

Intestinal Valves by Telescoping Anastomosis and Non-transected Muscular Valve

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Along with increasing number of extensive intestinal resection, development of an intestinal valve has come into attention of the surgeons. Much has been reported in reference to the anastomosing technique constructing intestinal valve as the solution for the easier post-operative cares of such cases.

On the other hand, in the course of a study of surgical treatment of Hirschsprung's disease, we have found an operatively constructed valve-like mechanism by telescoping anastomosis. (2)

Experiments were carried out to obtain satisfactory conditions of such valve, and clinical applications have been made so that it may improve post-operative diarrhea, mal-absorption and so forth.

Material and Method

1. *Construction of an intestinal valve by telescoping anastomosis.*

Adult mongrel dogs weighing six to sixteen kg were used for the experiment. Animals were anesthetized by 25 mg/kg Nembutal intravenous injection. Air-oxygen mixture was supplied through intratracheal tube by Harvard respirator during the operation. Laparotomy was done by lower midline incision. After transecting the ileum, the mesentery was detached from the proximal end over the length of the ileum to be intussuscepted. Then, four sero-muscular U-stay sutures with 0-4 silk or chromic cat-gut were layed evenly around the ileum. With the proximal segment inserted in the distal lumen, the U-stay suture at the root of the mesentery was first sutured to sero-muscular layer of the distal cut end. Next, the U-stay suture at the opposite side was sutured. After fixing the other two U-stay sutures likewise, additional interrupted sero-muscular sutures were made. (Fig. 1) No special care was necessary except for hemostasis of both transected ends. Telescoping anastomosis was performed ileo-ileostomy, and later, for ileo-colostomy. The valve function was affected by the length of inserted segment of the intestine. Various length of segments

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Key words : Intestinal valve, Telescoping anastomosis.

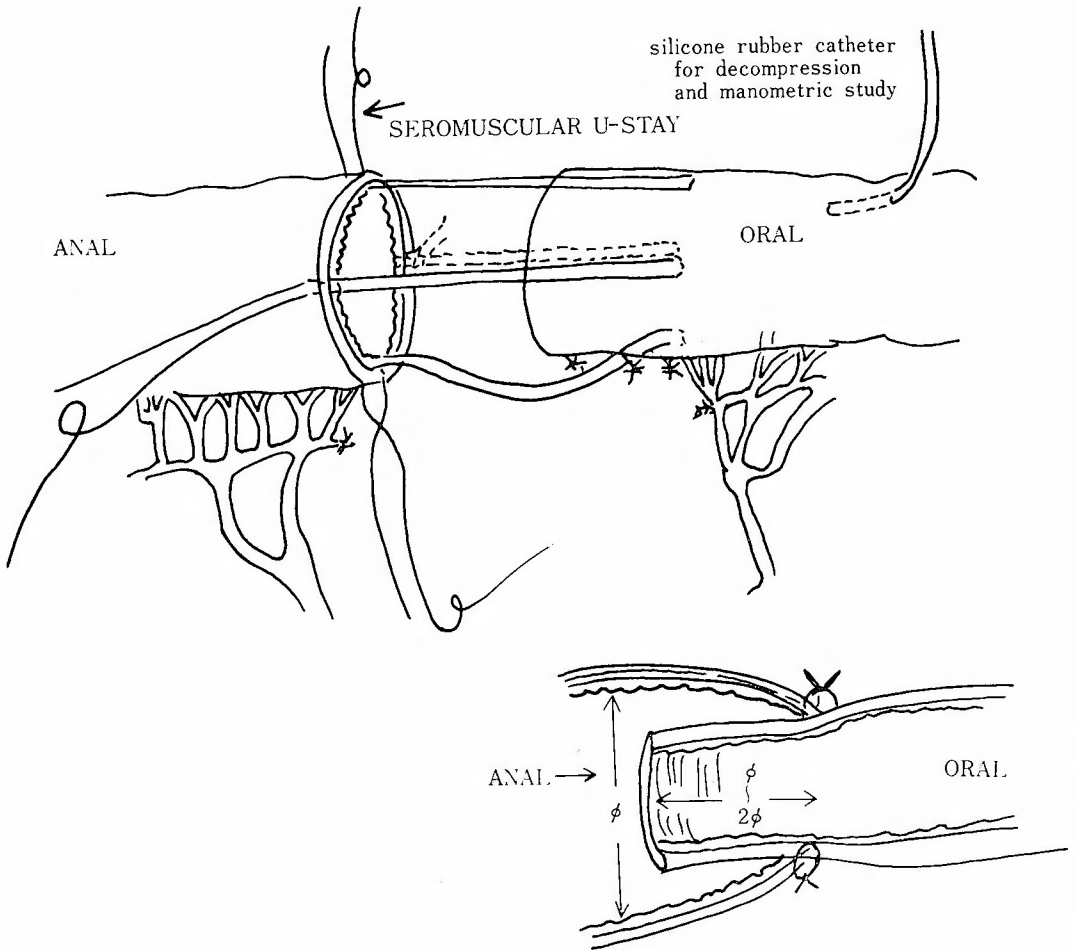


Fig. 1 Surgical procedure of intestinal valve construction by telescoping anastomosis.

Decompression catheter inserted into the lumen of the oral segment ca 10 cm above the anastomosis is essential to prevent intestinal obstruction which caused by immediate post-operative edematous swelling and / or serositis.

were tried for the purpose of valve function. Group 1 : Less than the diameter of the intestine. Group 2 : One to two times the diameter. Group 3 : Three times the diameter or more.

2. Procedure for construction of improved non-transected muscular valve.

In some cases with the intestinal valve by telescoping anastomosis, abscess formation around the anastomotic portion was observed. Transection of the intestinal canal was considered to be responsible for this hazard. On the other hand, interruption of the muscular layer at the anastomosis was essential in order to obtain a valve mechanism, especially from the view point of long-term follow-up study.

According to these experiences, an improved non-transected muscular valve was developed.

NON-TRANSECTED MUSCULAR VALVE

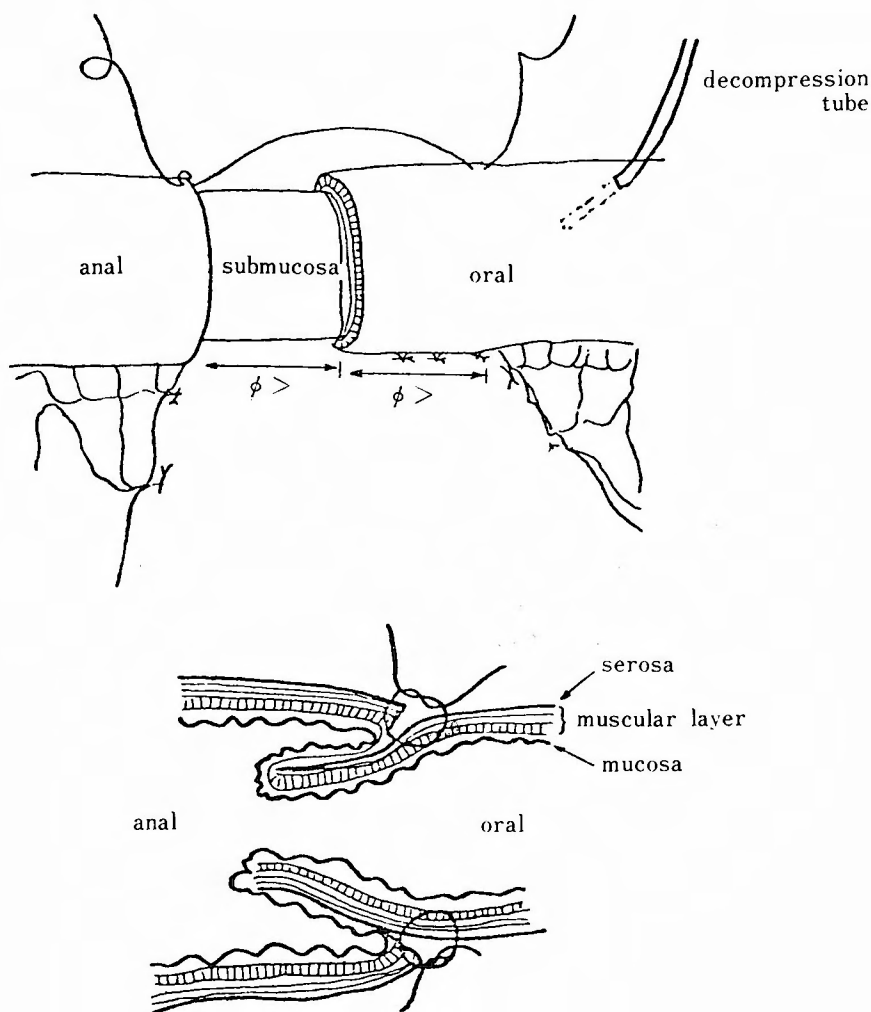


Fig. 2 Surgical procedure of non-transection muscular valve. (by Ohnishi) Serosal surface of the invaginated proximal (oral) segment is lined by the dorsal surface of the mucosal layer of which seromuscular layer has been peeled off. Mucosal layer is not transected at the valvular portion and continues from oral to anal segment without interruption.

Around the intestinal segment where the valve is to be settled, a circular excision (peeling) of the sero-muscular layer by a width equal to the intestinal diameter was performed. The proximal segment was invaginated to the distal canal, so that the mucosal layer of the peeled segment lines in the serosal surface of the invaginated proximal segment. (Fig. 2)

Fixation of the both segment was done by eight U-stay sutures. The proximal segment

was fixed to the mesenterium along 10 cm length by interrupted sutures in order to prevent further invagination which may cause intestinal obstruction.

A silicone rubber catheter (ϕ 1.5 to 2.0 mm) was inserted into the proximal segment about 10 cm orally to the anastomosis. This catheter facilitated decompression of the proximal intestine as well as measurement of the intra-luminal pressure. During 4 to 10 post-operative days, in some cases the anastomosis caused intestinal obstruction, and simple decompression easily improved this complication.

Physiological study of the valve mechanism.

Intra-canalicular pressure study by open tip method was carried out in order to estimate the physiological competency of the valves. As control group, ileocecal valve and ileo-ileo, end to end anastomosis were also studied for their peristaltic transportation and anti-reflux function. For the convenience of measurement, 20 cm long Thiry-Vella fistulae with each valve or anastomosis in the middle were constructed. A polyethylen catheter of 1.5 mm diameter was inserted into the lumen from each end of the fistula. These two catheters were connected to transducer and recorder (Nihon-Koden LPUO 1, Reticorder RJG 3024) so that the pressure at each side of the valve may be monitored. Another catheter was inserted for the purpose of filling the pre-and post-anastomotic lumen with saline solution. Total amount of 5 to 70 ml of saline solution was infused at the speed of 0.5 to 0.7 ml/sec, in order to raise the intra-canalicular pressure.

Histological Study

The valve was histologically studied. Around the tenth, 20th and 40th post-operative days, re-laparotomy was performed and specimens were taken. After fixation in 10% formalin solution for three days, either hematoxylin-eosin, Van Gieson's or azan staining was done.

Microangiography

At the intervals of 1,2,3 and 4 post-operative weeks, the segment with the intestinal valve was resected and prepared for microangiography.

Superior mesenteric artery and vein were ligated and canulation was done with polyethylene tube of 1 mm diameter. Irrigation was performed through the catheters using 38°C saline solution added

Table 1.

Softex, 20-25KVP, 2-10 mA.
duration 45-90 sec
distance 65cm

50 mg heparin per one liter. Irrigation was completed when the out flow fluid was observed as decolorization. Then, 10% barium sulfate solution was infused into the vessels through the catheters. Under the condition which was shown in table 1, microangiography was done by soft-x-ray. (Table 1)

Result

The intestinal segment shorter than the diameter failed to produce sufficient valve



Fig. 3 Macroscopic feature of the intestinal valve constructed in the canine ileum. Seven months after the operation.

function (Group 1).

Group 3 had cases of necrosis or excessive hypertrophy of the inserted segment which caused insufficient valve or stenosis. In the group 2, satisfactory valve function was seen in 6 out of 7 cases. (Fig. 3).

The histological study of the valve around the tenth post-operative day showed inflammatory edematous swelling of the serosal surface of the intussuscepted segment. This serositis, however, became diminished around the 30th post-operative day. The serosal surface was not yet covered by mucosa, and granulation was found between the cut end of oral intussuscepted segment and the suture line. The serosal surface of the intussuscepted intestine came to be completely covered by mucosal continuity from the cut end of the intussuscepted segment. The final histology exhibited shortening and hypertrophy of the longitudinal muscle accompanied with hypertrophy of the circular muscle and submucosal fibrosis. The picture resembles the structure of the anal sphinctor muscles. The hypertrophy of the muscle indicates the maintenance of valvular function by elastic segments and not cicatric stricture. (Fig. 4, 5)

Microangiographic findings

At the first week, contrast of the capillary features of the mucosa and serosa was remarkable, namely thinner mucosal capillaries and thick, congested serosal and subserosal capillaries were observed. These findings were caused by inflammatory changes especially of serositis of the invaginated proximal segment. (Fig. 6)

At the second week, inflammatory reactions were subsided and the intermuscular vessels were well developed supplying sufficient blood flow to the mucosal layer of the valve.



Fig. 4 Longitudinal section of the intestinal valve 20 days after the operation. hematoxylin-eosin $\times 2$



Fig. 5 Longitudinal section of the intestinal valve 40 days after the operation. Mucosal continuity is not yet completed. Van Gieson's $\times 2$

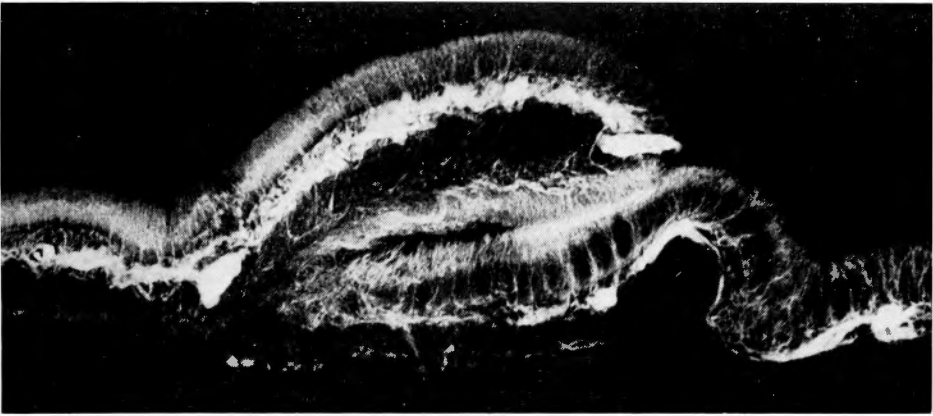


Fig. 6 Microangiogram of the intestinal valve by telescoping anastomosis. 2 weeks after the operation.

Serosal and subserosal vesseles especially of the invaginated oral segment are dilated and at the tip of the valve, the capillaries are thinner.

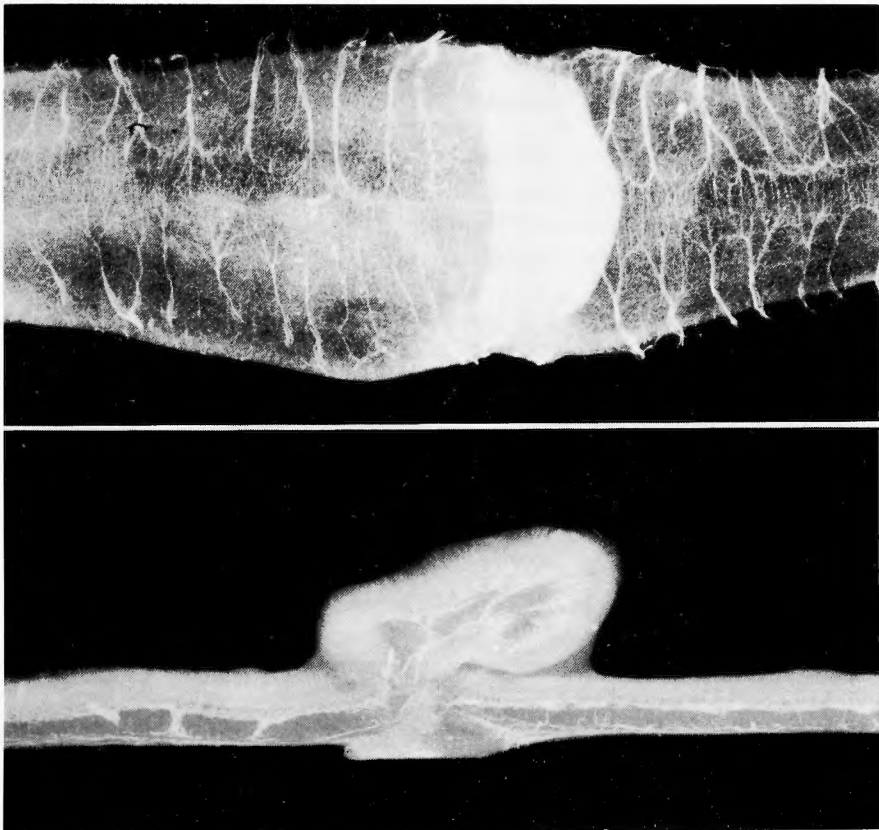


Fig. 7 Microangiogram of the intestinal valve by telescoping anastomosis, 4 weeks after the construction. Submucosal plexus shows high density quite similar to so-called compressible venous cushions of the ileo-coecal valve.

At the fourth week, vascular communication was completely re-established between the proximal and distal segment of the intestine including the valve area where the submucosal plexus showed high density similar to the so-called compressible venous cushions of the ileo-coecal valve. (Fig. 7)

Microangiographic findings of the revascularized anastomotic portion also suggested performance of an anatomically satisfactory valve construction.

Manometric evaluation

The ileo-colic valve (Baunhin) open at the pressure of 2.5-41 cm H₂O, mean of which was 20.4 cm H₂O, in the peristaltic direction. For anti-peristaltic flow (reflux) through the ileo-colic valve, internal pressure of 2.5-76.3 cm H₂O mean of which was 39.7 cm H₂O, was necessary. The values varied with the difference of peristaltic phases and location of the catheter tip. The results may show that a valve opening at under 20 cm H₂O in the peristaltic direction and closing at under 30 cm H₂O in the antiperistaltic direction is satisfactory for ileo-colic valve.

The telescoping anastomosis functions as a valve opening at 2.2-44.3 cm H₂O, mean of which was 25 cm H₂O in the peristaltic direction and at 7.5-75.7 cm H₂O, mean of which was 39.0 cm H₂O, in the anti-peristaltic direction. (Table. 2)

Clinical Experiences

Up to date, 13 patients were operated for construction of intestinal valves either by telescoping anastomosis or non-transected muscular type. Details of the cases are shown in table 3. (Table. 3 Fig. 8)

Table 2. A comparative study of ileocecal valve vs. constructed intestinal valve by telescoping anastomosis and end-to-end ileo-ileostomia.

	isoperistaltic		reflux	
	range	mean	range	mean
ileo-coecal valve	2.5-41.0	20.4	2.5-76.3	39.7
intestinal valve by telescoping anastomosis	2.2-44.3	25.0	2.5-75.7	39.0
end-to-end anastomosis	2.2-36.7		0-2.5	

Table 3 Clinical applications of the intestinal valves.

esophagojejunostomy	2	} valves were effective, reflux esophagitis was prevented
esophagoduodenostomy	1	
Roux-en-Y	4	3 died, of primary disease (choledochal atresia) 1 well controlled
total colectomy and ileostomy	2	1 ulcerative colitis and 1 colon diverticulosis both of them are well controlled.
ileo-colostomy	4	all of them were suffering from colon cancer 3 well controlled, 1 relaparatomized because of adhesions-ileus around the valve.

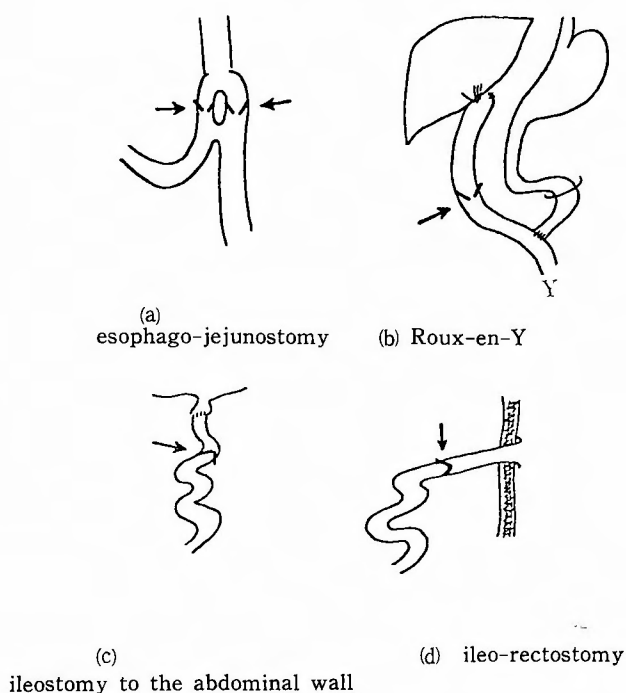


Fig. 8 Applications of the intestinal valve.

The first case of clinical application of the telescoping anastomosis was a 28 year old male from Ceylon. After total colectomy for ulcerative colitis, terminal ileum was placed in the right lower abdominal wall as ileostomy utilizing two layers of rectus muscle rings as sphinctors. The ileum was transected at 15 cm proximal of the ileostomy. The oral segment was inserted in the length of 1.2 times the diameter. Afterwards, the capacity between the anastomosis and the ileostomy was measured as 80 cubic cm. On the 11th post-operative day, soft feces started to appear mixed in the watery diarrhea. In 4 weeks, continuous soft feces were seen. Two months later, barium enema showed anti-reflux function of the valve. The capacity of the pouch was 40 to 100 ml. Taking the capacity of the sigmoid colon and the rectum into consideration, the pouch may be more desirable if it has 150 to 200 ml of capacity. The telescoping anastomosis showed very similar function as ileocecal valve, and its application for a totally colectomized case was satisfactory. (Fig. 9)

The second case was a 53 year old female. For the carcinoma of the transverse colon, right hemi-colectomy was performed. The ileum was transected at 6 cm oral of the ileocecal junction. The transverse colon was transected at 6 cm anal of the tumor, which was in the hepatic flexure. The ileum was inserted in the transverse colon by the length of the diameter of the ileum. The diameter of the anastomotic lumen was about 1.5 cm. Diarrhea started on the seventh post-operative day and changed to soft feces on the 10th day. Normal feces were seen after the thirteenth post-operative day. On the 25th day,



Fig. 9 Barium enema through the ileostomy of a 28 year old patient 2 months after the operation. Arrow shows the position of the valve.

barium enema revealed good passage of the stoma and moderate pre-anastomotic dilatation. No post-operative complication such as abdominal pain, diarrhea, malabsorption or constipation was noticed.

Discussion

Telescoping anastomosis is a simple and secure method, and it is especially advantageous in such cases as rectal amputation of an obese patient, in whom reconstructive anastomosis is difficult. Experimental study of this procedure by Cuthbertson (1), however, showed frequent incomplete bowel obstruction.

In our previous report (2) on "Endorectal Pull-through Operation for the Treatment of Hirschsprung's Disease", the valvular function of the pulled-through colon was reported. Based on this observation, we started to develop intestinal valve by intussusception of the intestine. The intestinal valve functions satisfactorily, when the length of intussuscepted segment is appropriate. The histological study of the valve revealed characteristic change of each layer. The preservation of each tissue layer indicates the maintenance of valvular

function by an elastic segment and not cicatric stricture. The excessive length of intussuscepted segment was often the cause of stensis. The optimal length to be intussuscepted was found to be from one to two times the diameter in the canine ileum. Since the wall of human ileum is thicker than the canine ileum with more prominent longitudinal and circular muscle layers, the optimal length in man was expected to be shorter than in dogs. It was clinically found that the optimal length in man is about the length of the diameter.

Persistent valve function was observed over 220 days in a dog. The first clinical case is still doing well after three years.

Intra-luminal pressure study by open tip method was carried out in order to estimate the physiological competency of the valve. The manometric study in dogs was as follows. The artificial valve constructed with the intestine twice the length of the intestinal diameter yielded the most similar results to those of ileocolonic junction. Mean isoperistaltic and antiperistaltic pressure of the telescoping anastomosis was measured as 25.0 ± 2.0 and 39.0 ± 3.8 . Those of the ileocolonic junction were 20.4 ± 2.2 and 39.7 ± 5.1 (cm H₂O). The study showed that the telescoping anastomosis function at about the same pressure range as ileocecal junction in each direction.

As practical problems, serositis of the inserted segment and possibility of stenosis by stricture are not yet completely eliminated. As a solution for these problems, application of myotomy (3) in the anastomotic region is being experimented. Insertion of a catheter proximal to the valve also effective to prevent symptoms of temporal intestinal obstruction by edematously-swelled valvular portion.

Summary

Intestinal valves by the telescoping anastomosis and non-transected muscular type were constructed in dogs. Histological and microangiographic studies showed well preserved tissue structure of the valve segment. Competence of the valves were observed by manometric evaluation.

Thirteen cases were operated for the construction of the valve, all of them except one case who was relaparatomized because of adhesions ileus around the anastomosis, showed satisfactory results.

References

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和文抄録

Telescoping 吻合による人工腸弁および non-transected 筋層弁の実験的、臨床的研究.

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消化管大量切除術症例の増加とともに、術后管理の上からも intestinal adaptation の促進が要求される。人工腸弁の開発も、これらの問題の解決の有力な一法として検討されて来た。

① 実験的に犬を用いて、回腸に telescoping anastomosis による人工腸弁を作成し、弁機構が、組織学的、生理学的に長期間にわたって保持されることを確認した。

弁機構を得るためには、挿入腸管の長さが、腸管径の1~2倍がよく、これより短いと、弁構造を形成しない、また、長すぎると狭窄を呈することを明らかにした。

② telescoping anastomosis は、時に感染の危険が

ある。腸管切除の際に同時に設置する場合は、本法の感染率も容認される。しかし単に人工腸弁の造設だけを要する症例では、感染防止の点から、non-transected muscular valve が優れていることを認めた。

人工腸弁の弁機構保持の第2の条件としては、弁の口側、肛門側腸管の筋層の断裂が必要であることが、本法の開発によって明らかにし得た。粘膜層のみ連続性をもたし、筋層、漿膜層の剝離、離断を行った上、invaginate する本法は、腸管内腔を開かない大きな利点を有する。

(3) 食道十二指腸吻合、食道空腸吻合 Roux-en-Y 吻合、回腸、回腸直腸吻合合計13例で、狭窄による再手術例1例を除き、極めて満足すべき成績を得た。