THE ILEO-CECAL AND APICO-BASAL VALVES OF THE HAMSTER CECUM (CRICETUS AURATUS)

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LLOYD ROBERT YONCE

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APPROVED:

Redacted for Privacy

Professor of Physiology

In Charge of Major

Redacted for Privacy

Head of Department of Zoology

Redacted for Privacy

Chairman of School Graduate Committee

Redacted for Privacy

Dean of Graduate School

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INTRODUCTION

Recently Rieschel and Krueger (4, pp.72-73) described gross anatomical aspects of four valves in the ileum-cecum-colon region of the hamster. On the basis of location and anatomical conformations, these valves were called the ileo-cecal valve, the apico-basal valve, the basal semilunar valve and the chevron valve. The ileo-cecal valve, located at the ileo-cecal junction, has a semilunar lip which projects into the lumen of the ileum. The apico-basal semilunar valve is located immediately on the apical side of the ileo-cecal junction. This valve projects into the lumen of the cecum and is partially a continuation of the ileal wall into the cecum. Internally the division of the cecum into an apical and basal portion is marked by the apico-basal valve and externally by a groove in the wall of the cecum, the groove corresponding to the fixed border of the apico-basal semilunar valve. The basal semilunar valve lies parallel to the apico-basal valve and is located about 5 mm. toward the colon from the apico-basal valve. The chevron valve at the cecal-colonic junction is formed by the termination of the ends of muscular chevrons found in the colon. One of these chevrons appears to extend into the cecum to the basal semilunar valve and forms a pocket on the basal wall of the cecum. (4, pp. 72-73)

It is the purpose of this paper to provide a detailed description of the ileo-cecal and apico-basal valves. A subsequent paper will deal with the basal semilunar valve and the chevron valve.

METHODS

The cecal and adjacent portions of the digestive tract were usually removed from the abdominal cavity and placed in Bouin's fixative as rapidly as possible to minimize autolysis. A slit was sometimes made in the cecum to allow free access of the fixative to the mucosa. Sometimes a cannula was inserted into the small intestine and the cecal lumen was perfused with 0.9% saline solution. Gentle pressure was used to aid in removing the contents. The cecum was then distended to approximately 1.5 times its normal size with fixative before placing in additional solution.

Subsequently the ceca were imbedded in paraffin and sectioned serially at 6 microns. The plane of the section was either perpendicular to the two epithelial faces and perpendicular to the bifurcating axis of the valve or perpendicular to the two epithelial faces and parallel to the bifurcating axis of the valve. Approximately 15 sections were mounted per slide. The sections were stained with either hematoxylin-eosin or Mallory's triple stain (6, p. 41).

GROSS ANATOMICAL FEATURES

The cecum of the hamster is slightly sacculated and divided into an apical and a basal portion. The basal portion is a bean-shaped structure into which the ileum enters and the colon leaves. The apical portion of the cecum as seen from the ventral side of the hamster is a blind tube that projects from the ileal end of the basal portion of the cecum and coils counterclockwise around the basal portion of the cecum.

Perusal of the histological sections indicates that the lips of the valves of the hamster cecum are the combination of the walls of at least two cylindrical tubes (fig. 1,3). The lip of the ileo-cecal valve is composed of the wall of the ileum and the wall of the basal portion of the cecum. The lip of the apico-basal valve is composed of the wall of the apical portion of the cecum and the wall of the basal portion of the cecum. The basal face of the valve is an extension of the ileum (plate 1 and fig. 3). The apical and basal portions of the cecum may be considered as portions of a tube that has been bent in a sharp "V" shape. The apex of the "V" is the junction of the apical and the basal portion of the cecum. Since the lip of the valve may be considered as formed from the combination of two cylindrical tubes joined together at an acute angle, the shape of the valve is an ellipsoidal crescent with the concave crescent border as the free edge of the valve and with the lateral edges of the valve, though anatomically formed by a combination of the walls of the intersecting tubes, as the attached borders (fig. 2).

Description of the valves will be with reference to a line drawn from the apex of the ellipsoidal crescent to the midpoint of the concave free edge. This line forms the bifurcating axis of the valves (fig. 2). The ileo-cecal and apico-basal valves lie mainly in a dorsal-ventral plane. Thus each valve has a dorsal attached border and a ventral attached border.

ILEO-CECAL VALVE

The ileum in the vicinity of the cecum is attached by a triangular shaped mesentary to the lesser curvature of the apical portion of the cecum. The ileum follows the approximate curvature of the apex, until it joins the lesser curvature of the basal portion of the cecum at an angle of 45° to 60°. The outside diameter of the ileum decreases in the final 1-2 centimeters before connecting with the basal portion of the cecum.

In sections perpendicular to the two epithelial faces of the valve and parallel to the bifurcating axis of the valve, the ileo-cecal valve appears as a combination of the walls of the inferior surface of the ileum and the lesser curvature of the basal portion of the cecum (plate 1 and fig. 3). Villi distinguish the ileal mucosa from the cecal mucosa. On the epithelium of the wall of the ileum opposite the free edge of the ileo-cecal valve, the villi extend past the valve approximately 1 mm. into the basal portion of the cecum. This is due to the angle at which the ileum joins the basal portion of the cecum.

In the lip of the valve the following layers (fig. 4-7) can be noted from the ileal to the cecal mucosa: 1. The ileal mucosa consisting of epithelium characterized by villi, tunica propria and lamina muscularis mucosae. 2. A very limited ileal submucosa, evident mainly with Mallory's triple stain. 3. A smooth muscle layer. 4. A thin cecal submucosa. 5. The cecal mucosa, without villi but with a lamina muscularis mucosae, tunica propria and epithelium.

The ileal epithelium consists mainly of tall columnar cells with granular eosinophilic cytoplasm. Elliptical nuclei are located in the center or basal third of the cells. The epithelial cells, extending between the villi through the tunica propria to the lamina muscularis mucosae, form glandular structures closely resembling the crypts of Lieberkühn. The deep cells of these glands become more basophilic and more cuboidal than those of the surface epithelium. The position of the nuclei of the glandular cells near the tunica propria has shifted and the nuclei lie closely adherent to the base of the cells. When stained with Mallory's triple stain, the majority of the cells of the glands appear clear. The basement membrane, adhering to the base of the epithelium, is marked by occasional nuclei which are associated with a radiating syncytium of cytoplasm. The nuclei of this membrane stain blue with hematoxylin and red with Mallory's triple stain. The cytoplasm stains pink with eosin and blue with Mallory's triple stain.

The tunica propria, lying between the epithelium and the muscularis mucosa, is a connective tissue layer, containing vessels, connective tissue cells and extra-vascular lymphocytes. The circulatory vessels range from capillaries in the villi to small blood vessels with smooth muscle in the tunica propria around the glands. There are also thin walled vessels within the connective tissue, containing a few scattered lymphocytes; these are probably lymph vessels. Blood vessels of this area contain lymphocytes and erythrocytes. A number of sections clearly show the erythrocytes lying in capillaries adjacent to the basement membrane of the epithelium at the tip or lateral border of the villi. Nerve cells were not observed in the tunica propria.

When the lamina muscularis mucosae is stained with hematoxylin and eosin, an outer longitudinal layer and an inner circular layer can be distinguished. Each of the bands is only 1 cell in thickness. When Mallory's triple stain is used, the lamina muscularis mucosae is barely visible, and in some places is not observable at all.

The ileal submucosa is a very thin layer containing collaginous fibers, blood vessels and Meisner's plexus. Mallory's triple stain was necessary to elucidate clearly the ileal submucosa.

A smooth muscle layer lies adjacent to the submucosa, but since this layer is formed by a combination of the ileal and cecal musculature, the description will be left until later.

The cecal submucosa is a band of collaginous fibers containing blood vessels and nerve plexuses and is more extensive than the ileal submucosa. However, the submucosal layer is not very broad.

The mucosa of the cecal side closely resembles that of the ileal side except there are no villi present. The epithelium is a smooth surface of tall columnar cells perforated by openings to the many glands. In the contracted valve, the epithelium is arranged in low folds; in relaxed valves, the epithelium becomes smooth. The nuclei of the epithelial cells are located in the basal half of the cell and the cytoplasm is granular and eosinophilic.

The mucosal glands, the tunica propria and the muscularis mucosae are as described for the ileal side of the valve.

Serial sections perpendicular to the two epithelial faces of the valve and parallel to the bifurcating axis show the relation of the smooth muscle from the ileum and basal portion of the cecum as they contribute to the musculature of the lip of the valve from the attached borders and the apex toward the free edge of the lip (fig. 7,8). The muscle fibers within the lip of the valve run from one attached border toward the other, parallel to the concave free edge of the valve. Thus these sections show the muscle fibers within the center of the lip of the valve cut in cross-section to the longitudinal axis of the fiber, and show a transition to fibers cut along their longitudinal axis in sections toward the attached borders.

In sections near the angle between the ventral attached border and the free edge, the circular muscle of the ileum, forming a large muscle mass at the attached border, invaginates into the lip of the valve. The circular muscle of the basal portion of the cecum does not enter the lip of the valve at this point (fig. 8). The longitudinal muscle of the basal portion of the cecum is closely adherent to the outside edge of the muscle mass formed by the circular muscle of the ileum, but it does not contribute to the musculature within the lip of the valve. The longitudinal muscle of the basal portion of the cecum merges into the longitudinal muscle of the ileum.

In sections along the remainder of the ventral attached border towards the apex of the valve, the muscle mass at the attached border is formed by the combined circular muscle of the ileum and the circular muscle of the basal portion of the cecum (fig. 7). The longitudinal muscle of the ileum is continuous with the longitudinal muscle of the basal portion of the cecum except for occasional nerve plexuses that separate these two layers along the outside edge of the muscle mass formed by the circular muscle layer.

The dorsal attached border is essentially symmetrical with the ventral attached border. In sections from the apex of the valve along the dorsal attached border, the musculature of the lip of the valve is formed by the combination of the circular muscle of the ileum and the circular muscle of the basal portion of the cecum. The longitudinal muscle of the ileum and the longitudinal muscle of the basal portion of the cecum are continuous along the outside of the combined circular muscles of the ileum and the basal portion of the cecum (fig. 7). Near the angle formed by the dorsal attached border with the free edge of the valve, the circular muscle of the basal portion of the cecum does not connect with the circular muscle of the ileum to form the muscle mass that extends into the valve. The muscle mass is now formed only by the circular muscle of the ileum (fig. 8).

Serial sections perpendicular to the two epithelial faces and perpendicular to the bifurcating axis show the relation of the smooth muscle from the ileum and the basal portion of the cecum as they contribute to the musculature of the lip of the valve from one attached border toward the other (fig. 4,5,6). In sections near the apex of the valve, along the dorsal attached border and along the ventral attached border, the circular muscle of the ileum and the circular muscle of the basal portion of the cecum join to form a muscle mass that extends into the lip of the valve. Near the apex the longitudinal muscles of the ileum and the basal portion of the cecum merge together across the outside of the circular muscle mass (fig. 4). There are indications that muscle fibers from these longitudinal bands connect with the circular muscle mass extending into the lip of the valve. This relation of the circular muscle and longitudinal muscle continues in sections toward the free edge of the valve almost to the angle between either the dorsal or ventral attached border and the free edge. The muscle mass near the apex between the attached borders and the free edge is formed only by the circular muscle from the ileum (fig. 5). The circular muscle of the basal portion of the cecum does not connect with the muscle mass but is separated by blood vessels and connective tissue. However, at the apex of the angle between the attached borders and the free edge, the muscle mass along the attached borders again is continuous with the circular muscle of both the ileum and the basal portion of the cecum (fig. 6). The merging ileal and basal cecal longitudinal muscles again extend across the outside of the circular muscle mass (fig. 6).

The smooth muscle of the ileo-cecal valve is therefore a sheet of muscle, the fibers of which run from one attached border to the other. This muscle sheet is connected with the circular muscle of the ileum and of the basal portion of the cecum along the attached borders except for a short distance near the angle between either attached border and the free edge, where it is connected only with the circular muscle of the ileum.

A thorough examination was made to determine the possibility of sphincter action at the ileo-cecal junction. There is no evidence of a thickened muscle except within the lip of the ileo-cecal valve. That is, there is no complete circle of thickened muscle in either the ileum proper or the basal portion proper of the cecum. However, this does not eliminate the possibility of sphincter action at the ileo-cecal junction involving the ileo-cecal valve muscle and the related non-thickened ileal circular muscle.

APICO-BASAL VALVE

The apico-basal valve is located between the apical portion of the cecum and the basal portion of the cecum (fig. 3). This valve presents a curved surface that guides the contents of the ileum into the basal portion of the cecum and does not allow the direct entry of this material into the apical portion of the cecum. Sections of the apico-basal valve show that it is composed of the junction of two walls, one from the apical portion of the cecum and one from the basal portion of the cecum. Components of the musculature of the ileum also supplement the structure of the apico-basal valve.

The histological characteristics noted for the mucosa and submucosa were similar for the apical and basal faces of the valve. The mucosa is composed of an epithelium, tunica propria and lamina muscularis mucosae; but it does not possess the tall villi that distinguish the ileum.

The epithelium, arranged as short projections which are flattened to form a smooth surface when the cecum is distended, consists of tall columnar cells and an occasional goblet cell. The columnar cells are arranged in a pyramidal or dome-shaped fashion, the cells becoming thinner in width from the base of the dome to the top. There is a heavy eosinophilic border along the margin of the cells exposed to the lumen. The nuclei, oval or irregular, are located in the basal half of the cell. Between the short projections of the epithelium are small openings to simple bulbous glands extending through the tunica propria to the lamina muscularis mucosae. The glands are composed of wedge-shaped cells with round nuclei lying nearly adjacent to the base of the cells. The cytoplasm of the gland cells is finely granular but more basophilic than the cytoplasm of the epithelial cells lining the cecal lumen. The epithelium closely adheres to a basement membrane marked by a thin, extended eosinophilic cytoplasm and oval basophilic nuclei.

The tunica propria includes a vascular area extending into the mucosal projections. This connective tissue layer contains numerous vessels, intra-vascular erythrocytes, intra-vascular and extra-vascular lymphocytes, and extra-vascular connective tissue cells. Lymphocytes are more or less evenly dispersed throughout the entire tunica propria, but collections into follicles were not noted. Erythrocytes are found in close proximity to the basement membrane. Small blood vessels may be seen in the tunica propria near the lamina muscularis mucosae and sometimes can be traced to the capillaries adjacent to the basement membrane.

The lamina muscularis mucosae is an indistinct layer, 1-2 cell layers thick, of smooth muscle. With Mallory's triple stain this layer can only be distinguished by the nuclei.

The submucosa is very thin and difficult to discern in the hematoxylin and eosin preparations, but with Mallory's triple stain it shows as a band of collaginous fibers.

The apico-basal valve appears to be formed from the bending of the cecum in the vicinity of the junction of the ileum with the cecum. The bending of the cecum back upon itself would produce an elipsoidal crescent lip extending into the lumen of the cecum. The bend divides the cecum into a basal portion which the ileum and the colon join and into a spiraled apical portion which ends blindly. The apical portion of the cecum not only bends upon the basal portion but also twists dorsally so that the line of attachment of the valve extends around the cecum for slightly more than 360° (4, pp.72-73).

The smooth muscle of the apico-basal valve is directly continuous with the smooth muscle of the ileum, of the basal portion of the cecum and of the apical portion of the cecum. The base of the valve will be considered as that portion of the valve connected with the smooth muscle of the ileum in the area of the apex of the valve (fig. 2). Therefore, the base of the valve will be an area extending from either side of the apex of the valve approximately one-fourth the distance to the angle between the attached borders and the free edge.

Sections perpendicular to the epithelial faces and parallel to the bifurcating axis of the valve show the relation of the musculature from the attached borders and base of the valve toward the free edge (fig. 9-12). In these sections, the circular muscle of the apical portion of the cecum extends into the lip as a band adjacent to the submucosa of the apical face of the valve (fig. 9-12). The fibers of this band run diagonally toward the free edge across the entire face of the valve from the ventral attached border to the dorsal attached border. The fibers are cut diagonally, due to the dorsal twisting of the apical portion of the cecum. On the ventral attached border the longitudinal muscle of the apical portion of the cecum follows the circular muscle to the attached border of the valve and connects with the longitudinal muscle from the basal portion of the cecum (fig. 9). In sections along the ventral edge of the base of the valve, the longitudinal muscle of the apical portion of the cecum no longer joins with the longitudinal muscle of the basal portion of the cecum, but is now continuous along the base of the valve in conjunction with the longitudinal muscle of the ileum (fig. 10,11). Along the dorsal attached border through sections beyond the base of the valve, the longitudinal muscle of the apical portion of the cecum again joins with the longitudinal muscle of the basal portion of the cecum to form a muscle band extending across the attached border of the valve (fig. 12). The longitudinal muscle of the ileum and of the apical portion of the cecum invaginates the lip of the valve along the base and the dorsal attached border respectively to form a muscle band that extends nearly to the free edge of the valve (fig. 11).

The circular muscle of the basal portion of the cecum extends only as far as the ventral or the dorsal attached border, and does not proceed into the lip of the valve. The circular muscle of the ileum invaginates along the base of the valve, extends almost to the free edge of the lip, and lies next to the submucosa of the basal face of the valve (fig. 10). On either side of the bifurcating axis, the extension of the ileal circular muscle into the lip gradually decreases until the ileal component is no longer apparent along the dorsal or ventral attached borders. The muscle fibers from the circular muscle of the ileum run perpendicular to the bifurcating axis of the valve.

Sections of the apico-basal valve perpendicular to the two epithelial faces and perpendicular to the bifurcating axis show the relation of the smooth muscle of the ileum, basal portion of the cecum and the apical portion of the cecum from one attached border of the lip of the valve to the other (fig. 13,14,15). The circular muscle of the apical portion of the cecum extends completely across the lip of the valve from one attached border to the other and is visible in sections from the apex of the valve to the free edge (fig. 13,14,15). The fibers of this muscle sheet are cut diagonally to their longitudinal axis.

The longitudinal muscle of the apical portion of the cecum joins with the longitudinal muscle of the basal portion of the cecum to form a muscle band across the outside edge of either attached border. However, the longitudinal muscle of the apical portion of the cecum along the dorsal attached border is also connected with a band of muscle fibers within the lip of the valve (fig. 13,14). This band of muscle is the continuation of the longitudinal muscle of the ileum at the base of the valve. The fibers are cut perpendicular to their longitudinal axis. At the base of the valve, this muscle band reaches completely across the lip of the valve from the dorsal to the ventral attached border, lying between the circular muscle from the ileum and the circular muscle from the apical portion of the cecum.

The circular muscle of the basal portion of the cecum does not contribute directly to the musculature of the lip of the apico-basal valve along the attached borders. On the dorsal attached border, the circular muscle of the basal portion of the cecum turns in toward the lip of the valve but stops abruptly without invaginating (fig. 13,14). It is separated from the longitudinal muscle by a thin layer of connective tissue, but the muscle fibers run in the same direction--from the base toward the free edge. At the ventral attached border, the circular muscle of the basal portion of the cecum is also separated from the muscle layers of the lip by a thin connective tissue sheet (fig. 13,14).

The circular muscle of the ileum invaginates the lip of the apico-basal valve at the base and extends from the dorsal attached border to the ventral attached border. In sections toward the free edge of the valve the circular muscle from the ileum decreases in width until it forms an apex on the bifurcating axis near the free edge of the valve. This muscle band lies adjacent to the submucosa of the basal face of the valve.

There are, therefore, three sheets of muscle within the lip of the apico-basal valve. In order of their appearance from the apical submucosa to the basal submucosa, they are: (1) the layer of muscle extending across the entire face of the valve in a diagonal direction, continuous with the circular muscle of the apical portion of the cecum; (2) a layer of muscle continuous along the attached borders with the longitudinal muscle of the apical portion of the cecum and along the base with the longitudinal muscle of the ileum; and (3) a layer of muscle that is an extension of the circular muscle of the ileum into the lip of the valve.

DISCUSSION

The histological description of serial sections of the ileocecal and apico-basal valves provides the basis for a theoretical estimate of the function of the valves with respect to the direction of flow of material through the cecal region. The absorption, secretion and digestion that occur in the cecum cannot be evaluated to any great degree from this histological study. These items and the direction and magnitude of content flow can be answered adequately only by extended physiological research.

The ileo-cecal valve is controlled by the musculature from the ileum and the basal portion of the cecum. The sheet of muscle within the lip of the valve is connected along the dorsal and ventral borders with the circular muscle of the basal portion of the cecum and the circular muscle of the ileum. Any stimulus affecting the circular musculature of the terminal ileum and any stimulus affecting the circular muscle layer of the basal portion of the cecum may involve the musculature of the valve. Since the muscle fiber runs across the valve from the dorsal attached border to the ventral attached border, the effect of contraction of the muscle sheet of the valve in conjunction with the circular muscle of the ileum and the basal portion of the cecum would be to occlude partially or completely the aperture between the ileum and the basal portion of the cecum. The degree of closing cannot be determined from this study.

Any material being forced down the ileum by a peristaltic wave is preceded by a zone of relaxed muscle and followed by a zone of contracted muscle (2, p.354 and 3, p.449). This may mean that as the material is about to enter the cecum from the ileum, the advancing zone of relaxed muscle would be in the vicinity of the ileo-cecal valve. This would allow a more uninhibited flow of the intestinal contents into the cecum. After the passage of the contents into the cecum, the ileo-cecal valve would be involved by the contracted zone of the peristaltic wave. Contraction of the circular muscle of the ileum, together with contraction of the ileal component of the valve would inhibit the further flow of contents into the cecum.

The possibility of the passage of material from the cecum back into the ileum should also be considered. Since the musculature of the basal portion of the cecum is continuous with that of the valve, it follows that any stimulus of the cecum in this area will affect the valve. A contraction of the basal portion of the cecum with the purpose of passing material into the colon would alter the position of the lip unless simultaneously the ileal component together with the associated circular muscle of the ileum contracted and decreased the aperture between the ileum and the cecum.

The musculature of the apico-basal valve is connected at the base with the musculature of the ileum. The longitudinal muscle of the ileum forms a sheet of muscle in the lip of the valve that is continuous on either side with the longitudinal muscle of the apical and basal portions of the cecum. The fibers of this sheet of muscle run from the base toward the angle formed by the free edge of the valve and the attached borders, thus parallel or slightly oblique to the bifurcating axis of the valve. The circular muscle of the ileum extends into the lip of the valve with fibers running perpendicular to the bifurcating axis of the valve. This sheet at the base of the valve is quite narrow, but broadens as it goes toward the free edge and then gradually narrows again until it disappears. Thus it forms a rough oval-shaped sheet of muscle within the lip of the valve with fibers running perpendicular to the bifurcating axis. The circular muscle of the apical portion of the cecum forms a sheet of muscle fibers running diagonally toward the free edge from the ventral border to the dorsal border. The circular muscle of the basal portion of the cecum extends only to the dorsal and ventral attached borders. There is no evidence of direct connection of the circular muscle of the basal portion of the cecum with the musculature within the lip of the apico-basal valve. From the attachments of the musculature of the apico-basal valve, any stimulus affecting the activity of the ileum or the apical and basal portions of the cecum will involve the lip of the valve.

Theoretical considerations of the functions of this valve suggest that it may be involved in the movement of material from the ileum into the cecum, in the movement of material from the basal into the apical portion of the cecum and in the movement of material from the apical into the basal portion of the cecum. Although these actions are interrelated, by considering them separately a clearer picture of the functioning of the valve may be suggested.

When the contents of the ileum are emptied into the basal portion of the cecum by a peristaltic wave, this same wave may involve the lip of the apico-basal valve. Since a zone of relaxation precedes the zone of contraction, the musculature of the valve may first relax. However, the contracted zone of the peristaltic wave would cause a contraction of the musculature of the valve connected with the ileum. The contraction of the longitudinal ileal component of the apico-basal valve should pull the free edge of the valve into a straighter line, since the fibers of this sheet run from the base of the valve to the angle between the free edge and the attached borders. The opening between the apex and the base of the cecum would be enlarged. The circular muscle from the ileum, on contracting, should draw the attached borders of the valve closer together. This is because the circular layer is a sheet of muscle with fibers running across the face of the valve, but not continuous beyond the attached borders. The combined contraction of the longitudinal and circular ileal components of the lip could lead to a wider aperture between the apical and basal portions of the cecum. The enlarged aperture between the apical and basal portions of the cecum, due to the contraction zone of the peristaltic wave from the ileum, would encourage a greater passage of material between the apical portion of the cecum and the basal portion of the cecum.

With the concurrent arrival of material from the ileum, the passage of material would preferably be toward the apex. This discussion was predicated on a partial or entire closure of the basal semilunar valve.

The movement of material from the basal to the apical portion may be further aided by contractions of the circular muscle of the basal portion of the cecum. The circular muscle extends to the dorsal and ventral attached borders but not into the lip of the valve. A contraction of this layer of muscle would pull on either side of the lip of the valve, tending to increase the distance between the attached borders. This would straighten the free edge of the valve, producing a larger aperture.

The closing of the ileo-cecal valve and the opening of the apico-basal valve are congruent with each other, since the ileo-cecal valve should be closed at the time material is going from the basal portion of the cecum to the apical portion of the cecum in order to prevent the regurgitation of the cecal contents into the ileum. Since the longitudinal muscle of the basal portion of the cecum and the longitudinal muscle from the ileum are interconnected, their contraction would straighten and pull on the free edge of the apico-basal valve, shortening the bifurcating axis of the valve. This action decreases the size of the valve and increases the aperture between the apical and basal portions of the cecum.

The function of the apico-basal valve during the movement of material from the apical to the basal portion of the cecum is similar to that of the ileo-cecal valve. A peristaltic wave in the apical cecum is considered as being from the blind tip toward the basal portion of the cecum. Such a wave is preceded by a relaxed zone which relaxes the muscle sheet from the apical portion of the cecum to allow the passage of material from the apical to the basal portion of the cecum. Following the passage of this material, the contracted zone of the peristaltic wave now affects the muscle sheet, causing a decrease in the aperture between the apical and basal portion of the cecum. As was true of the ileo-cecal valve, the movement of material from the apical to the basal portion of the cecum would coincide with the peristaltic waves down the apical portion of the cecum.

This discussion of the function of the ileo-cecal and apico-basal valves has not considered the interaction of the Meisner's nerve plexus in the submucosa and Auerbach's plexus between the longitudinal and circular muscle layers. Nerve plexuses in the lips of both valves are unusually prominent and without a doubt contribute to the functioning of the valve, but this study provides no information about the nerve connections or interactions.

SUMMARY

The ileo-cecal valve is formed by the junction of the wall of the ileum and the wall of the basal portion of the cecum. The apico-basal valve is formed by the junction of the walls of the apical and basal portions of the cecum. The ileal face of the ileo-cecal valve has the features of the mucosa and submucosa of the distal portion of the ileum. The mucosa and submucosa of the basal faces of the ileo-cecal and apico-basal valves resemble the mucosa and submucosa of the basal portion of the cecum. The mucosa and submucosa of the apical face of the apico-basal valve correspond to the mucosa and submucosa of the apical portion of the cecum.

The fibers of smooth muscle of the ileo-cecal valve run from one attached border to the other. Near the angle between the dorsal and ventral attached borders and the free edge, the circular muscle of the ileum invaginates into the ileo-cecal valve. Toward the apex of the valve, the muscle mass of the valve is formed by the combined circular muscle of the ileum and the circular muscle of the basal portion of the cecum. The longitudinal muscle of the basal portion of the cecum, closely adherent to the muscle mass formed by the circular muscles, does not contribute to the musculature within the lip of the valve, but merges into the longitudinal muscle of the ileum.

The apico-basal valve appears to be formed from the bending of the cecum back upon itself to produce an ellipsoidal crescent lip extending into the lumen of the cecum. On the dorsal and ventral attached borders, the circular muscle of the basal portion of the cecum turns in toward the lip of the valve but stops abruptly before invaginating. The circular muscle of the ileum invaginates along the base of the valve, extends almost to the free edge, and lies next to the submucosa of the basal face. On either side of the bifurcating axis, the extension of the ileal circular muscle into the valve gradually decreases until the ileal component is no longer apparent along the dorsal and ventral attached borders.

The circular muscle of the apical portion of the cecum continues into the valve, extends completely across the lip from one attached border to the other, lies next to the submucosa of the apical face and is visible in sections from the apex to the free edge.

The longitudinal muscle of the apical portion of the cecum joins with the longitudinal muscle of the basal portion of the cecum to form a muscle band across the outside edge of either attached border. The longitudinal muscle of the apical portion of the cecum along the dorsal attached border is also connected with a band of muscle fibers within the lip of the valve. This band of muscle is the continuation of the longitudinal muscle of the ileum at the base of the valve. The fibers run parallel to the bifurcating axis of the valve. At the base of the valve, this muscle band reaches completely across the lip of the valve to the ventral attached border. At the ventral attached border, the band lies between the circular muscle of the ileum and the circular muscle of the apical portion of the cecum. The longitudinal muscle of the basal portion of the cecum is closely adherent to the muscle mass formed by the circular muscle of the ileum; but it does not contribute directly to the musculature within the lip of the valve.

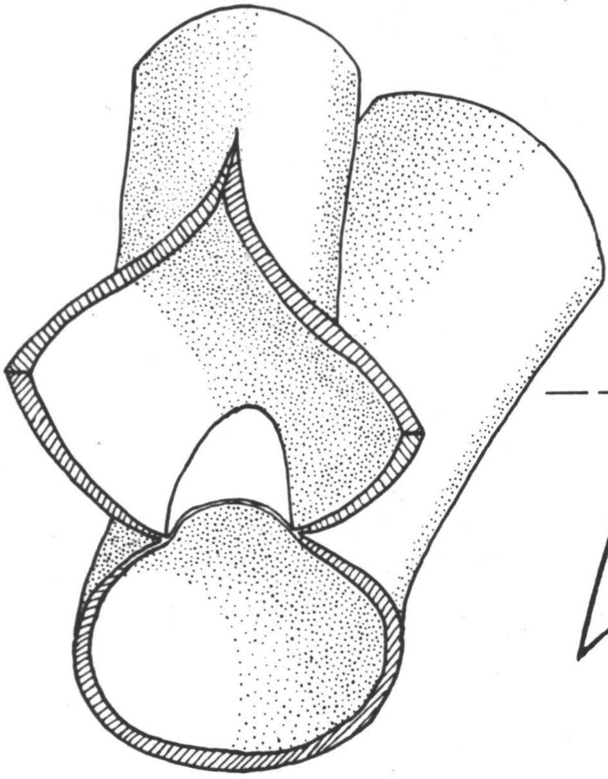

FIG. 1

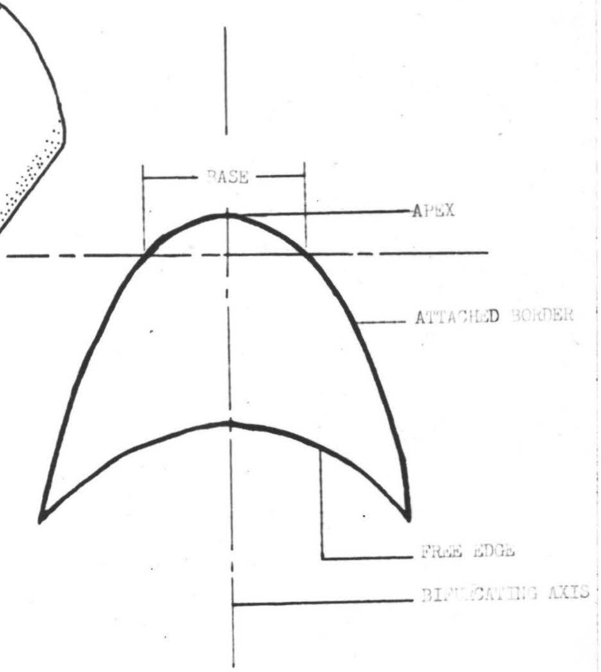

FIG. 2

PLATE 1

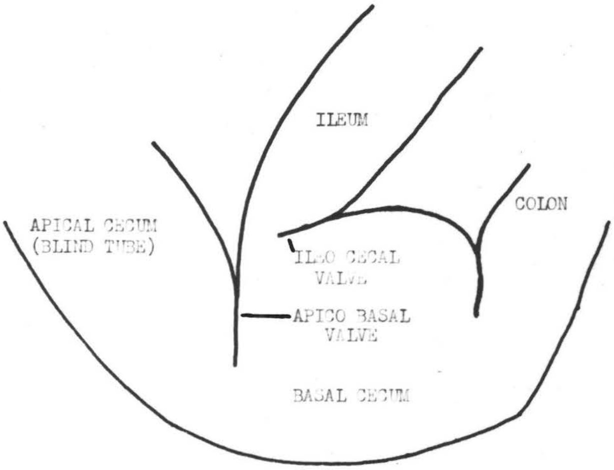

FIG. 3

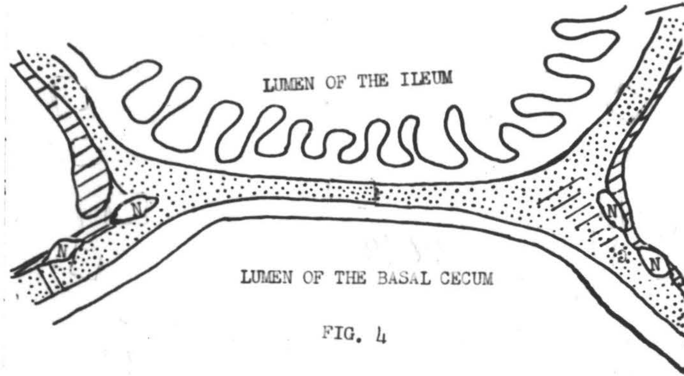

FIG. 4

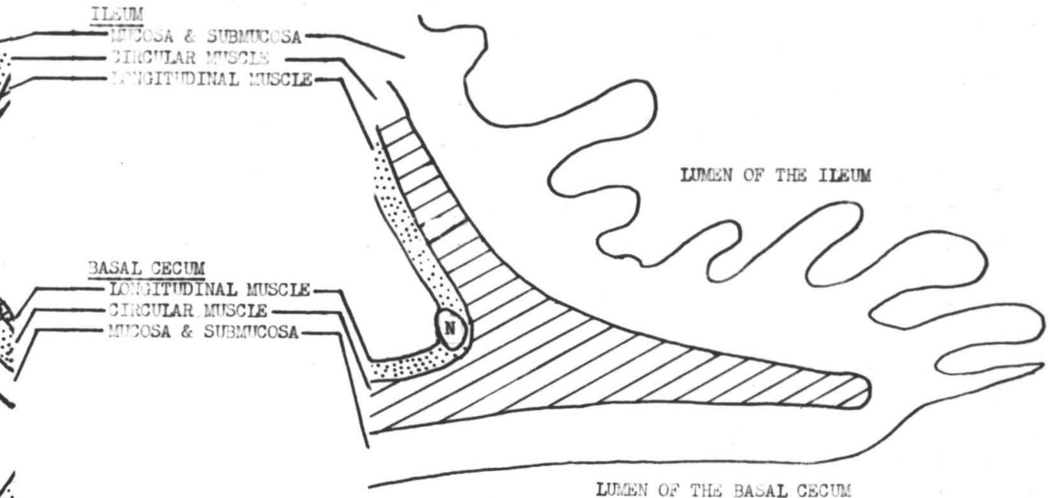

FIG. 7

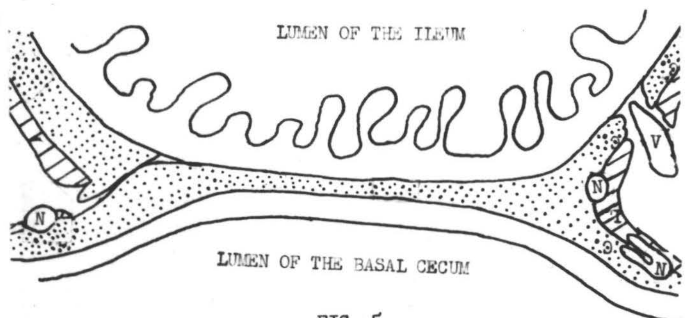

FIG. 5

N - NERVE TISSUE
V - BLOOD VESSEL

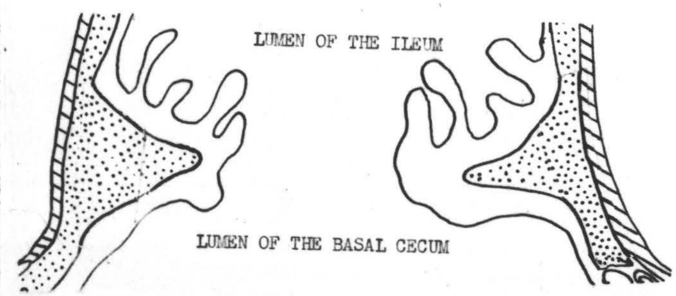

FIG. 6

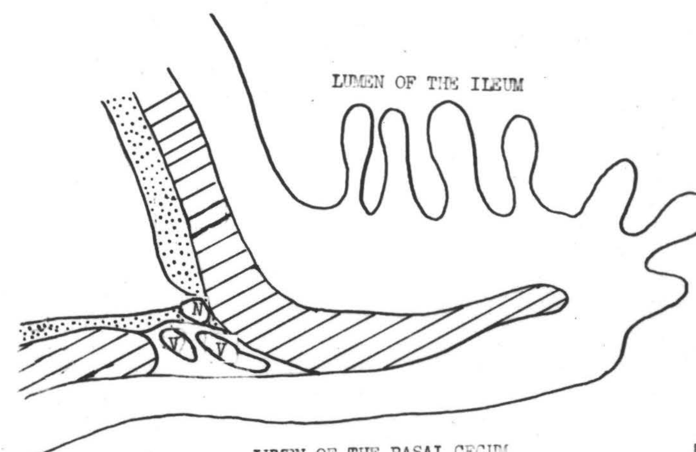

FIG. 8

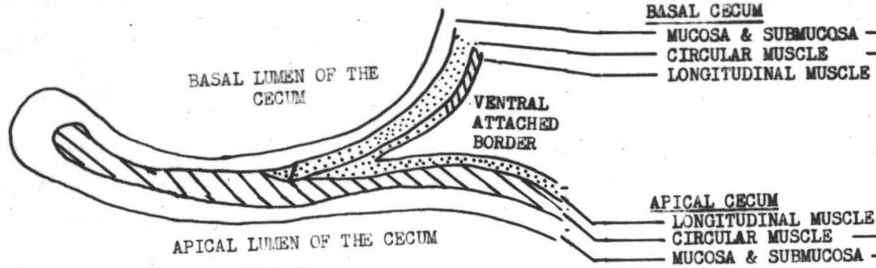

FIG. 9

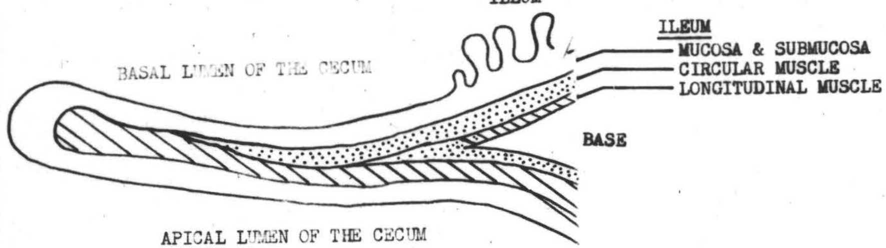

FIG. 10

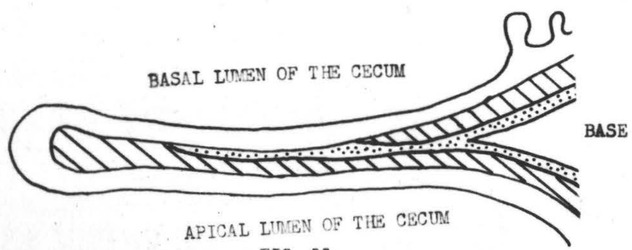

FIG. 11

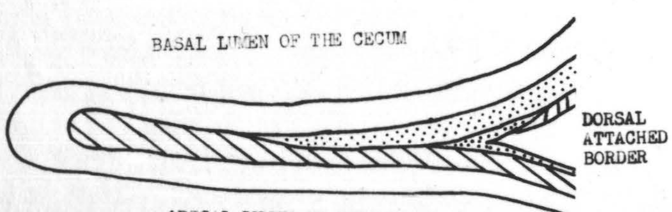

FIG. 12

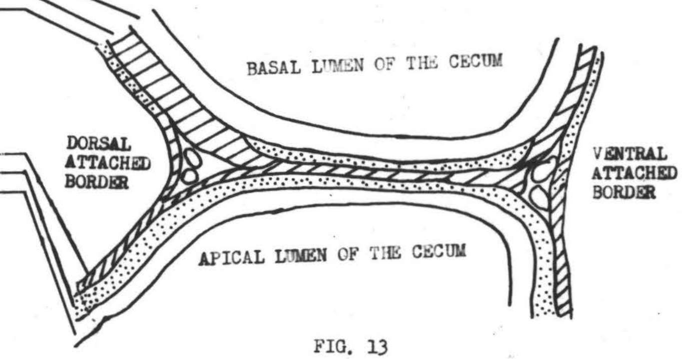

FIG. 13

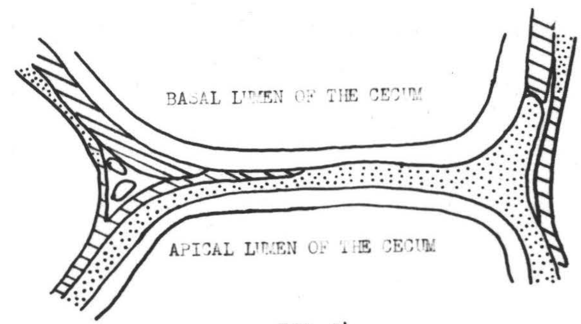

FIG. 14

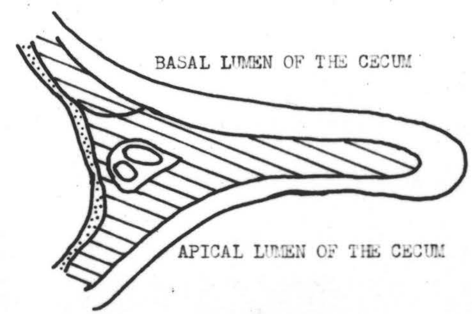

FIG. 15

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