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Morphologic Comparison of the Elastic Fibers Found in the Submucosal Layer in Different Portions of the Stomach

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Abstract: This study was carried out on 30 human stomachs (from cadavers) obtained from different medical faculties. The elastic fibers in the submucosal layer in the pylorus, corpus and antrum were studied and compared in terms of their length, and density per unit area. The submucosal layer containing elastic fibers was longer and their densities per unit area were greater in the pylorus than those in the corpus and the antrum. Another feature of this study is the use of the vizopan microscop, which is used in the field of forestry engineering for measurements.

Key Words: Tunica submucosa, elastic fibers, pylorus.

Introduction

In the human digestive tract, the functions of the stomach depend on its morphology. However, the exact role of the morphology of the stomach wall in terms of its function is not known. The stomach wall consists of tunica serosa-subserosa, tunica muscularis, tunica submucosa and tunica mucosa layers from exterior to interior respectively. The tunica serosa-subserosa and tunica submucosa layers contain elastic fibers (1).

The stomach has three important functions. These include motility, absorbtion and secretion. The motor activities (peristaltism, tonus) facilitate the gastric mixing, tossing and emptying of the gastric contents into the duodenum (2). Once the stomach is filled up to a specific capacity, the peristaltic waves begin while the food advances towards the pylorus. When the consistency is not adequate to pass through the duodenum, the gastric contents return to the gastric corpus as a result of the antral systol (3,4). The pylorus is of physologic importance when the stomach is relaxed. Here there is a region in which a continuous intraluminal pressure increase is found. However, the presence of reflux has not yet been demonstrated due to the decrease in intraluminal pressure in the pylorus ring (5,6). When the pressure in the antrum reaches its maximum, the bulbus duodeni starts contracting. Later the antrum, pylorus and bulbus once again are relaxed. Therefore, the most important role of the pylorus sphincter is the prevention of the return of the chyme into the stomach from the duodenum (7,8). Any morphologic disorder in the muscular or nervous tissues of the pylorus results in reflux. In some people, even though no neuromuscular morpholgy disorder exists, reflux has been seen to develop due to the insufficiency of the sphincter. Some authors reported in dogs that elongated ligaments may increase stomach mobility and predispose partial or complete gastric valvulus (9).

In our study, the power of the muscle that provides sphincter function and the importance of the elastic fibers in the submucosa were researched. The length of the fibers, and the density per unit area in the elastic fiber containing the layer of submucosa were examined (Figure 1). Sufficient studies have not been carried out on the role of elastic fibers in the prevention of reflux and in the contraction of the digestive tract while functioning and later returning to its normal shape.

The examination of elastic fibers goes back to the end of the 19th century. Some writers have carried out studies on elastic fibers in a number of organs and on the elastic fibers in the valvula ileocecalis (10,11).

The presence of elastic fibers in the stomach was demonstrated by Meinel in 1902 and Stohr in 1919. Mosken and McGregor, in 1928, demonstrated the presence of elastic fibers in the tela submucosa of the

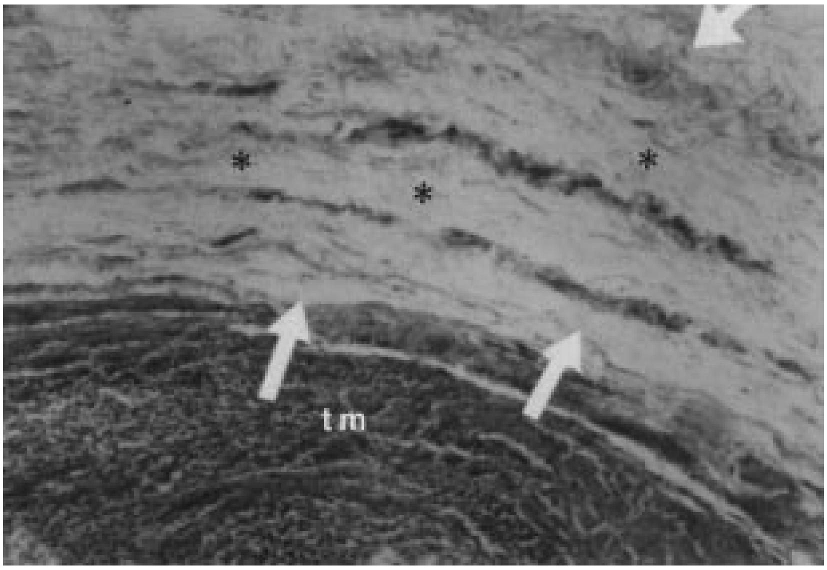

Figure 1. Photograph of Vizopan microscope

cardia. In 1907, Schutz demonstrated the increase in the elastic fibers in the pylorus (10). In 1995, Ferraz de Carvalho et al. described elastic fibers in the hepato-duodenal ligament and subserosa and adventitia of the duodenum (12). In our study, the fibers in the submucosa of the pylorus were compared with those of the corpus and antrum.

Materials and Methods

Thirty human stomach from cadavers obtained from different faculties of medicine were examined in this study. Care was taken to ensure that none of the stomach had had any pathology. The samples were taken from individuals between 25 to 55 years of age without regard to sex.

The samples once obtained were fixed with 10% formaldehyde. Later, the anatomical sphincter in the pylorus of each stomach was determined to be the main point. From this exact point to the back, with 3 cm spaces, samples were taken from five different areas. The samples were named pylorus (P), antrum-1 (A1), antrum-2 (A2), corpus-1 (C1) and corpus-2 (C2). It was carefully noted that the preparations taken from the stomach contained all the layers and were followed up in accordance with the parafinization technique. In the experimental samples, the submucosa layer cross-section was stained using the Verhoeff Van Gieson technique. The following were measured from the preparations;

-The length of the elastic fibers in the submucosa layer.

-The density per unit area of the elastic fibers in the submucosa layer.

The vizopan microscope with a screen, which is at the Faculty of Forestry at KTU, Department of Forestry Industry Engineering laboratory, was used for the measurements of the preparations. Thus, the length of the elastic fibers and their density per unit area were examined (Figure 2). The highest magnification of the vizopan (X 570) was used for the measurements. To determine the units of magnification from millimetric values, the Carl-Zeiss scale was placed in the vizopan plate, and converted into micron units by fixing the values to a marked ruler where a millimeter was divided into energy 1/100 of the unit space. In this case, the value seen on the screen as 1 mm was determined to be 1.76 microns and the gross value was multiplied by 1.76 and the time value was obtained in microns.

Vizopan's 80 mm radius screen divided into 25 mm^2 areas was used to count elastic fibers. The area of the circle was found according to the πr^2 formula to be $3.14 \times 80^2 = 20096$. When this was divided into 25 mm^2 squares, 20096 / 25mm^2 = 804 squares were obtained. Their fiber content was observed and the density per unit area of the fibers was thus obtained.

Since the vizopan microscope with the screen does not have a photographing feature, the preparations were photographed by the X 400.

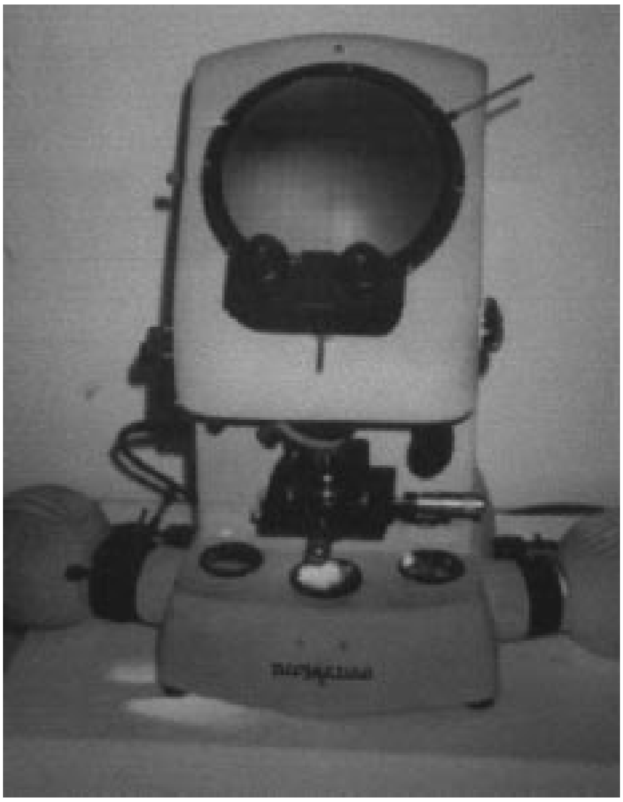

Figure 2. In pylorus area, elastic fibers on tunica submucosa layer (X 400)
* : elastic fibers
tm: tunica mucosa layer

The SSPS student version 6.0 program was used for the analysis of the statistical values. Evaluation and comprasion of independent measurable data (density per unit areas of fibers) for different region of stomach were made by one way variance analyses and Newman-Keuls testfor post hoc comparison. When the parametric hypothesis was not considered (fiber length) Kruskal Wallis variance analysis was used and for post hoc comparison Mann-Whitney U- test was used by decreasing the level of error. Since the number of comparisons was 4, the P value was taken to be 0.05 / 4 = 0.0125.

Results

In the research, it was possible to see the elastic fibers in the tunica submucosa of the stomach. The elastic fibers in preparations stained by Verhoeff Van Gieson elastic stain were differentiated by the black-purplish thread-like appearance. The mucosa layer was brown, and the muscular layer red and light brown stained. The findings of this study are summarized in table.

The length of the elastic fibers in the pylorus was found to be statistically greater than those in other areas (P: 0.0001).

The elastic fibers density per unit area in the pylorus was found to be statistically greater than that in other areas (P: 0.0001).

Discussion

In humans, different parts of the digestive tract manifest various physiological functions in a continuous manner. These functions especially depend on the regular pattern of movement of the digestive tract. The presence of the sphincters separating the different parts morphologically allows proper functioning and prevents the reflux of the contents and their mixing (13,14). If the histological stucture is not appropriate reflux can occur and whole physiology can be disordered (15). The cause of the reflux is sphincter dysfunction. Although the functions of the sphincters might be different from each other, their effects are generally regulated by neurologic, hormonal, and intraluminal material and substances effects via the hematogenous route (16). All these components affect the motility of the sphincter muscle and these sphincters display their controlling junctions (17-19). In the present study, the effect of the elastic fibers in the submucosa layers on the function of the sphincter was researched.

The pylor muscle of the stomach has continuous contraction during resting but it has an open space of 3-4 mm. The antro-pyloric area also has a high pressure

	PYLORUS	ANTRUM-1	ANTRUM-2	CORPUS-1	CORPUS-2
Length of the fibers	44.17+2.25	24.39+1.68	22.77+1.31	27.27+1.55	25.92+1.84
Density of the fibers	15.36+0.48	11.93+0.67	11.50+0.68	9.95+0.49	9.99+0.46

(0.0001)

Table: The length and density of the elastic fibers in submucosal layer of pylorus, antrum and corpus parts of stomach (μ: micron) during resting. As a result, a high pressure difference occurs between the corpus of the stomach and duodenum (13,14).

Therefore, the contents of the stomach pass into the duodenum in the form of a bolus with the strong prepulsive movements of the stomach. The contents of the duodenum, however, cannot get back to the stomach. The above specificity also prevents the passive liquid reflux.

The difference between the anatomic and physiologic sphincters of the digestive system has been studied at length at the level of the light microscope. The terminal ileum in particular has been studied in relation to this topic and it was found that the number of elastic fibers increases as the terminal ileum is approached (10,11). In one study, the distal positions of the esophagus in relation to the stomach have shown an increase in elastic fibers (19). In some studies, the elastic fibers in the areas with muscle but not of sphincteric type have been reported to show physiologic functions (10,11,19).

This study demonstrated that the elastic fibers in submucosal layers have a longer length and a higher density in the pylorus than in the corpus and antrum region.

In the stomach, peristaltic movements reach greater levels through the pylorus. In light of these results, it was may be speculated that the elastic fibers play a role in the storage of food, the sphincteric function, and the tonus and elasticity of the muscle tissue. The values of the elastic fibers per unit area support this. As a result, the elastic fibers density per unit area in the pylorus was found to be statistically greater than that of the antrum and the corpus area.

In this study, it was found that the length of the part containing elastic fibers in submucosa layer was longest in the pylorus and shortest in the antrum 2; the density per unit area of the elastic fibers was found to be greatest in the pyloric region and lowest in the corpus 2 region.

Thus, we came to the conclusion that it is important to research in vivo whether these morphologic structural properties are the cause of various clinical dysfunctions. Thus, the role of the elastic fibers in the reflux from duodenum into the stomach can be explained. In the future, focusing on strenghening the elastic fibers and collagen with some pharmacological agents should be considered. These drugs may be considered for the treatment of the reflux.

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