The effect of stomach's different fullness levels on the topography of intestines in New Zealand rabbit (Oryctolagus cuniculus L.)

Özcan Özgel*, Emine Karakurum, Yasin Demiraslan, Mevlüt Aykut

Mehmet Akif Ersoy University, Faculty of Veterinary Medicine, Department of Anatomy, Burdur, Turkey
Received: 02.08.2016, Accepted: 25.10.2016
**ozcangel@gmail.com

Yeni Zelanda tavşanında (Oryctolagus cuniculus L.) midenin farklı do-luluk derecelerinin bağırsakların topografisi üzerine etkisi

Öz

Amaç: Yeni Zelanda tavşanlarında midenin farklı doluluk derecelerinin karın organlarının topografi üzerine etkisi araştırıldı.

Gereç ve Yöntem: Tavşanlar; normal beslenenler, midesi boş ve midesi dolu olmak üzere 8'er adetlik 3 gruba ayrıldı. Doğankunlukları farklı olan her üç gruptaki tavşanlardan 6 tanesi (3x2) diseke edildi. Bu üç grup hayvandan paramedian ve transversal kesitler alındı.

Bulgular: Çalışmada Yeni Zelanda tavşanında mide boşken duodenum’un başlangıcının arcus costales’in bitiş seviyesinde olduğu görülüldü. Çalışmada cecum’un midesi boş tavşanlarda karın boşluğunun ventral’inde, midenin curvatura ventriculi major’u ile pelvis boşluğu giriş arasında, karın boşluğunun sağ tarafında, sağ karın duvarına temas eder durumda bulunduğu görüldü. Midesi dolu tavşanlarda ise cecum’un curvatura ventriculi major’un sağ kısmının altında, sağ karın duvarına dayalı olarak caudal yönde uzandığı belirlendi. Midesi boş tavşanlarda colon’un regio umbilicalis’te cecum’ın kıvrımlarının arasında ampulla coli halinde basladığı, midesi dolu tavşanlarda ise colon’un karın boşluğunun sağ ve ventral kısmında, median düzlemi in sol kısmına da geçmiş pozisyonu, karın boşluğunun ventral duvarına temas eder durumda yerleştiği görülmüştür.

Öneri: Tavşanların normal abdomen bölgesinin kesit anatomininde mide dolulüğunun barsaklar üzerine etkili olabileceğini ifade edilabilir.

Anahtar kelimeler: Topografi, mide, tavşan, bağırsak

Abstract

Aim: The objective of the present study was examining the effect of stomach’s different fullness levels on the topography of abdominal organs in rabbits.

Materials and Methods: Rabbits were divided into 3 groups, each of which consisting of 8 rabbits. 6 rabbits of those in each group with the same fullness level (3x2) were dissected. Paramedian and transversal sections were taken from this 3 groups.

Results: It was observed that when the stomach was empty, duodenum’s beginning was on the ending level of arcus costales in New Zealand rabbits. When the stomach was full, it was pushed from pyloris towards the cranial. Cecum was observed to be in contact with right abdominal wall on the right side of the abdominal cavity as contacting uterus between stomach’s curvatura ventriculi major and pelvis cavity entry in ventral abdominal cavity in rabbits with empty stomachs. In rabbits with full stomachs, cecum was determined to extend caudally contacting right abdominal wall and it was located under the right side of curvatura ventriculi major. Cecum was found to start as ampulla coli between the folds of cecum in region umbilicalis in rabbits with empty stomachs; whereas, it was located as being contacted with the ventral wall of abdominal cavity in a position passing the left part of median level in right and ventral part of the abdominal cavity in rabbits with full stomachs.

Conclusion: It may be concluded that fullness of the stomach effects on intestines in the cross-sectional anatomy of the normal abdominal region in the rabbit.

Key words: Topography, Stomach, Rabbit, Intestines.
Introduction

Rabbit is a species belonging to the family leporidae of the order lagomorpha (Barone at al 1973). New Zealand rabbit is an animal species which is often preferred by researchers due to its availability to be used in experimental studies. It appears as an animal model that is used in the research of certain diseases and surgical practices due to its anatomic and physiological characteristics (Craigie 1969, Chiasson 1973, Breiling 1994).

In the last 10 years, the increase in the number of the interest shown in rabbits in Europe brings along developments on rabbit medicine. This leads medicine to new pursuits. One of them is cross-sectional anatomy. It is important to have a good command of cross-sectional anatomy for an effective diagnosis (Deniz 1966). In addition, cross-sectional anatomy is also atlas for computerized tomography, ultrasonography, and magnetic resonance imaging techniques. There are two types of intestines as small intestines and large intestines. While small intestines are shaped by duodenum, jejunum, and ileum, large intestines are shaped by cecum, colon, and rectum. The large part of duodenum is found in the upper right side of abdominal cavity (except for dogs) as being hanged with mesoduodenum. During its course, duodenum shapes ampulla duodeni, pars cranialis, flexura duodeni cranialis, pars descensdens, flexura duodenica caudalis, pars transversa, pars ascendens flexura duodenojejunalis, and reaches its end after combining with jejenum (Fike at al 1980, Feeney at al 1991, Evans 1993, Evans and Delahunda 1996, Dursun 2005). Jejunum is spiral shape of small intestines that are found in the ventrocudal area of cavum abdominis (Evans and Delahunda 1996, Dursun 2005). Ruminants are found in the right half of the abdominal cavity and surround colons (Fike at al 1980, Feeney at al 1991, Evans 1993). Ileum is the shortest and last part of small intestines and opens to large intestines through valva ileocolica (Feeney at al 1991, Flecknell 1992, Evans 1993, Evans and Delahunda 1996, Dursun 2005). In rabbits, the last part of ileum has an open formation that has a round shape, is half-enlarged and is as called sacculus rotundus which is not found in other animals (Flecknell 1992, DeRycke at al 2005). Cecum is qualified as the first part of large intestines. It occupies a large area in rabbits and therefore creates a spiral shape. The narrower last part of cecum, which is composed of three sections, goes through the dorsal position and reaches backwards; this part with thick walls is called as processus vermiformis or appendix (Flecknell 1992, DeRycke at al 2005). Colon, which comprises the big part of large intestines in rabbits, leaves cecum in sacculus rotundus area which is largely distinguished with its marsupialized walls. The first part of colon is assumed as the cecum structure that constitutes ampulla cecalis coli (DeRycke 2005). Colon is found in the dorsal area of the abdominal cavity. Colon is divided into two 2 parts as colon ascendens and colon descendens (Fox 1984) or into 3 parts as colon ascendens, colon transversum and colon descendens (Feeney at al 1991, Evans 1993, Evans and Delahunda 1996, Gezici and Eken 2001, Dursun 2002, DeRycke et al 2005, Dursun 2005).

In the literature review, no data concerning how or to what extend the intestine parts of New Zealand rabbit are affected by the stomach’s fullness level has been found. Therefore, the purpose of this study was to determine the effect of stomach’s fullness level on intestine parts of New Zealand rabbit by using dissection, paramedian and transversal sections.

Materials and Methods

In this study, 24 healthy adult New Zealand rabbits including 12 males and 12 females were used. The rabbits were divided into three groups; those fed normally, those with empty stomachs and those with full stomachs. The rabbits in all three groups were put into cages and the rabbits in the first group were fed with normal meals, whereas no food was given to the rabbits in the second group for 24 hours. The rabbits in the third group were not given any food for 24 hours, and then they were given feed in the amounts that they can consume and in the period they were deprived of food they could drink only water. Later on, the rabbits were anaesthetised with 5 mg/kg xylazin HCl and 35 mg/kg ketamine HCl (Gezici 1999). Their blood was discharged before they came out of anaesthesia. Latex coloured with blue and red was injected into v. jugularis and a. carotis communis in order to ensure that the arteries and veins in the abdominal cavity are openly revealed. 6 (3x2) rabbits out of all three groups with the same stomach fullness levels were dissected. Remaining rabbits were frozen at -20°C in sternal position (Hillen 1984, Deniz 1966, Güzel and Yavru 1997). Paramedian sections were taken from totally 9 rabbits including three rabbits from these three groups and transversal sections were taken from the other 9 rabbits with the help of reciprocating saw (Bosch-PFz. 500e brand) in order not to damage tissues and organs too much. Although there are literature data concerning the transversal sectioning areas and section thickness (Klesty 1984, McLaughlin and Chiasson 1990, Deniz 1966, NAV 2005, König and Liebich 2007) in our study transversal sections were taken backwards starting from the last vertebra thoracica as separately from each vertebrae lumbaral level. The interval between each vertebrae lumbaral was measured to be approximately 2 cm. Later on, the rabbits, which were dissected and from which transversal and paramedian sections were taken, were photographed with a Nikon D80 brand camera. After cleaning the section surfaces, transversal sections were photographed from the cranial surfaces of received sections. Literature data (Popescu et al 1992, Deniz 1966, DeRycke et al 2005, Pearce et al 2007) were used in defining the anatomic structures observed in paramedian and transversal sections. While Mitutoyo Digimatic Caliper was
used to measure anatomic structures determined on rabbits, Nomina Anatomica Veterinaria (NAV 2005) was used for de-
nominating them.

The use of rabbits in this study was approved by Suleyman Demirel University Animal Experiments Local Ethics Com-
mittee Department’s decision dated 27.11.2008 and numbe-
red 09/09.

Results

A-Dissected animals

1st Group: Normally-fed rabbits

Duodenum was observed to begin with pylorus, make a mild swelling called as ampulla duodeni, and shape flexura duode-
ni cranialis in a position contacting the side wall of the abdo-
nominal cavity in a position close to columna vertebralis right
at the end of arcus costalis. Then, it was found to reach the
cecum level with the name of pars descendens in a parallel
position with right abdominal wall (Figures 1-c, 4-g, 5-g and
10-e). After this point, it makes a bend called as flexura duode-
ni caudalis, forms pars caudalis, and reaches the left side.
This part was determined to be pars ascendens which has a
course towards cranial and dorsal direction, and later on
combines with jejunum. Jejunum was observed to form the
folds called as ansa jejunalis, to be the empty intestine part
and is mainly found in the left and bottom side of abdominal
cavity (Figures 1-g, 4-d and 5-f). When abdomen’s ventral
wall was dissected, jejunum was found in the caudal of the
stomach and observed to be in contact with cecum in a posi-
tion close to median level. It was determined to be separate
from ileum through plica ileocaecalis. Ileum is located in the
right side of the abdominal cavity, shows a transversal course
from the median level from a point close to right abdominal
wall after jejunum where it begins and was observed to re-
ach between cecum and colon ascendens (Figures 1-I, 4-h
and 5-k). It was determined to end its course with ampulla ilei
or with an expansion called sacculus rotundus. Cecum was
observed to occupy a major part of abdominal cavity’s
regio umbilicalis area and regio abdominis lateralis dexter,
and reach the right fossa paralumbalis (Figures 1-f, 4-e and
5-h). Presence of colon ascendens and ileum was observed
between its folds. At the blind end of cecum, a worm-like for-
mation called as appendix vermiformis which is found only
in humans and rabbits was determined (Figure 11-h). Colon
was observed to proceed with the name of colon ascendens
in cranial direction in parallel with the long axis of the body
in the right and dorsal part of the abdominal cavity (Figures
1-h, 4-I and 5-i). This part of the colon makes an expansion
called as ampulla coli, makes a bend called as flexura coli
dextra and goes from right side to left side with the name of
colon transversum. Then, it makes a bend called as flexu-
ra coli sinistra, proceeds with the name of colon descendens
nearly along the median level in caudal direction and ends
after forming rectum near the entry of cavum pelvis called as
colon sigmoideum.

2nd Group: Rabbits with empty stomach

Duodenum which begins from pylorus was observed to make
a mild swelling called as ampulla duodeni (Figure 2-e). Later
on, immediately after the end of arcus costales, it shapes fle-
xura duodeni cranialis in a position contacting the side wall
of the abdominal cavity in a position close to columna ver-
tebrais. Later on, it reaches the cecum level with the name
of pars descendens in parallel level with right abdominal
wall. After this point, it makes another bend called as flexura
duodeni caudalis, forms pars caudalis, and reaches the left
side. This section shows a course towards cranial and dor-
sal direction, and was found to be the pars ascendens which
combines with jejunum. Jejunum was found to be in a posi-
tion totally filling regio abdominis sinistra in the ventral ab-
dominal cavity (Figures 2-g, 6-g and 7-f). Corpus ventriculi
part of the stomach was observed from the front side to be
in contact with curvatura ventriculi major on a wide surfa-
ce. The last part of jejunum shows a transversal course on
regio umbilicus from regio abdominis lateralis sinister; goes
towards regio abdominis lateralis dexter and forms ileum
between cecum and the starting part of the colon ascendens
on the right side of the median level. Although ileum had a
thickness of 4.78 mm between cecum and colon ascendens
in ventral examination, it shows a transversal course on the
median level (Figures 6-k and 7-i). It ends its course with am-
pulla ilei or with an expansion called as sacculus rotundus.
Cecum was found to be in the ventral abdominal cavity, in
contact with uterus between stomach’s curvatura ventriculi
major and the entry of pelvis cavity and fill median line and
the right side of the abdominal cavity as contacting the right
abdominal wall (Figures 2-f, 6-h, 7-g and 12-h). Right after
its beginning, cecum was found to follow a course on the me-
dian level towards caudal, contact the cornu uteri of the right
uterus and make a bend to the right side. Later on, it goes
on towards the craniodorsal direction in regio abdominis
lateralis, makes a curve ventrally on 13th vertebra thoracica
– 1st vertebra lumbaris level, continues towards the caudal
direction until the 12th – 13th vertebrae thoracicae level, and
forms the beginning of colon ascendens as ampulla ilei. Ap-
pendix vermiformis found on cecum extends from right side
to the left on the last ventral part of jejunum, has an app-
proximate length of 87.60 mm and an approximate width of
12.40 mm, and is located between left abdominal wall and
jejunum. Colon was observed to start in regio umbilicalis be-
tween the folds of cecum as ampulla coli (Figures 2-h, 6-I, 7-h,
12-e, g and 13-e, j). It was found to go on towards craniome-
dial direction for a length of 31.24 mm from its starting point
contacting the ventral wall of the abdominal cavity, go on at
first towards the cranial, then the craniodorsal direction, and
reach the right abdominal wall. It was found to go on as co-
lon ascendens along this wall and form transverse colon on median level in the caudal of stomach’s curvatura ventriculi major. Colon transversum was determined to go ahead the caudal passing on the right side of the median level on the caudal edge level of ren sinister after passing on the left side of median level. It was found to draw on the right side of cavum pelvis entry forming colon sigmoideum with a cavity facing the left side shaped like ‘U’ and reach rectum on median level with the name of colon descendens.

3rd Group: Rabbits with full stomach

Duodenum was found to go from pyloris towards the cranial on liver’s visceral surface on regio hypocondriaca dextra. It went first towards the cranial, then towards the caudal starting from stomach’s pylorus part (Figures 3-e, 8-f, 9-g and 14-f). It was found to verge with cecum and reach the pelvis cavity entry at the right side of the median level. In female animals, it went towards the median level right in front of the uterus and join jejunum. Jejunum was found to go towards stomach’s caudal between colon descendens and colon ascendens along the median level by hanging with mesojejunum on the dorsal wall of the abdominal cavity after duodenum (Figures 3-g, 8-g, 9-f and 15-g). It was determined to fill regio abdominis lateralis sinister in the ventral abdominal cavity and reach towards cecum on stomach’s curvatura ventriculi major’s caudal and along the median level. Ileum was found to go on between cecum and colon ascendens (Figures 3-k, 8-k and 9-k), and reach an end after opening through ostium ileocecale reaching the cecum and colon border after the expansion called as ampulla ilei. Cecum was found to reach towards the caudal direction contacting the right abdominal wall after the caudal level of the area where pylorus is located under the right part of curvatura ventriculi major (Figures 3-k, 8-d, 9-h and 15-f). Pelvis cavity was observed to be in contact with jejenum rings and with corpus uteri and cornu uteri in female animals. Colon was observed to have a localization and a course similar to those that were fed normally. It was found to be located in right and ventral side of the abdominal cavity, in a position reaching also the left side of median level, as being in contact with the ventral wall of the abdominal cavity (Figure 14-g). Cranial edge was determined to cover the whole full stomach, and to be in contact with jejenum on the left side.

Discussion

Knowing intestine topography is important for the diagnosis and treatment of a number of diseases. Güzel and Yavru (1997) indicated that it is important to know the topographical locations of organs to diagnose diseases by using imaging techniques. Researchers (Fike et al 1980, Hillen 1984, Fee-ney et al 1991, Breiling 1994) have emphasized that transversal cross-section images are on high demand especially in the practices of abdominal computerized tomography. In this


Figure 7. Paramedian section of animals with empty stomach-left aspect: 1. Diaphragma, a. Cor, b. Pulmones, c. Hepat, d. Corpus ventriculi, e. Colon transversum, f. Jejunum, g. Cecum, h. Colon ascendens, i. Ileum, m. Vesica urinaria.


study, the effect of stomach's fullness level on the topography of intestine parts of New Zealand rabbit were determined by using transversal and paramedian sections.

Studies conducted on cats have stated that stomach’s different fullness levels are affected by duodenum’s location and shape (Deniz 1966, Klesty 1984). It has also been reported in studies that when the stomach is empty, duodenum starts on 8th (Van Caelenberg et al 2010) or 10th (Klesty 1984) intercostal spaces. When the stomach is full, duodenum’s beginning has been reported to be on 9th (Gezici 1999), 10th (Deniz 1966) or 11th (Klesty 1984) intercostal spaces. In our study, it was observed that when the stomach was empty, duodenum’s beginning was on the ending level of arcus costales in New Zealand rabbits. When the stomach was full, it was pushed from pyloris towards the cranial.

In a study conducted by Deniz (1966) on cats, increasing stomach volume was found to push jejunum towards caudal. In the same study, jejunum was reported to be on 4th vertebra lumbalis level when stomach was empty and on 6th level when stomach was full (Deniz 1966). Gezici (1999) emphasized that jejunum in cats was on 3rd – 4th vertebra lumbalis levels when stomach was empty and on 5th – 7th vertebra lumbalis levels when stomach was full. In this study, jejunum was observed to totally fill regio abdominalis sinistra in rabbits with empty stomachs. In rabbits with full stomachs, jejunum was pushed towards stomach’s caudal between colon ascendens and colon descendens.

Deniz (1966) reported that topography of ileum was not affected by stomach’s fullness level. Gezici (1999) reported that in rabbits with empty stomachs, ileum opened to cecum on 4th – 5th vertebra lumbalis levels; whereas, it opened to cecum on 6th vertebra lumbalis level in rabbits with full stomachs. In this study, it was found that topography of ileum was not affected by stomach different fullness levels in New Zealand rabbits.

In this study, cecum was observed to be in contact with right abdominal wall on the right side of the abdominal cavity as contacting uterus between stomach’s curvatura ventriculi major and pelvis cavity entry in ventral abdominal cavity in rabbits with empty stomachs. In rabbits with full stomachs, cecum was determined to extend caudally contacting right abdominal wall from the caudal level of the area where pylorus was located under the right side of curvatura ventriculi major. In the literature review, no information has been found to determine if cecum topography is affected by stomach’s fullness levels. In fact, this may be assessed within the study’s limitations.

In their study, Gezici and Eken (2001) reported that the colon ascendens started on 5th vertebra lumbalis level in cats with empty stomachs whereas it started on 6th vertebra lumbal-
In the same study, colon descendens were reported to start on 6th vertebra lumbalis level in the left abdominal cavity in both groups. However, in this study, colon was found to start as ampulla coli between the folds of cecum in region umbilicalis in rabbits with empty stomachs; whereas, it was located as being contacted with the ventral wall of abdominal cavity in a position passing the left part of median level in right and ventral part of the abdominal cavity in rabbits with full stomachs.

**Conclusion**

It was revealed in our study to what extent New Zealand rabbits’ intestine sections are affected by stomach’s fullness levels with the help of dissection and cross-sectional images. In the present study, the full and empty stomachs changed the topography of duodenum, jejunum or colon, however there were no changes in the topography of the ileum and cecum in rabbits. Results obtained from the study are thought to contribute to both rabbits’ clinical anatomy and clinical practices especially in studies using imaging techniques.

**Acknowledgement**

This article is a part of a study supported by the Research Fund of Mehmet Akif Ersoy University. (Project Number: NAP-0061-08).

**References**


Fox RR, 1984. The rabbit as a research subject. Physiologist, 27, 393-402.


