Morphometric and quantitative evaluation of the gastroepiploic artery

Running title: Morphometric evaluation of gastroepiploic artery

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Conflict of interest statement

Kodai Tomioka and other co-authors have no conflict of interest.

Abstract

Background: The gastroepiploic artery (GEA) has been described in various ways by anatomical texts and surgical manuals. Currently, there are no studies that have investigated the thickness and length of GEA using gross anatomical methods. In the present study, we measured the length, circumference, area, and major axis of GEA, and quantitatively evaluated the differences between right and left GEA (RGEA and LGEA), using gross anatomical and morphometric methods for the first time.

Materials and Method: Seventeen cadavers were selected. The median age of the cadavers was 82 years. We observed and evaluated GEA with naked eyes, as well as under a stereoscopic microscope.

Results: RGEA was significantly longer than LGEA (p < 0.0001). The mean length of RGEA and LGEA were 26.51 ± 5.15cm and 14.05 ± 3.12cm, respectively. The mean area of RGEA, LGEA, and the anastomotic point were 3.31 ± 1.71 mm^2, 1.33 ± 1.01 mm^2, and 0.51 ± 0.28 mm^2 respectively.

Conclusion: RGEA was significantly longer and thicker than LGEA. The results also showed that in almost all of the cases RGEA and LGEA anastomosed with each other and grew thinner as they approached the middle of the greater curvature of the stomach.

Key words: gastroepiploic, artery, morphometric

Introduction

The stomach has its developmental origin in the foregut, and is supplied by the branches of the celiac artery. Its distribution is divided into the greater curvature side, which is supplied by the right gastric artery, and the lesser curvature side, supplied by the right gastroepiploic artery (RGEA), left gastroepiploic artery (LGEA), and the short gastric artery. RGEA and LGEA run along the greater curvature of the stomach, at a distance of 1 cm from it, and form an arterial arch anastomosing at the middle of the stomach [1]. There is no consistent information on the gastroepiploic artery (GEA) available in anatomical texts and surgical manuals. There is also no consensus on the thickness of the artery, with one anatomical text reporting that RGEA is thicker than LGEA [2], some reporting that they are equal [3-7], and others reporting that they are independent of each other [8, 9]. There is only one report that measured the length of RGEA for coronary artery bypass graft surgery [10]. There are also no studies that examined the thickness and length of GEA using morphometric methods. In this study, we used morphometric methods to measure the lengths of RGEA and LGEA, and the circumference, area, and major axis of the artery lumen in cross sections of RGEA, LGEA, and the artery at the anastomotic point. We also quantitatively evaluated the differences between RGEA and LGEA, and investigated the distribution of the artery in the greater curvature. This study must be useful to make a basic data to describe the distribution of GEA in the stomach, and to depict correctly the GEA form in the textbooks.

Materials and Methods

In 2014, we dissected twenty-eight adult cadavers that were donated for dissection practice to the medical department of the Showa University. Seventeen cadavers [five males and twelve females; median age, 82 years; (68–95 years)], with no surgical history involving the stomach, were selected for this study. All cadavers were fixed with 10% formalin solution. The stomach, duodenum, spleen, celiac artery, common hepatic artery, splenic artery, gastroduodenal artery, RGEA, and LGEA were excised en-bloc. After excision, the adipose and connective tissue around the stomach and arteries were removed, and RGEA and LGEA were examined carefully. The thin arteries that were visible with the naked eye were retained as far as possible.

The length of RGEA and LGEA were measured by calculating the distance from the proximal portion of the arteries to the thinnest/anastomotic point (Figure 1-a). We also observed and sliced the artery perpendicularly at the three points as the RGEA root, LGEA root, and artery at the anastomotic point (we described as middle), took pictures of the arterial lumens in cross sections with the help of a stereoscopic microscope (Figure 1-b). Then we performed the image processing on these photos of the arterial lumen (Figure 1-c). After that, we used these images to measure the circumference, area, and major axis of each arterial lumen using ImageJ [11, 12]. Three cases were excluded as their anastomotic points were difficult to identify. The data was expressed in the form of mean ± SD, and the Mann–Whitney U test was used for analysis. All statistical analyses were performed using JMP version 11.0 (SAS Institute Inc., Cary, NC), and a p-value < 0.05 was considered significant. Informed consent was obtained from all patients.

Result

In all the cadavers, RGEA branched from the gastroduodenal artery, whereas LGEA branched from the splenic artery. Obvious mutation was not recognized.

<u>The length of the artery</u>

Mean length of RGEA was 26.51 ± 5.15 cm from the root to the thinnest point or anastomotic branch, whereas that of LGEA was 14.05 ± 3.12 cm (Table 1). The length ratio of RGEA to LGEA was 1.89:1. RGEA was significantly longer than LGEA ($p < 0.0001$).

<u>The circumference, area, and major axis of the arterial lumen in a cross section</u>

The mean circumference, area, and major axis of RGEA were 7.43 ± 1.46 mm, 3.31 ± 1.71 mm^2, and 2.71 ± 0.50 mm, respectively, whereas that of LGEA were 4.42 ± 1.68 mm, 1.33 ± 1.01 mm^2, and 1.63 ± 0.60 mm, respectively. With respect to the anastomotic point, the mean circumference, area, and major axis were found to be 2.70 ± 1.41 mm, 0.51 ± 0.28 mm^2, and 1.00 ± 0.56 mm, respectively (Table 1). RGEA consistently showed significantly higher values than LGEA ($p < 0.0001$).

Discussion

The results of the quantitative analysis showed that RGEA was approximately twice the length of LGEA, and exhibited a wider distribution area than that of LGEA on the greater curvature side. This was approximately in agreement with El-Eishi *et al* who investigated the arterial distribution area of the stomach on the greater curvature side.

[13].

The RGEA lumen showed the highest mean values, followed by LGEA, and finally the anastomotic point. The results also revealed that RGEA and LGEA tended to anastomose with each other, and became thinner as they progressed from their origin to the center of the greater curvature side. With respect to area of the arterial lumen, the ratio of RGEA to LGEA was 2.34:1, indicating that RGEA was significantly thicker than LGEA. Typically, the blood flow velocity is directly proportional to the cross sectional area of blood vessels. Thus, it has been suggested that RGEA is a major nutrient artery in the greater curvature of the stomach.

The results of this study must be basic data to describe precisely the distribution of GEA in the stomach greater curvature area and the GEA form to the textbook as anatomical texts and surgical manuals. Moreover, RGEA is widely used as an arterial graft for coronary artery bypass graft surgery [10, 14], and we hope that the results of our study will contribute to this field.

Our study has certain limitations. First, we performed dissection in only seventeen cadavers, and a bigger sample may be required to provide stronger evidence.

Second, there is a possibility of selection bias; and finally, some vessels were in elliptical, however, all of the cadavers were fixed under the same conditions. Thus, more cases should be studied in the future.

Conclusion

We quantitatively assessed the right and left GEA, using gross anatomical and morphometric methods, to accumulate basic information regarding the distribution and form of GEA in the greater curvature of the stomach. Our results showed that RGEA was significantly longer and thicker than LGEA. Moreover, in almost all of the cases, RGEA and LGEA were seen to anastomose and become thinner towards the middle of the greater curvature of the stomach. From these findings, it appears that the descriptions provided in the anatomical books and surgical manuals are not necessarily correct. We hope the results of this morphometric and quantitative study will be utilized in many fields.

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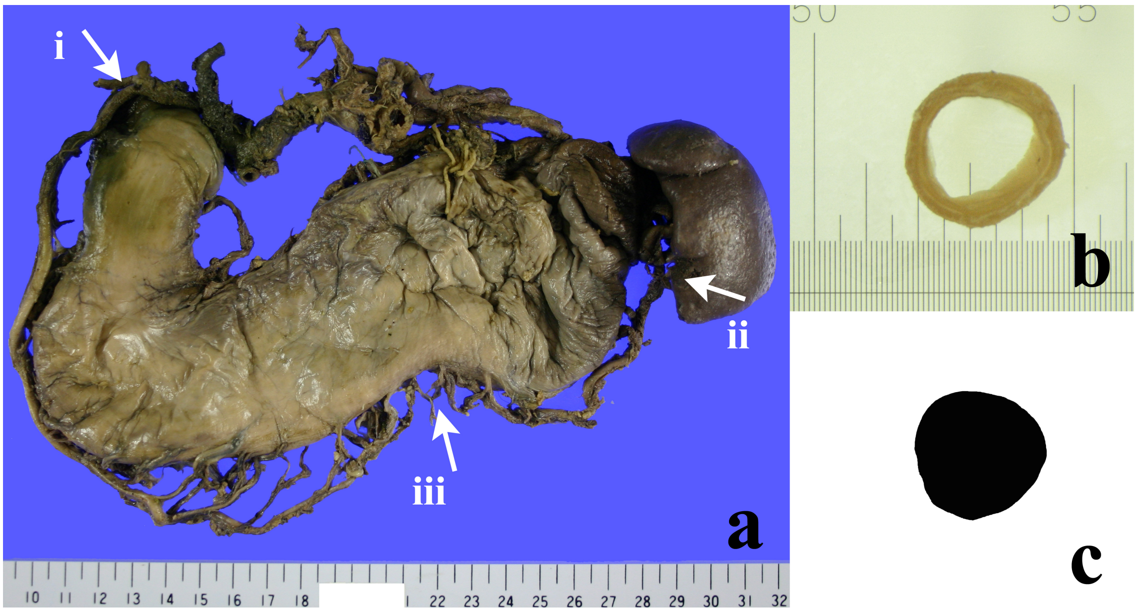
Table 1. Results from three points of the gastroepiploic artery

Artery	Length (cm)	Circumference (mm)	Area (mm^2)	Major axis (mm)
RGEA	26.51 ± 5.15	7.43 ± 1.46	3.31 ± 1.71	2.71 ± 0.50
middle		2.70 ± 1.41	0.51 ± 0.28	1.00 ± 0.56
LGEA	14.05 ± 3.12	4.42 ± 1.68	1.33 ± 1.01	1.63 ± 0.60

RGEA: Right gastroepiploic artery LGEA: Left gastroepiploic artery

Figure 1.



Legends

a-i: Root of RGEA, a-ii: root of LGEA, a-iii: anastomotic point.

b: Sliced artery in a cross section in a stereoscopic microscope.

c: The sliced artery was performed image processing.