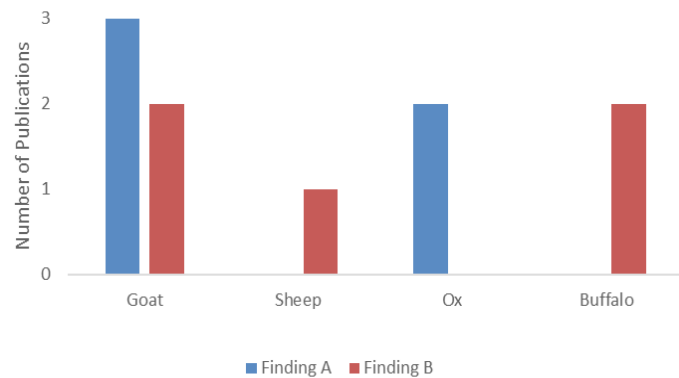


Figure 4: A graph showing the branches of the splenic artery in the goat, sheep, ox and buffalo.

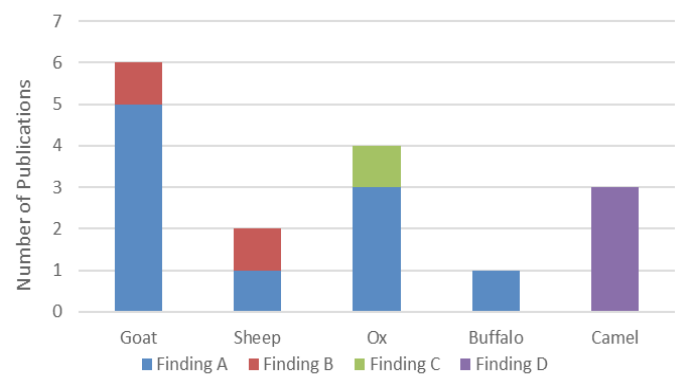


Figure 5: A graph showing the origin of the right ruminal artery in the goat, sheep, ox, buffalo and camel.

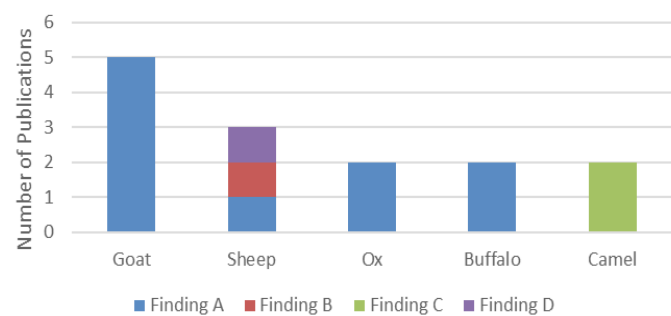


Figure 6: A graph showing the origin of the epiploic artery in the goat, sheep, ox, buffalo and camel.

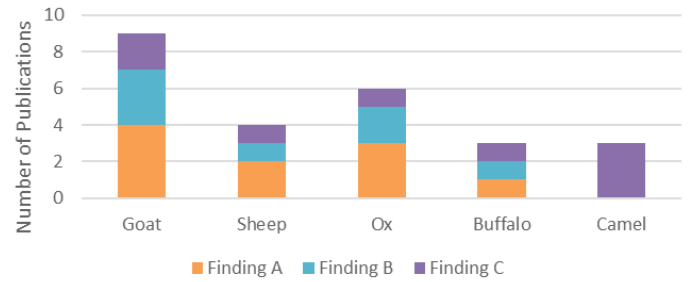


Figure 7: A graph showing the origin of the left ruminal artery in the goat, sheep, ox, buffalo and camel.

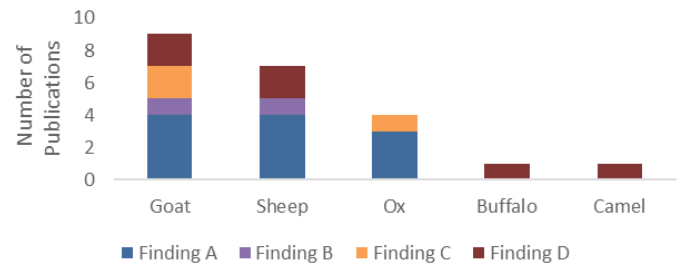


Figure 8: A graph showing the origin of the reticular artery in the goat, sheep, ox, buffalo and camel.

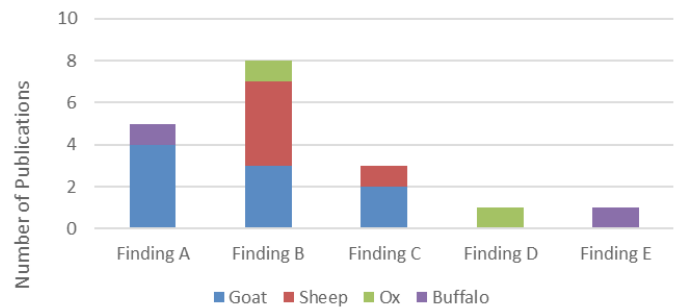


Figure 9: A graph showing the origin of the left gastric artery in the goat, sheep, ox and buffalo

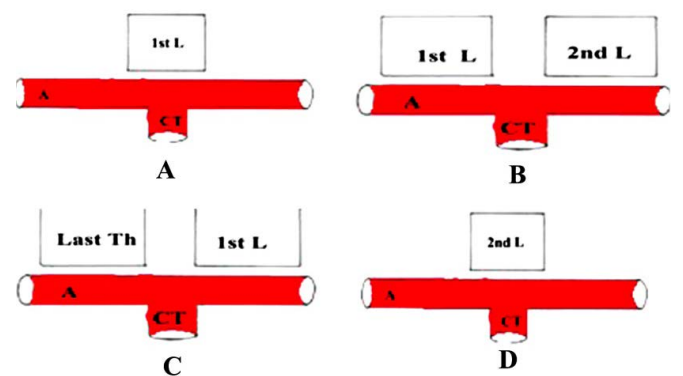


Figure 10: Schematic drawing showing the level of the origin of the celiac trunk in the goat (A and B), sheep (A), ox (A), buffalo (C) and in camel (A and D). 1st L- First lumbar vertebra; 2nd L- Second lumbar vertebra; Last Th- Last thoracic vertebra; A- Abdominal aorta; CT- Celiac trunk.

The obtained results showed that the main branches of the celiac artery in ruminants were the splenic, hepatic and left gastric arteries which originates either separate or by common trunks with other branches. Further, the results showed that right and left ruminal

arteries as well as an epiploic branch are detached from the splenic artery. However, the right and left ruminal arteries could also originate from the celiac trunk in the goat, sheep, ox and buffalo and from the left gastric artery in the goat, sheep, ox, buffalo and camel. Moreover, the epiploic artery could also originate from the celiac artery in the sheep and from the right ruminal artery in the camel. For the reticular artery, the results show that it originates either from the celiac artery in the goat and ox or from the splenic artery in the goat and sheep or from the left ruminal artery in the goat, sheep and ox or from the left gastric artery in goat, sheep, buffalo and camel.

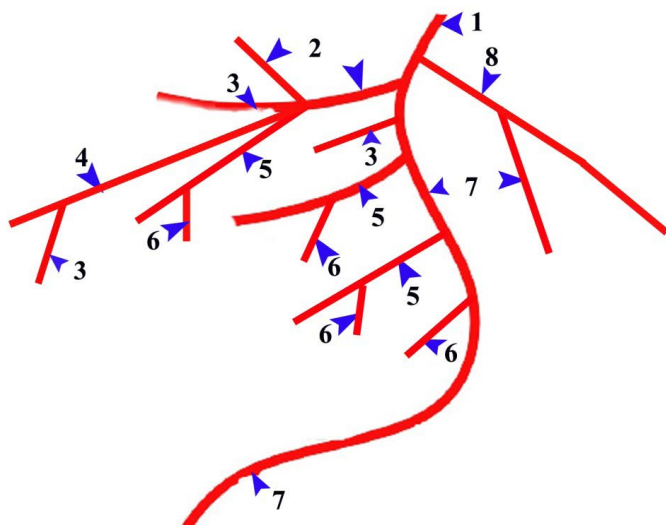


Figure 11: Schematic drawing showing the variability of the branches of the celiac trunk in ruminants. 1- Celiac trunk; 2- Splenic artery; 3- Epiploic artery; 4- Right ruminal artery; 5- Left ruminal artery; 6- Reticular artery; 7- Left gastric artery; 8- Hepatic artery.

Observations of the present study showed that the origin of the left gastric artery is either the celiac trunk in the goat, ox and buffalo, or the hepatic artery in the goat and sheep or a branch from the ruminogastric artery in the buffalo or represents the direct continuation of the celiac artery in the goat, sheep and ox.

Conclusions and Recommendations

Variation in the branches of the celiac trunk is very common in small and large ruminants. It is important to emphasize the possible variations of the celiac trunk to veterinary surgeons which may have implications for imaging studies and surgical interferences in the abdominal region in ruminants such as in rumenotomy and abomasal displacement.

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Author Contribution

The author collected the data, carried out the research, wrote, and revised the review paper.

Conflict of Interest

The author declared no conflicts of interest

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