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OPERATION TECHNIQUE AND HEALING PROCESS OF TELESCOPIC ILEOCOLOSTOMY IN DOGS

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The healing process of telescopic anastomoses was found in an animal experiment with 12 mongrel dogs. After the division of vessels an ileal segment of different length was invaginated into the lumen of the colon using single-layer interrupted sutures. The following four groups were used: *Group A* (n = 3): end-to-side ileocolostomy, single-layer interrupted suture (invagination length: 0 mm), survival time: 21 days. *Group B* (n = 3): invagination length: 20 mm, survival time: 7 days. *Group C* (n = 3): invagination length: 10 mm, survival time: 21 days. *Group D* (n = 3): invagination length: 20 mm, survival time: 21 days. At the end of the above survival times the anastomosis area was removed. The bursting pressure was measured and morphological as well as histological examinations were performed. In each case the 0-day look-alikes of anastomoses were performed using the remnant bowels, and bursting pressure measurements were done on these models as well. Anastomosis leakage did not occur. The serosal layer of the intracolonic part of the ileum disappeared during the healing process. The free surface of the intracolonic ileal segment became covered by the sliding mucosa of the colon and the prolapsing mucosa of the ileum. The following could be concluded after the experiments: The inner pressure tolerance of a telescopic ileocolostomy promptly after preparation is better than in case of another single-layer anastomosis. This fact results in increased safety against leakage on the first postoperative days. The inner pressure tolerance of the telescopic ileocolostomy increases during the healing process and it does not depend on the length of the invaginated part (0 day–20 mm: 56 mmHg ± 6, *Group A:* 252 ± 39, *Group B:* 154 ± 19, *Group C:* 249 ± 20, *Group D:* 298 ± 2). There is no difference in pressure tolerance between the telescopic and the end-to-side single-layer interrupted anastomoses after the healing process. The invaginated section within the lumen of the large intestine does not suffer ischaemic or any other kind of damage. This inexpensive and simple anastomosis technique could be useful in the veterinary surgical practice as well.

Key words: Telescopic anastomosis, ileocolostomy, anastomosis healing

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The history of telescopic anastomosis dates back to the turn of the 19th and 20th century. The method was worked out by Maylard, an English and by Sonnenburg, a German surgeon independently of each other. They performed ileocolostomy using telescopic technique for the first time (Moore and Forrest-Hamilton, 1953). They invaginated a 15–20 cm long section of the ileum with its mesentery into the large bowel. The first surgeon performing telescopic anastomosis for colocolostomy was Grekov (Guleke, 1955). After division of vessels a long section of intestine was invaginated into the aboral bowel stump using two or three suture lines. The bowel section which was dissected from its blood supply necrotised and left per vias naturales. Nowadays a 10–20 mm long mesentery-free section of the oral bowel is invaginated into the aboral one using single-layer interrupted suture line. The blood supply of the short invaginated section is provided by the submucosal vascular network. Numerous Hungarian authors have reported favourable experience with telescopic anastomoses (Kopasz, 1964; Kun et al., 1975; Mencser and Tóth, 1975; Krasznay et al., 1998). In our practice, the telescopic anastomosis technique is successfully applied in humans for ileocolostomy, oesophagogastrostomy and oesophagojejunostomy as well (Szűcs et al., 1999).

This method could be useful also in the veterinary surgical practice, when performing bowel resection and ileocolostomy for neoplasia or other obstructive bowel diseases (Aiello, 1998).

We tried to get a clear picture of the healing process of telescopic anastomosis in our experiments since data concerning this could not be found in the literature. We looked for answers to the following questions:

– What happens to the invaginated part of the ileum within the lumen of the large bowel?

– Is there any significance of the length of the invaginated bowel section?

– How does the pressure tolerance of the anastomosis change during the healing process?

Materials and methods

Mongrel dogs were used for the experiment (with the licence of The University of Debrecen, Committee of Animal Research, licence number: 66/99 CAR). Twelve animals divided into 4 groups were used:

Group A (n = 3): Type of anastomosis: end-to-side ileocolostomy. This was the so-called ‘0 mm invagination’ group. Survival time was 21 days.

Group B (n = 3): Type of anastomosis: end-to-side telescopic ileocolostomy. The length of the invaginated part was 20 mm. Survival time was 7 days.

Group C (n = 3): Type of anastomosis: end-to-side telescopic ileocolostomy. The length of the invaginated ileum part was 10 mm. Survival time was 21 days.

Group D: (n = 3) Type of anastomosis: end-to-side telescopic ileocolostomy. The length of the invaginated part was 20 mm. Survival time was 21 days.

The 12 dogs proved to be healthy on veterinary examination. Physical and laboratory examinations were done and all dogs were dewormed (Aniprantel® 1 tablet/10 kg). One day before the operation the animals were on fluid diet and received a laxative (1 ml/kg oleum paraffini). They were allowed to drink water *ad libitum*. Preoperatively a single dose of antibiotic prophylaxis was applied (Aktil®, amoxicillin-clavulanic acid, 20 mg/kg intravenously 1 h before the operation). Intratracheal intubation with a combination of $N_2O + O_2$ and intravenous Ketamin®-Rometar® were used as general anaesthesia (after 0.04 mg/kg atropine premedication, Ketamin 10 mg/kg and Rometar 1 mg/kg by intramuscular application as induction dose, then intravenous boluses every 15–30 min as maintenance depending on the physiological parameters monitored).

Median laparotomy was performed in each case. After performing appropriate division of vessels the small bowel was sutured using UKL-60 stapler and transected just before the ileocolic junction. The instrumental suture line was covered with a layer of interrupted suture.

End-to-side single-layer ileocolostomy was prepared in the three dogs of Group A. The stitches involved the mucosa as well, and the knots were inside.

Telescopic anastomosis was prepared in animals of Groups B, C and D.

According to the length of bowel that we decided to invaginate, the 10 mm or 20 mm long distal section of the ileum was divided from its mesentery. Bleeding from the submucosa was stopped by using electrocoagulation or fine ligations. Then at the borderline of the division of vessels and 2–3 cm aborally from the original junction the ileum was sutured to the large bowel using interrupted seromuscular stitches. In that way the posterior wall of the suture line was ready (Fig. 1a). Four mm from the suture line and parallel to the latter, the lumen of the large bowel was opened (Fig. 1b). The bleeding from the submucosa was stopped carefully. The vessel-free section of the ileum was inserted into the large bowel. The anterior suture line and in this way the anastomosis were prepared by performing stitches 4 mm far from the anterior wound side of the large bowel (Fig. 1c). The knots were tied outside the lumen (Fig. 1d). The schematic drawing of the section of an anastomosis can be seen in Fig. 2. The distal 20 mm long part of the ileum lies freely in the lumen of colon. The wall of the large bowel encircles the ileum like a 4 mm wide belt. The stitches do not drain the lumen directly. Atraumatic, 3/0 absorbable monofil Monocril® suture material was used. It was important that the stitches did not contain the mucosa. After reconstructing the free ends of the mesentery the abdominal cavity was closed. The animals were cared for and observed by veterinarians in the postoperative period. Analgesics were applied every four hours on the day of operation and later during the first few days every 6–12 hours (Demalgonil® 2 ml by subcutaneous application). On the first postoperative day the dogs were allowed to drink water, on the second and third days they got fluid nutrition, and later normal nutrition was given gradually. At the end of the previously determined survival time the animals were sacrificed, and the anastomosis was excised with the oral half of the large bowel and the distal 30 cm of the small intestine. Anastomosis leakage did not occur.

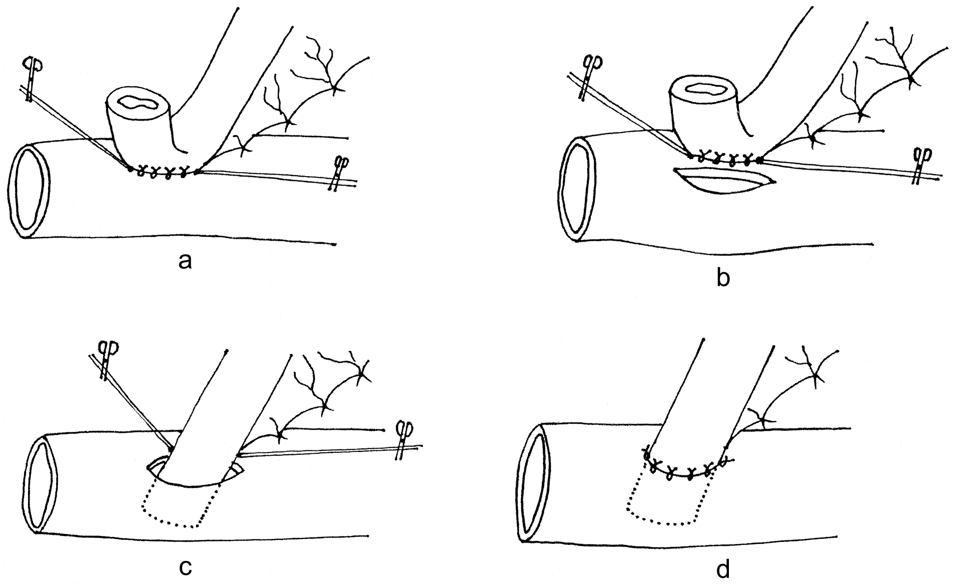

Fig. 1. The steps of performing telescopic ileocolostomy

The anastomosis was excised using UKL-60 linear stapler. The remaining large and small bowels were put into physiologic saline solution.

The stapled suture line of the experimental specimen was covered by a continuous suture line. The small bowel was connected to the bursting pressure measuring system 40 mm far from the anastomosis. The preparation with the anastomosis was immersed into physiologic saline solution and insufflated with CO_2 gas. A sphygmomanometer was connected with a T-shaped plug to the insufflator tube. The pressure at which the first gas bubble appeared from the anastomosis line or the disruption occurred was recorded as the bursting pressure (mmHg). Later the preparation was opened and the anastomosis was examined, then it was fixed in 10% formaldehyde solution. Paraffin embedding was used for the purpose of histological studies and longitudinally sectioned slides were prepared from the region of the anastomosis. Special staining methods were used besides haematoxylin-eosin staining to identify different types of connective tissue fibres: Masson's trichrome staining for collagen fibres identification, Van Gieson's elastica (Hart) staining for identifying elastic fibres, and silver impregnation for identifying reticular fibres.

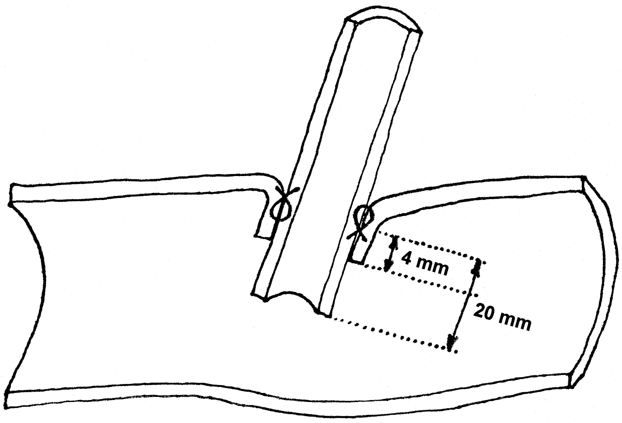

Fig. 2. Schematic drawing of the section of telescopic ileocolostomy

The look-alikes of anastomosis were performed as control group using the above-mentioned large and small intestine remnants (so-called '0-day anastomosis'). These anastomoses were prepared by the same method and using the same suture material like in the surviving groups. The immediate ('before-healing') bursting pressure was measured on these preparations.

We applied '*t*' test for statistical evaluation using Microsoft Office Excel 97 software. P values less than 0.05 were regarded as statistically significant.

Results

The length of the invaginated ileal section, the survival times, the average bursting pressure, the standard deviations and the P values calculated during the comparison of the average bursting pressure data between different types of anastomosis are shown in Table 1. 0-day groups are marked with identical small letters.

The average bursting pressure of anastomoses on day 0 (Groups b, c, d) was between 47 and 56 mmHg. The average bursting pressure of 0-day end-to-side single-layer interrupted anastomoses (Group a) was only 26 mmHg, which is significantly lower than in the case of telescopic anastomoses (Table 1/I).

The length of the invaginated ileal part was the only difference between Group c (10 mm) and Group d (20 mm). The detected bursting pressures were approximately equal in Groups b, c, and d (Table 1/II). The length of the invaginated part had no effect on the bursting pressure just after performing the anastomoses (0-day groups).

Table 1

Average bursting pressure data of different kinds of ileocolostomy and their comparison

Group	n	Survival time (days)	Length of invaginated section (mm)	Average bursting pressure values			
				mmHg	SD	kPa	SD
A	3	21	0	252	39	33.19	5.13
a	3	0	0	26	2	3.42	0.26
B	3	7	20	154	19	20.53	6.44
b	3	0	20	56	6	7.46	0.79
C	3	21	10	249	20	32.76	2.63
c	3	0	10	47	4	6.26	0.53
D	3	21	20	298	2	39.72	0.27
d	3	0	20	48	4	6.39	0.53

The compared pairs of groups and the calculated P value (in parentheses): **I. a↔b** (0.007)*; **c** (0.013)*; **d** (0.028)*; **II. c↔d** (0.339); **b** (0.218); **III. B↔b** (0.020)*; **c** (0.007)*; **d** (0.006)*; **IV. B↔C** (0.048)*; **D** (0.006)*; **V. A↔C** (0.926); **D** (0.157); **VI. C↔D** (0.057); *Significant difference

The average bursting pressure of the 7th-day anastomoses (Group B) was 154 mmHg compared with its 0-day analogue which had 56 mmHg bursting pressure. This difference was statistically significant (Table 1/III). The bursting pressure of 21-day telescopic anastomoses (Groups C and D) was 249 mmHg and 298 mmHg, respectively. The difference compared with the 7-day group (Group B) was significant (Table 1/IV). The bursting pressure of single-layer interrupted end-to-side anastomoses (Group A) was 252 mmHg on the 21st day. There was no significant difference between Group A and Groups C and D in bursting pressure (Table 1/V). So the two types of anastomosis could tolerate the same inner pressure on the 21st day.

The bursting pressure measurements of Groups C and D showed that the length of the invaginated part on the 21st day, after the healing process, was irrelevant from this point of view (Table 1/VI).

The macroscopic picture of the anastomosis cannot be characterised by numbers, only some tendencies can be reported. By the 7th day, the outer surface of the ileum within the lumen of the large bowel was not free. Its surface was covered by the prolapsed mucosa of the ileum and the 'sliding' mucosa of the large bowel. Macroscopically the two mucous membranes joined circularly, they were swollen and oedematous. Extreme signs of inflammation were not noticed. By the 21st day oedema had disappeared (Fig. 3). The healing process was complete concerning 10 mm and 20 mm long invaginated sections of the ileum. The Group A anastomoses also showed a complete healing without any disorder.

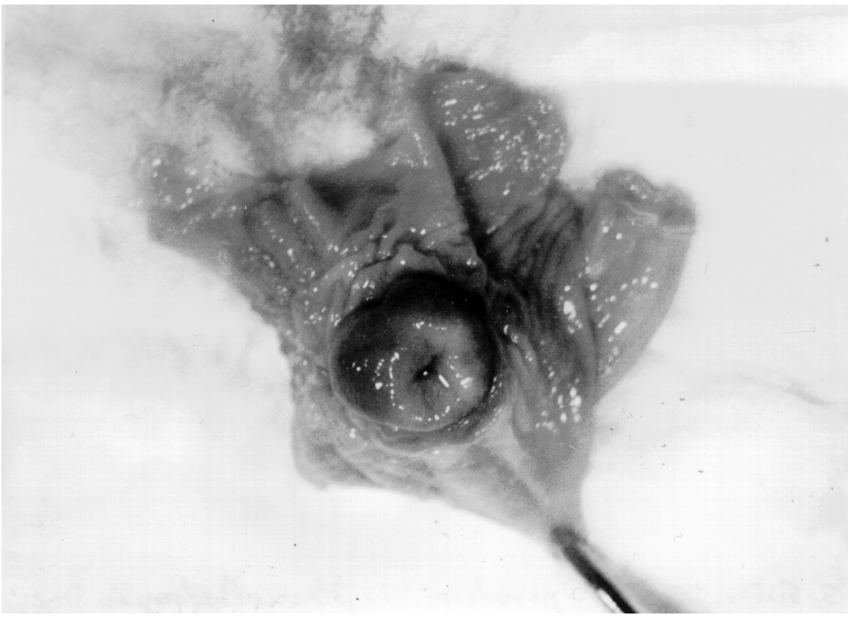

Fig. 3. The macroscopic picture of telescopic ileocolostomy on the 21st day

Fig. 4. The connecting area of the ileal and the colonic mucous membranes on the 21st day. The joining of the two mucosae is undisturbed. Longitudinal section, haematoxylin and eosin, original magnification × 100

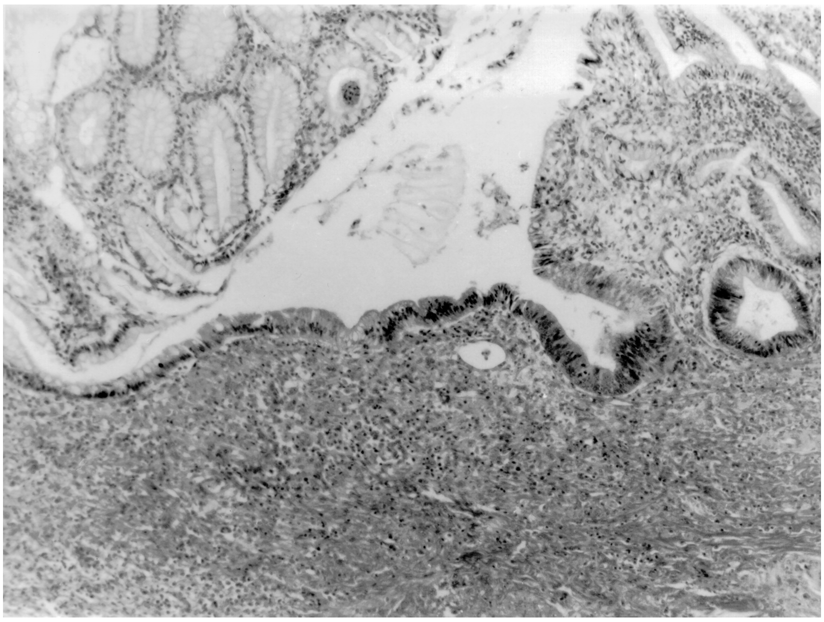

Fig. 5. The connecting area of the ileal and the colonic mucosae on the 21st day. Between the two mucosae a regeneration tissue has appeared. Longitudinal section, haematoxylin and eosin, original magnification × 100

During our histological studies we concentrated on the meeting surfaces of the anastomosed organs, the free surface of the ileum lying within the lumen of the large bowel, and the processes occurring at the joining of the two mucosae. The serosal layers of the anastomosing intestines on the inverted wall of the large bowel and on the external surface of the invaginated small bowel were not identified by the 7th day. Granulation tissue appeared between the muscular wall of the large and that of the small bowel. Collagen fibres could be detected within the granulation tissue on the 7th day, but on the 21st day the reticular and elastic fibres were dominant. Neither ischaemic damage nor inflammatory signs were noticed in the invaginated ileal section. The external surface of the invaginated ileum was covered with the sliding mucosa of the large bowel and with its own prolapsed mucosa. In ideal cases the ileal and colic mucosae met each other on the surface of the ileum (Fig. 4). In those regions where the joining did not occur, mucosal regeneration filled the gap (Fig. 5). First of all the mucus-producing glandular epithelium appeared on the free surface, followed later by the deeper layers of the mucosa. During the process of regeneration, the small intestine showed the greatest activity. Mucosal regeneration was complete by the 7th day in one of the anastomoses. This process was complete in all of the 6 telescopic anastomoses on the 21st day. The three end-to-side anastomoses also showed an undisturbed healing process by the 21st day.

Discussion

The technique of telescopic anastomosis is advantageous because the intraluminal pressure at the suture line presses the organs' walls to each other rather than forcing open the sutured region. The piercing channels of sutures do not drain the lumen. These structural characteristics increase the safety of the anastomosis during the first postoperative days (Moore and Forrest-Hamilton, 1953; Kopasz, 1964; Kun et al., 1975; Mencser and Tóth, 1975; Krasznay et al., 1998). The telescopic oesophagogastrostomies and oesophagojejunostomies can tolerate higher internal pressures promptly after their preparation than any other type of single-layer interrupted anastomoses. This has been proven in our experiments on porcine models (Szűcs et al., 2001).

In our recent experiment the 0-day telescopic anastomosis (Groups b, c and d) showed significantly higher bursting pressure data than the end-to-side single-layer interrupted anastomosis (Group a). Ability of the anastomosis to tolerate the internal pressure immediately after its preparation without losing its integrity is only one of the most important conditions of undisturbed healing.

On the other hand, the structure of telescopic anastomosis can cause concern. The identical layers of anastomosed organs do not lie close to each other, they are at a certain distance from each other. In the case of telescopic ileocolostomy, the distance between the wound ends depends on the length of the invaginated ileal part. The external surface of the invaginated ileum comes into direct contact with the intestinal contents. In such circumstances, this might lead to severe healing disturbances. According to our clinical experience, this does not occur.

Telescopic anastomoses showed minimal complications of healing with good functional result. Our animal experiments proved this. What seemed to be problematic was the behaviour of the ileal segment within the lumen of the large intestine. The colonic mucosa covers the external surface of the invaginated small intestine. This is possible because of the loose submucosal layer. The colonic mucosa with its submucosa slides forward onto the small intestinal muscular wall. Similarly, the small intestinal mucosa with its submucosa prolapses from the lumen and meets with the above-mentioned large intestinal sliding mucosa. However, mucosal regeneration was needed occasionally and only on a small section of the circumference.

Our opinion is that the 'sliding' mucosa plays a key role in the healing process of the telescopic anastomosis. The large intestinal mucosa-submucosa layer which slides forward onto the wall of the invaginated small bowel soon isolates completely the meeting surfaces of the anastomosed organs and thus the suture line becomes isolated from the colonic lumen. Ideal conditions develop in this isolated region that can help the healing process. After the healing process, the mucosal overlay gives protection for the invaginated section against the surrounding aggressive, foreign environment. According to our knowledge there is no primary wound healing in the gastrointestinal tract (Török and Karlinger, 1958; Langer et al., 1974; Langer and Kupczyk, 1982; Garth and Ballantyne, 1984; Lündstedt et al., 1993). Inflammation is always identified in the line of the anastomosis, especially in the submucosa. The advantage of the single-layer suture line is that the structure of the wound is simple, and the inflammatory exudates can pass out through the wound sides (Török and Karlinger, 1958; Langer et al., 1982; Harder and Kull, 1987; Lündstedt et al., 1993; Zoedler et al., 1995). These conditions are provided by telescopic anastomosis as well, but the sliding process of the mucosa-submucosa excludes the suture line from the inflammatory region. In a conventional anastomosis the inflammatory process involves the suture line directly and endangers it until the complete healing of mucosa. We invaginated a 10–20 mm long section of the ileum. The length of the invaginated part was 20 mm in animals that survived 7 days. According to our observation, the mucosa completely overlay the invaginated section by the 7th day, although histologically this process was complete only by the 21st day. In the clinical practice it is unnecessary to invaginate an ileal section longer than 10–15 mm. The shorter the invaginated section, the lower the risk of circulation disturbances in the invaginated bowel part. Many researchers think that the telescopic anastomosis works as a valve preventing the back-flow of the intestinal contents. In case of ileocolostomy it could substitute for the function of the ileocaecal valve (Kopasz, 1964; Mencser and Tóth, 1975; Langer and Kupczyk, 1982). From this point of view, a longer invaginated ileum section may be advantageous. Further examinations would be needed to clarify this. The length of the invaginated part within the range of 20 mm was irrelevant in respect of the healing process. The invaginated intestine does not suffer any damage. Similar bursting pressure data can be recorded independently of the length of the invagination both after preparing the anastomoses and in the 21st day anastomoses. Pressure tolerance gradually and significantly increases between days 0–7 and 7–21. Based on the data of different authors we can conclude that by the 6th–7th days the bursting pressure reaches 60–80 percent of that on the 14th–21st days (Souchon et al., 1982; Egger et al., 1998; Rabau et al., 1998; Shashidharan et al., 1999). This tendency can be proved in ileocolostomies as well. The difference which can be measured in the bursting pressures to the advantage of telescopic anastomosis on day 0 cannot be realised on the 21st day in the completely healed anastomoses.

In summary, we can conclude that in case of using 10–20 mm length of invaginated section:

– The inner pressure tolerance of a telescopic ileocolostomy promptly after its preparation is better than that of any other single-layer anastomosis. This fact results in increased safety against leakage on the first postoperative days.

– The inner pressure tolerance of the telescopic ileocolostomy increases during the healing process and it does not depend on the length of the invagination.

– There is no difference in pressure tolerance between the telescopic and the end-to-side single-layer interrupted anastomoses after the healing process.

– The invaginated section within the lumen of the large intestine does not suffer ischaemic or any other kind of damage.

– The distance between the wound ends of the anastomosed organs does not disturb the healing process of this type of anastomosis.

– The forward sliding of the colonic mucosa onto the surface of the ileum forms a mechanical and a biological barrier. It protects the suture line from the intestinal contents. Although inflammatory reaction is always noticed, this does not come into direct contact with the suture line.

– The mucosal overlay provides protection for the invaginated bowel section after the healing process.

On the basis of our observations and results we think that this inexpensive and simple anastomosis technique could be useful in the veterinary surgical practice as well.

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