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Morphometric Study in Stomach of Rabbits

Estudio Morfométrico del Estómago en Conejos

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SUMMARY: Thirty three healthy, New Zealand rabbits, underwent a total gastrectomy via laparotomy and subsequent evaluation of gastric dimensions. Were measured the lengths of the lesser and greater gastric curvature, in addition to the largest diameters of the organ. They presented average overall length of the lesser and greater curvature, respectively 6.7 cm and 27.3 cm. In addition, open surgical specimen presented a total area of 172.6 cm^2. The sample was divided into two groups by age to perform comparisons between weight and stomach measures. Group 1 consisted of animals with age equal or less than 138 days and group 2 those with more than 138 days. No significant differences were found between the groups. This may suggest the use of younger animals to perform experiments related to surgical training involving the stomach, without dimensional prejudice of organ or generation of technical difficulties. Finally, it was noted also the predominance of the left gastric artery in the irrigation of the gastric wall and the presence of a transparent film between the liver and stomach in all animals.

KEY WORDS: Rabbit; Morphology; Stomach; Surgery; Training.

INTRODUCTION

Increasingly, in the world of animal experimentation, we realized the great potential of rabbit (Oryctolagus cuniculus) related to its numerous advantages such as easy handling, short reproductive cycle, no need for preoperative fasting, the possibility of only intramuscular anesthesia, low cost, among others (Hristov *et al*., 2006; Calasans-Maia *et al*., 2009; Alves *et al*., 2011; Amorim *et al*., 2011).

Still there is little presence of indexed literature related to specific anatomical description of the rabbit abdominal organs, aiming the substantiation for surgical procedures, especially the stomach (Bensley & Craigie, 1948; Piaseckie & Wyatt, 1986; Hristov *et al*.; Abidu-Figueiredo *et al*., 2008; Rodrígues-Alarcón *et al*., 2010; Alves *et al*.).

This, to the inspection, it is possible to distinguish the following regions: cardic, fundic, body and antrum pyloric (Bensley & Craigie; Hristov *et al*.; Rodrígues-Alarcón *et al*.). It is located in the abdominal cavity, predominantly in the left part of the abdomen and only the pylorus to the right, in contact with the 7th rib (Hristov *et al*.).

When comparing the stomach of the rabbit with the man, is evident in the presence of a hyper-development fundic region (Bensley & Craigie; Rodrígues-Alarcón *et al*.; Alves *et al*.); division of layers of the gastric wall mucosa (with various concentrations of villi as gastric regions), submucosa, proper and serosa lamina (Ghoshal & Bal, 1989; Oliveira *et al*., 2001; Brewer, 2006; Abidu-Figueiredo *et al*.; Rodrígues-Alarcón *et al*.); presence of most cranial cardiac region (Hristov *et al*.; Rodrígues-Alarcón *et al*.) and more developed lower esophageal sphincter (Johnson-Delaney, 2006; Rodrígues-Alarcón *et al*.; Meredith & Jepson, 2011); besides thinner gastric wall, with weaker muscles in the fundic regions and in the body (Ghoshal & Bal; Johnson-Delaney; Rodrígues-Alarcón *et al*.; Alves *et al*.). This means the need for constant ingestion of food several times a day, more than 30X/day (Johnson-Delaney), so the new gastric content push forward the former, it is not possible occurs gag reflex (Calasans-Maia *et al*.; Rodrígues-Alarcón *et al*.; Alves *et al*.; Meredith & Jepson).

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Furthermore, the dimensions of the rabbit's stomach could resemble to those in an infant (Rodrígues-Alarcón *et al*.).

Then Rodríguez-Alarcón *et al*., presented a real initiative to scale the rabbit's stomach, through the measurement of cardial bottom distances, bottom line cardio-fundic between the lesser and greater curvature, and length and width of the antrum to produce inferences related to the possibility of using animals for laparoscopic surgery.

However, doubts remain related to the size of the rabbit' stomach, factors that may influence its dimensional increase, such as age or weight of the animals, as well as what are the lengths of the lesser and greater curvatures.

Therefore, this study mainly aims to generate information that can answer these questions, obtaining as a result the complementation of the description of gastric morphometry, and identify the possible presence of other anatomical features of the rabbit' stomach.

Consequently, we also expect to generate knowledge to serve as a basis for future studies related to anatomy and gastric physiology of these animals, as well as support future comparative research with humans (Galvão *et al*., 2010).

MATERIAL AND METHOD

Thirty-three white rabbits (Oryctolagus cuniculus) lineage of New Zealand, male, weighing between 3000 and 4200 g, healthy, provided by an single creator of creation patterns of conventional restrooms, light / dark cycle of 12 h, with feed intake 140 g/day/animal and water ad libitum, were submitted to anesthesia exclusively intramuscular with ketamine hydrochloride (30 mg/kg) and xylazine chloridrate (3 mg/kg), and local infiltration of the abdominal wall with 10 ml of 1% lidocaine.

After 5 minutes, median laparotomy was performed, inspection of the cavity and stomach and after a total gastrectomy “in block”, as a standard technique (Alves *et al*.). Observation: After removal of the organ, we proceeded to euthanasia of the animal via induction of barbiturate coma (thiopental sodium 25 mg/ml) and infusion of 10 ml potassium chloride at 19.1% (Alves *et al*.).

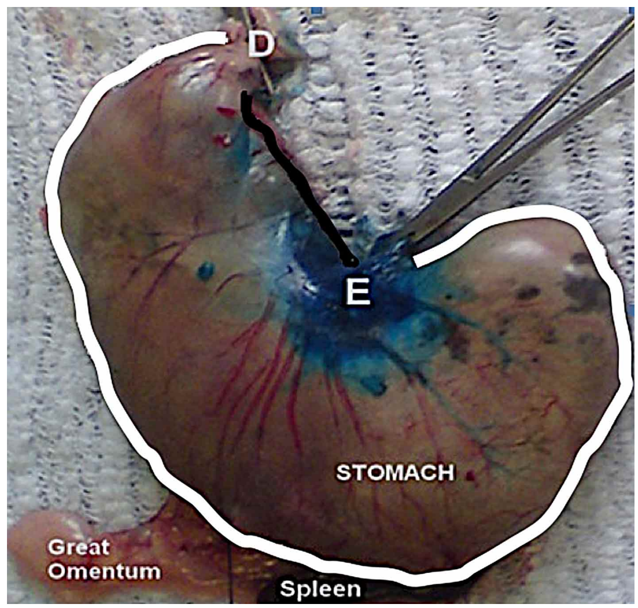

Fig. 1. Measurement of greater (white line) and lesser (black line) gastric curvature. Esophagus (E), duodenum (D). Observation: The stomach appeared contrasted with blue in the cardial region, because the organ is the product of another experiment in which is injected in the subserosa of the gastric wall, the blue dye. Figure adapted from Alves *et al*. (2011).

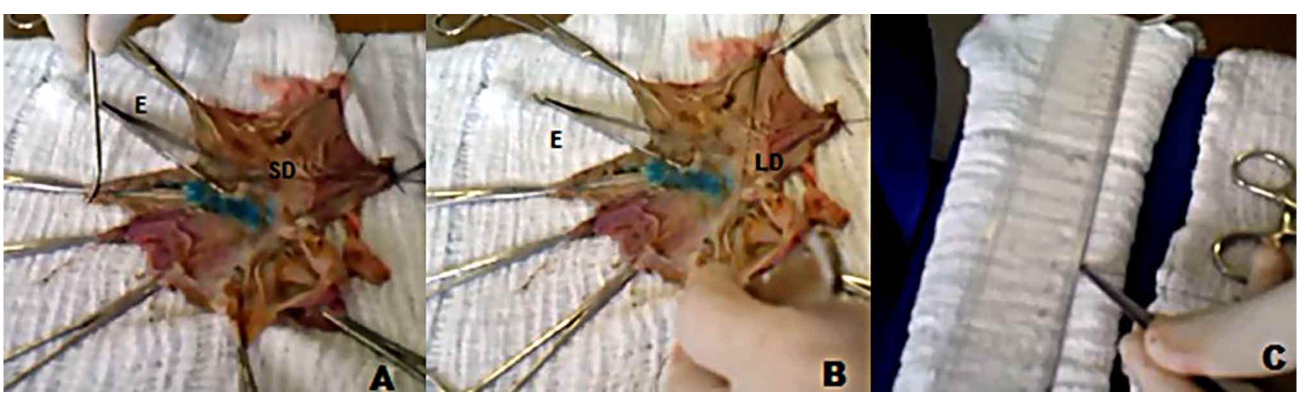

Fig. 2. Benchmarking of diameters: (A) smallest (SD); (B) largest (LD) with the stomach open and flat on the bench, with cotton thread and a millimeter ruler (C). Clamp was introduced at the ostium esophageal (E).

After with the stomach closed with a tweezer in the duodenum and another in the abdominal esophagus on a bench, we proceeded to the measurement of lengths of the lesser and greater gastric curvature with the aid of a cotton thread and a millimeter ruler (Fig. 1)

After, we proceeded to the opening of the organ at the edge of the greater gastric curvature, discarding its content, then to stretch it, without traction on a bench, enabling the visualization of its mucosa (Fig. 2). In this position, we proceeded with the aid of cotton thread and a millimeter ruler, measuring of the two largest diameters, and the lowest measured necessarily through the passage of wire on the esophageal ostium (Fig. 2).

This study is part of a project approved by the Ethics Committee on Animal Use - CEUA State University of Campinas - SP, under protocol n° 2033-1.

Statistical analysis. Descriptive analysis was performed with the presentation of measurements of position and dispersion for numeric variables. For comparison of numeric measures between the two groups, we used the Mann-Whitney test (Conover, 1971).

In order to verify the linear association between the two variables, we used the Spearman correlation coefficient (r). This can range from -1 to 1, with values near the extremes will indicate positive or negative correlation, respectively, and values near 0 indicate no correlation. For the interpretation of correlations magnitude was adopted the following classification: $r < 0.4$ = correlation of weak magnitude; $r \geq 0.4$ a < 0.5 = moderate magnitude; e $r \geq 0.5$ = strong magnitude (Hulley *et al*., 2003). The significance level (α) for statistical tests was 5%.

RESULTS

The sample consisted of 33 rabbits that had the characteristics described in Table I. Through inspection of the peritoneal cavity was found in all animals the presence of thin transparent peritoneal membrane between liver and stomach, as described by Bensley & Craigie (Fig. 3).

Furthermore, we noted the predominance of irrigation of the gastric wall made by the left and right ventral branches of the left gastric artery in all animals (Fig. 4).

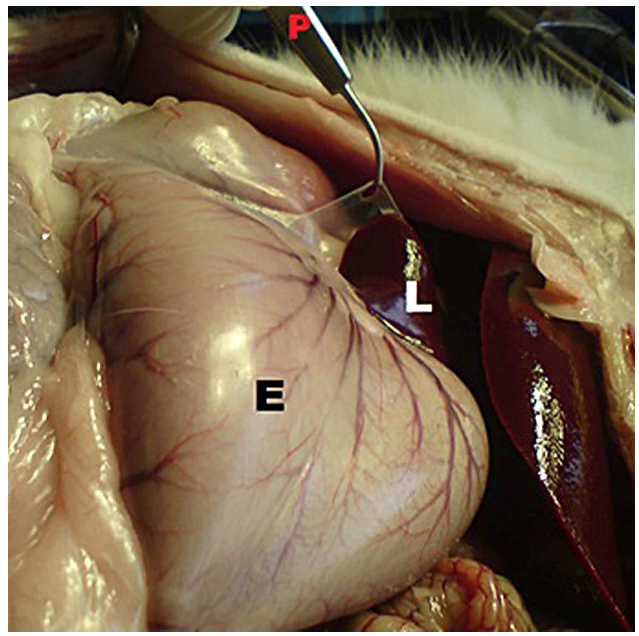

Fig. 3. Demonstration of transparent peritoneal membrane between the liver (L) and stomach (E), seized by a clamp (P).

Table I. Descriptive analysis of the age, weight and measures presented by the rabbits' stomachs, in the sample (Conover, 1971.

Variable (n = 33)	Minimum Value	Average	Maximum Value	IC 95%	Standard Deviation	Median
Age (days)	103	139.24	176		20.93	138
Weight (grams)	3000	3425.76	4200		342.35	3500
Leng. of Lesser Curv. (cm)	4.20	6.67	8.50	6.30 – 7.04	1.04	6.80
Leng. of Great Curv. (cm)	20.00	27.27	32.90	26.17 – 28.37	3.10	27.50
Largest diameter (cm)	11.00	14.41	20.90	13.66 – 15.16	2.11	14.00
Smallest diameter (cm)	9.00	11.89	13.50	11.45 – 12.33	1.24	12.10
Index (cm)	48.30	60.24	70.60	58.22 – 62.27	5.72	60.70
Area (cm^{2})	104.50	172.58	261.25	159.61 –	36.57	178.20

95% CI, limits the range of 95% confidence interval for the average, cm, centimeters, Leng., length, Curv., gastric curvature; index = amount of the four measures (Lesser Curv. + Great Curv + Largest Diameter + Smallest Diameter); Area = product of largest and smallest diameters of the stomach stretched on a bench, without tension, without considering geometric irregularities.

Table II. Application of linear correlation coefficient of Spearman (r) between measurements in the sample (n = 33) (Conover, 1971; Hulley *et al*., 2003).

Variables		Weight	Lesser Curv.	Great Curv.	Smallest Diameter	Largest Diameter	Index	Area
Age	**r**	0.4413	-0.3098	0.0032	-0.1122	-0.0037	-0.0811	-0.0124
	p	0.0102	0.0794	0.9859	0.5340	0.9837	0.6536	0.9453
Weight	**r**	----	0.0935	0.2750	0.1268	0.2553	0.2921	0.2570
	p	----	0.6048	0.1214	0.4820	0.1515	0.0991	0.1488
Area	**r**	----	0.0112	0.7033	----	----	----	----
	p	----	0.9508	<0.0001	----	----	----	----

Lesser Curv.= Length of the lesser gastric curvature; Great Curv.= Length of the greater gastric curvature.

Dividing the sample according to age and based on the median value into two groups, we have: Group 1 (G1) = animals aged under or equal to 138 days (19 animals), Group 2 (G2) = animals aged over 138 days (14 animals). They presented the average size of lesser and greater gastric curvatures, largest and smallest diameters with the open part on the bench, respectively: G1 = 6.9 cm, 27.3 cm, 14.5 cm and 11.9 cm; and G2 = 6.35 cm, 27.21 cm, 14.27 cm and 11.8 cm.

By applying the Mann-Whitney test did not identify statistically significant difference (p = 0.1557) for body weight among the animals of G1 and G2.

DISCUSSION

As described by Rodríguez-Alarcón *et al*., the stomach of the rabbit resembles proportionally in size to the human in phase of lactation, resulting in the possibility of using this animal in many forms of surgical training. Although his study detailing several measures related to the animal's stomach, was not described the linear length of lesser and greater curvatures.

Thus, in order to complement the full measure of the stomach, the present study, respecting the contours of the organ (fresh surgical specimen) showed average measure, in each sample, the length of the lesser and greater gastric curvature, equal respectively to 6.67 cm and 27.27 cm, as well as only in G1 of 6.9 cm and 27.3 cm and only in G2 of 6.3 cm and 27.2 cm.

We evidenced the presence of a gastric area (A) average = 172.58 cm^2 (G1 = 172.55 cm^2; G2 = 168.38 cm^2), and the length of the greater gastric curvature have the greatest influence (p <0.0001) and a strong correlation (r = 0.7) with the gastric area (Table II).

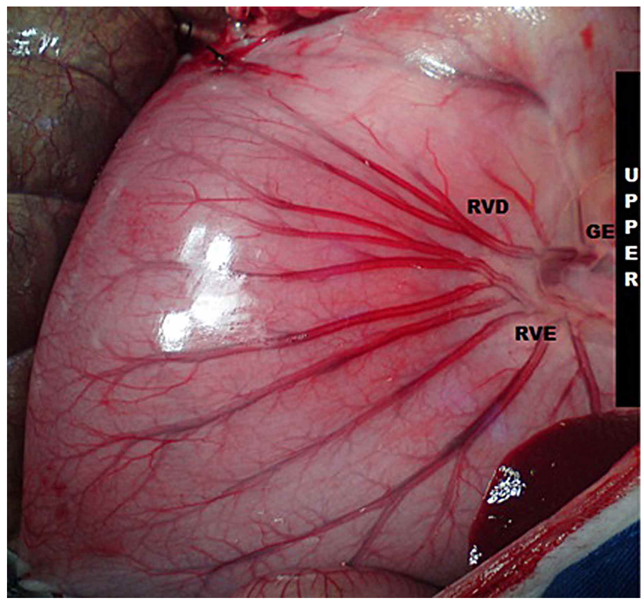

Fig. 4. Presentation of the branch of the left gastric artery (GE) on its right ventral branches (RVD) and left ventral branches (RVE) on the anterior surface of the stomach.

Moreover, it was proved in this study that there was no significant difference (p = 0.1557) between the animals' weight (G1 and G2), despite the existence of moderate positive correlation (r = 0.44) between age and weight, i.e., the higher the age, the greater the weight (Table II).

It was found that in this sample there was no significant difference for the lengths of lesser, greater gastric curvature, smallest and largest diameters of the stomach, index values and area when correlated with animals' age or weight.

In conclusion, it is possible to infer the existing possibility in using younger animals (<138 days) in the experiments related to surgical training involving the stomach, allowing a faster replacement specimens without prejudice to the size of the organ or technical difficulties.

Finally, indirect inferences were produced with the present study, by identifying the prevalence of left gastric artery, related to vascular nutrition of the gastric wall (Bensley & Craigie; Piaseckie & Wyatt), and its preservation may be vital to perform partial gastrectomies in experiments without significant damage of the nutrition of organ, beyond the constant presence of a transparent peritoneal membrane between the liver and stomach (Bensley & Craigie) absent in men.

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RESUMEN: Treinta y tres conejos, neozelandeses, sanos, se sometieron a una gastrectomía total por laparotomía y posterior evaluación de las dimensiones gástricas. Se midió la longitud de las curvaturas gástricas menor y mayor y el diámetro mayor del órgano. La longitud total promedio de las curvaturas menor y mayor fue de 6,7 cm y 27,3 cm, respectivamente. La zona quirúrgica abierta presentada 172,6 cm^2. Según la edad y para hacer comparaciones entre el peso y las medidas gástricas la muestra se dividió en dos grupos. Grupo 1 animales con menos de 138 días y grupo 2 animales que tenían más de 138 días. No se encontraron diferencias significativas entre los grupos. Esto puede sugerir que para el entrenamiento quirúrgico el uso de animales más jóvenes puede ser llevado a cabo en los protocolos. Finalmente, se observó en todos los animales predominio de la arteria gástrica izquierda en la irrigación de la pared gástrica y la presencia de una fina capa peritoneal transparente entre el hígado y el estómago.

PALABRAS CLAVE: Conejo; Morfología; Estómago; Cirugía; Capacitación.

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