

دراسة تأثير الخيوط الجراحية الكات جت والنايلون والحرير ذات
السلك الواحد على عملية التئام الأمعاء الدقيقة بعد ازالة جزء منها
وتوصيله بهذه الخيوط

للككتور م . الجندي واللككتور م . ا . الشرى واللككتور م . ت . سامى

الملخص

أجرى البحث على ثلاثة مجاميع من الكلاب كل منها مكون من ١٨ حيوان لكل نوع من
الخيوط .

قسمت كل مجموعة الى ثلاثة مجاميع أخرى (كل مجموعة من ستة حيوانات) لدراسة
عملية الالتئام فى الأزمان الآتية : ٧ أيام ، ١٥ ، ٣٠ ، ٤٠ يوم .

وقد أعطت خيوط الكات جت أحسن النتائج بالمقارنة الى خيوط النايلون والحرير .
وكانت ظاهرة الالتهاب بسيطة مع عدم وجود تغيرات مرضية فى الأنسجة المنتهية وكانت عملية
الالتئام كاملة بعد ١٥ يوم من اجراء العملية مع ذوبان وامتصاص هذه الخيوط تماما .

بعد مضي شهر من اجراء العملية عاد قطر تجويف الأمعاء وسلك الجدار عند مكان
العملية الى وضعها الطبيعى .

ويمتاز الكات جت أيضا عن الخيوط الأخرى بأنه يسبب أقل بروز من الأنسجة عند
مكان العملية داخل تجويف الأمعاء .

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THE INFLUENCE OF DIFFERENT SUTURE MATERIALS ON THE HEALING PROCESS OF INTESTINAL ANASTOMOSIS IN DOGS

(8 illustrations)

By

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SUMMARY

The influence of 4/0 plain catgut, 4/0 silk and 4/0 nylon suture materials, on the process of repair of the inverting end-to-end intestinal anastomosis were studied in three groups, each of 18 dogs, examined at intervals of 7, 15, 30 days.

The catgut suture material was superior than nylon and silk in that, it causes the least cellular reaction and undetectable tissue alteration. The healing process was completed at 15 days at the end of which the catgut was completely absorbed. At the end of one month the intestinal diameter, wall thickness, lumen diameter at the operation site returned to normal. Catgut caused the most smallest diaphragm inside the lumen of the intestine.

INTRODUCTION

In the field of experimental surgery, the effect of the suture materials are of great importance in studying the healing process of the gastro-intestinal tract. Different suture materials like catgut, silk, dacron, reconstituted collagen, nylon and cotton were used.

HAXTON (1965) found that catgut loses rapidly its tensile strength and was accompanied by intensive inflammatory reaction. The author stated that silk is better than catgut for gastro-intestinal surgery. Dacron used by GETZEN, ROE and HOLLOWAY (1966) caused few adhesions, while silk provoked numerous filmy adhesions, both in the mesentery and around the incision. REYNOLDS (1966) found that the reconstituted collagen sutures showed early separation, fragmentation and hyper fiberilosis about the sutures.

ADLER, MONTES, DAYER and HARROD (1967) were of the opinion that reconstituted collagen fibers was superior than catgut in that it was more rapidly absorbed and shorten the period of reaction. GRIER (1968) used cotton and recorded that it causes foreign body granuloma.

In the light of these conflicting results, the aim of this work was to evaluate the influence of catgut, nylon and silk on the healing process of inverting end-to-end intestinal anastomosis in dogs.

MATERIALS AND METHODS

54 clinically healthy dogs one to three years old, with body weight ranging from 15-25 Kgm were selected at Assiut province. The dogs were divided into three main groups, (each of 18 animals) depending upon the type of suture material used.

The suture materials used were 4/0 plain catgut, 4/0 silk and 4/0 nylon. Each of the previous groups was further subdivided into three groups, each of six dogs, depending upon the intervals of tacking the specimens for macroscopical and histopathological study (7, 15 and 30 days).

Inverting end-to-end method of intestinal anastomosis operations were carried out on the surgery department. The animals were sacrificed on the 7th, 15th, 30th day following the operations.

Small pieces for longitudinal and transverse sections of the intestine, from the site of anastomosis were fixed in neutral buffered formaline. The specimens were dehydrated and embedded in paraffin. Thin sections of 7 microns were cut and stained by heamatoxylin and eosin Van gieson stain for histopathological examination.

RESULTS

Grossly, the following indexes were inspected for the intestinal changes at the operation site : adhesions, intestinal diameter, wall thickness, diameter of the intestinal lumen, size of inverted flange and the absorption of the suture materials.

Adhesions between the omentum and the enveloped part of the intestine at the suture line of anastomosis were observed. In the catgut group, the adhesions were very slight in all cases with the exception of one strong case after seven days. After 15 days, they were very slight and smooth. At the end of one month, adhesions were very smooth.

In the nylon group, slight omental adhesions were detected in the three groups of 7, 15 and 30 days.

In the silk group, the adhesions were moderate after 7 days, slight to moderate after 15 days and slight after 30 days.

Other types of adhesions between the omentum and the laparotomy wound and between the intestinal loops were recorded in few exceptional cases, in the three groups of different suture materials.

The diameter of the bowel, at the operation site was increased in comparison with the normal adjacent caudal part. In the catgut group, the ratio of this increase was 1.4 : 1 after 7 days. After 15 days the increase was moderate in half numbers of animals and slight in the other half with ratio of 1.2 : 1. After one month, the diameter at the seat of anastomosis was nearly the same diameter in comparison with the adjacent caudal part.

In the nylon group, the increase of diameter was slight reaching average ratio of 1.5 : 1.3 after 15 days. At the end of one month, half of the cases were normal, while the other half showed increase in the diameter in a ratio of 1.6 : 1.3.

In the silk group, the ratio of increase was 1.5 : 1.1 after 7 days. After 15 days the diameter increased reaching about 1.11 times as that of the adjacent posterior part. After 30 days the ratio was 1.3 : 1. The cranial part of the intestine near the operated area was found to be dilated about 1.25 times as the seat of anastomosis.

The wall of the intestine at the area of anastomosis was increased in thickness, with the formation of very small fibrous layer between the serosa and the muscle layer.

In the catgut group, the increase in thickness was moderate after 7 days, slight after 15 days. At the end of one month half of the animals showed a return to normal wall thickness, while the other half showed slight thickness.

In the nylon group, the wall was greatly thickened after 7 days. 15 days after operation, there was variation in the increased thickness from slight to moderate. 30 days after operation, the thickness of the wall was slightly increased in all cases, with one exceptional case showing great increase in thickness.

In the silk group, the wall was thickened two times as that of adjacent wall after 7 days. After 15 days the thickness varied from slight to moderate. 30 days later, variable degrees were recorded.

The changes in the diameter of the intestinal lumen showed variations.

In the catgut group, 3 cases showed slight narrowing of the lumen at the operation site. The other cases showed moderate narrowing after 7 days. 15 days later, the constriction was slight. At the end of one month, 3 cases presented an equal lumen diameter with that of the neighbouring intestine and the other three were slightly constricted.

In the nylon group, all cases demonstrated moderate stenosis at the suture line with dilatation cranial to this line. After 15 days, half the cases showed only moderate stenosis, with the presence of mucosal folds. In the other half the constriction was slight. After 30 days, half the cases were of normal diameter, while the other half showed slight constriction.

In the silk group, the degree of constriction varied. It was great after 7 days, lesser after 15 days and moderate 30 days later.

The inverted tissue at the operation area, resulted in the formation of moderate flange.

In the catgut group, 7 days after the operation, a small to moderately large inverted flange was observed. While 15 days later, half of the group showed a very small flange. The other half showed the presence of a faint small cuff of tissue in some areas, and complete absence of the flange in the other areas. At the end of one month the flange was very small in two cases. Other two cases showed absence of the inverted tissues in an area and its presence in other areas. The other two cases were normal.

In the nylon group, there was a moderate sized diaphragm after 7 days in all the cases. 15 days later, this flange was moderately large in four cases and small beginning to slough on the other two cases. After 30 days, the flange decreased in size and thickness as becoming very small and nearly absent in some areas.

In the silk group, a moderate flange was present after 2 days. The flange was not uniform along the anastomotic attachment after 15 days. 30 days later, the gross fibrous tissue led to loss of normal architectural folding of the mucous membrane.

The absorption of the suture materials differed among the groups. The catgut suture materials were not observed macroscopically at the end of seven days.

The fine nylon suture materials were seen intact at the line of anastomosis on the mucous membrane with difficulty up to 15 days. After 30 days the nylon suture materials were seen grey in colour, loose from the anastomosed mucous membrane and escaping towards the lumen of the bowel.

The silk suture materials were found in position and appeared to be lightly tied on the inverted flange after 7 days. After 15 days, it was slightly loose and beginning to protrude inside the lumen. After 30 days it disappeared from the intestinal wall and escaped towards the lumen.

The Results of Histopathological Examination :

The catgut groups : 7 days after the operation, the healing processes were occurring on background of inflammatory reaction, which started mainly in the serosa. The serosa all over the intestinal diameter were thickened. The blood vessels were diffusely hyperaemic. Heavy polymorphonuclear infiltration was seen, diffusely and in aggregation around adipose cells and blood vessels. Over the area of junction, the serosa were highly expanded, where active proliferative processes started with the formation of highly vascular, highly cellular granulation tissue. The direction of the granulation extends and merged to construct the continuity of the reunited tunics ; muscularis, submucosa, muscularis mucosa. In some cases the proliferating granulation were not completely healthy, but foci of myxomatous degeneration and foci of suppuration were seen.

The smooth muscle fibers of the tunica muscularis fail to regenerate. Muscular necrobiosis were observed at the region of junction. The continuity of the musculosa was reconstructed by mature granulation.

The submucosa manifested hyperaemia, oedema, foci of haemorrhages, disorganization of connective tissue fibers as well as polymorphonuclear cell infiltration. At the area of junction active granulation were prominent. The tunica muscularis mucosa failed to regenerate.

In five cases the mucosa were not reconstructed. There were still a defect of the mucosa at the tip of the flange over the area of junction. Remnants of destroyed necrobiosed intestinal glands and surface epithelium were seen. Cattahral inflammation was seen in the mucosa in the neighbourhood of dissection (Fig. 1).

In one case simple columnar epithelium arising from the near by remnant of intestinal glands regenerated and crept to cover the defect over the flange (Fig. 2). The catgut stitches were observed through the serosa, muscularis, submucosa. The stitches were encapsulated by granulation tissue rich in polymorphonuclear leucocytes. The degree of disintegration and absorption of the stitches differed. Some stitches were intact but attacked by polymorphonuclear leucocytes (Fig. 3), others were fragmented. A third variety was completely absorbed leaving an empty space filled by macrophage cells.

After the end of fifteen days, the granulation tissue reconstructing the serosa, muscularis, submucosa and muscularis mucosa were more mature as indicated by decrease vascularity and cellularity, while the fibrocytes and collagen bundles predominated. The inflammatory process of the serosa became subacute.

In one case the submucosa contained glandular inclusions, composing of several cross sections of detached intestinal glands. Some of these glands were cystically dilated and lined by flattened epithelium (Fig. 4). The lamina propria inbetween these glands was rich in leucocytes. In another case the glandular inclusions were extending to muscularis.

Regenerated simple epithelium, in some places stratified crept from near by intestinal gland to cover the mucosal defect. The architecture of villi formation was lost. The majority of intestinal glands were destroyed (Fig. 5).

Thirty days following operation fibrous tissue scar was establishing the continuity of the serosa, muscularis and muscularis mucosa. The mucosa was regenerated in five cases, but in one case it failed to regenerate, and the continuity was established through fibrosed lamina propria. Chronic inflammatory cells infiltrate the mucosa in general.

At the end of one month, failure of smooth muscles of the tunica muscularis and muscularis mucosa to regenerate was established. In two cases the submucosa contained cystic glandular inclusions and aggregations of lymphoid follicles. No evidences of the catgut stitches were seen at the end of one of month. Inversion of the mucosa at the area of approximation on the tip of the flange was observed in one case and resulted in approximation of mucosa-to-mucosa contact (Fig. 6).

The groups of the nylon suture material :

It was evident in these groups that the alterations were comparatively sever than those of the catgut groups. Microscopic heamorrhages were detected in the serosa. Even the proliferative granulation was more embryonic as it was composed of fibroblasts and capillary net on back ground of homogenous substances. The appearance of collagen fibrillae was retarded. The tunica muscularis suffered from hyline destrophy and necrobiosis. In one case, the musculosa demonstrated micro-absesses in the region of the flange. The submucosa all over was hyperaemic and dialated in patches by serous exudate and inflammatory cells. The tunica muscularis mucosa failed to regenerate. The mucosa was severly destroyed over the junction of the flange. The mucosa adjacent to the junction showed inflammatory reaction, but mucous dystrophy was a general character of the whole mucosa.

The nylon stitches were intact through the different tunics. The stitch was composed of several nylon fibers in cut section and surrounded by wide zone of granulation.

At the end of 15 days, the granulation tissues reuniting the intestinal tunics was more fibrous. The nylon stitches were still intact. The serosa over the junction was thickened by granulation rich in lymphocytes. The tunica muscularis suffered proteinous dystrophy, focal histocytic proliferation was found between the muscle fibers all over the diameter of the intestine. The mucosal reconstruction was not complete over the junction of the flange. In part the mucosa was defective on bare muscularis mucosa. In other part simple columnar epithelium creeped to cover the submucosa which contains glandular inclusion.

At the end of 30 days, the nylon stitches were not absorbed. The majority of the stitches were encapsulated by fibrous connective tissue capsule (Fig. 7). Other stitches were surrounded by suppurating granulation. The connective tissue reuniting the intestinal tunica, although mostly composed of mature fibrous tissue, but still preserving area of highly cellular granulation. The mucosa was constructing the flange in four cases. In two cases, the mucosa failed to regenerate. The construction of the mucosa was not typical as it lost its villar architecture. It only contained deformed remnant of intestinal glands. Submucosal inclusions were common.

The groups of silk suture :

In this group, the inflammatory reaction after seven days was sever in all the intestinal layers. This was demonestrated by richness of the neutrophilic infiltrations and the well pronounced degenerative changes in the

intestinal tunica. The granulation tissue constructing the continuity of the intestinal tunics was highly cellular, specially rich in neutrophiles. The mucosa in most cases was not constructed over the junction. In one case, the junction result in infolding of the mucosa. In this infold, regenerated columnar epithelium was seen, where in some places it was stratified. The silk stitches appeared as microabscesses, the core of which is unabsorbable silk (Fig. 8).

After the elapse of fifteen days, the granulation tissue was still highly vascular and highly cellular. Most of the stitches were encapsulated by very thick granulation tissue, which were studied by massive numbers of neutrophiles. Few stitches were encapsulated by mature fibrous capsule. The mucosa was not constructed in four cases. In one case, it was covered by simple epithelium.

At the end of one month, suppurated stitches were still present. The intestinal tunica were united by mature granulation, which still manifest areas very rich in polymorphonuclear cells. The mucosa was not reconstructed.

DISCUSSION

It was evident that the process of repair occurred by substitution. Active proliferative process began within 7 days in the serosa, with formation of young highly vascular, highly cellular granulation. It construct the continuity of the reunited tunica, muscularis, submucosa and muscularis mucosa. In our experiment, the muscle fibers of the tunica muscularis and muscularis mucosa failed to regenerate up to one month. This do not agree with the work of MALL (1896) and FLINT (1917) who claimed that muscularis mucosa regenerated after 21 days and 23 days respectively.

The epithelial regeneration started at the 15th day and was complete at one month. The mucosal reconstruction was atypical as it lost the villar architecture and the intestinal gland formation.

The results of our experiment evaluated catgut to be superior than nylon and silk in many aspects.

Catgut suture material intiated the least cellular reaction, and undetectable tissue alteration. The maturation of granulation tissue was complete at 15 days. The absorbtion of catgut stitches started at the 7th day and was completed at the 15th day. The epithelial regeneration and regeneration and mucosal reconstruction were completed at the 15th day.

Grossly, at the end of one month, the intestinal diameter, wall thickness, lumen diameter at the operation site returned to normal in the majority of cases. Catgut caused the most smallest diaphragm, which was totally absorbed.

These results agreed with the results of MADDEN'S (1964), WEINBERG (1964), FECHER (1965), BRAND, BROWN and SCHELLER (1966) and KHATER (1973). But objection against the use of catgut were raised by many authors. Catgut caused considerable inflammatory reaction, marginal epithelial cysts (KLOSE and ROSENBAUM-CANNE 1923), abscess formation (GERBODE 1942) and lost rapidly its tensile strength (HAXTON 1965; BRUMBACK and Mc PHERSON 1967).

The nylon suture material initiated moderate inflammatory reaction and slight tissue alteration. The maturation of the granulation was completed at the 15th day. The nylon stitches were unabsorbed and encapsulated by mature fibrous tissue at the end of one month. Some stitches were surrounded by areas of suppuration. The epithelial regeneration and mucosal reconstruction were partial at the 15th day, complete at the 30th day, but not in all cases.

Grossly, the nylon suture material caused moderate increase of intestinal diameter, moderate degree of wall thickness, and fibrosis, considerable lumen constriction and large unabsorbed diaphragm.

POTH and GOLD (1968) advised the use of nylon because of its strength, hardness and working qualities. On the contrary, BENNETT and ZYDECK (1970) stated that nylon stimulated granuloma formation, which may result in obstruction after years.

The silk suture material caused the heaviest inflammatory reaction and the more pronounced tissue alteration. The maturation of granulation tissue was retarded up to 30 days. The silk stitches were unabsorbed. The majority of the stitches were transformed into microabscesses. The rest were unabsorbed and encapsulated by mature fibrous tissue. The epithelial regeneration started at the 15th day in some cases, but mucosal reconstruction was not complete at 30 days in the majority of cases. Suture inclusions were recorded.

Grossly, silk caused the most pronounced omental adhesions, the largest increase of intestinal diameter, the largest degree of wall thickness and fibrosis, the most considerable lumen constriction and the largest unabsorbed diaphragm.

Our results with silk suture materials coincided with the work of many authors in that, silk suture material caused suture inclusions (MARCHAND 1901), delayed healing process (GOULD 1909), lead to the persistence of large fibrous flange (REICHERT and HOLMAN 1925), provoked numerous adhesions (GETZEN *et al.*, 1966) and initiated more inflammatory cellular reaction (BRUMBACK and Mc PHERSON 1967).

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Fig. 1.—Destruction and sloughing of the mucosa over the tip of the flange, 7 days after the operation using catgut. H. and E. (2.5×12.5).

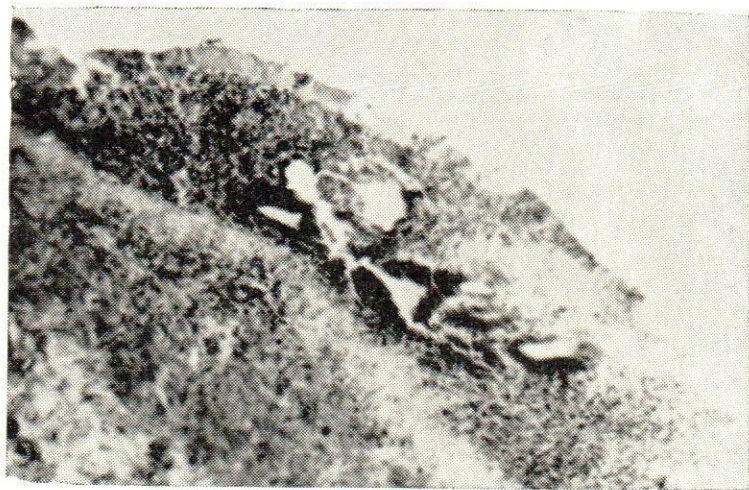
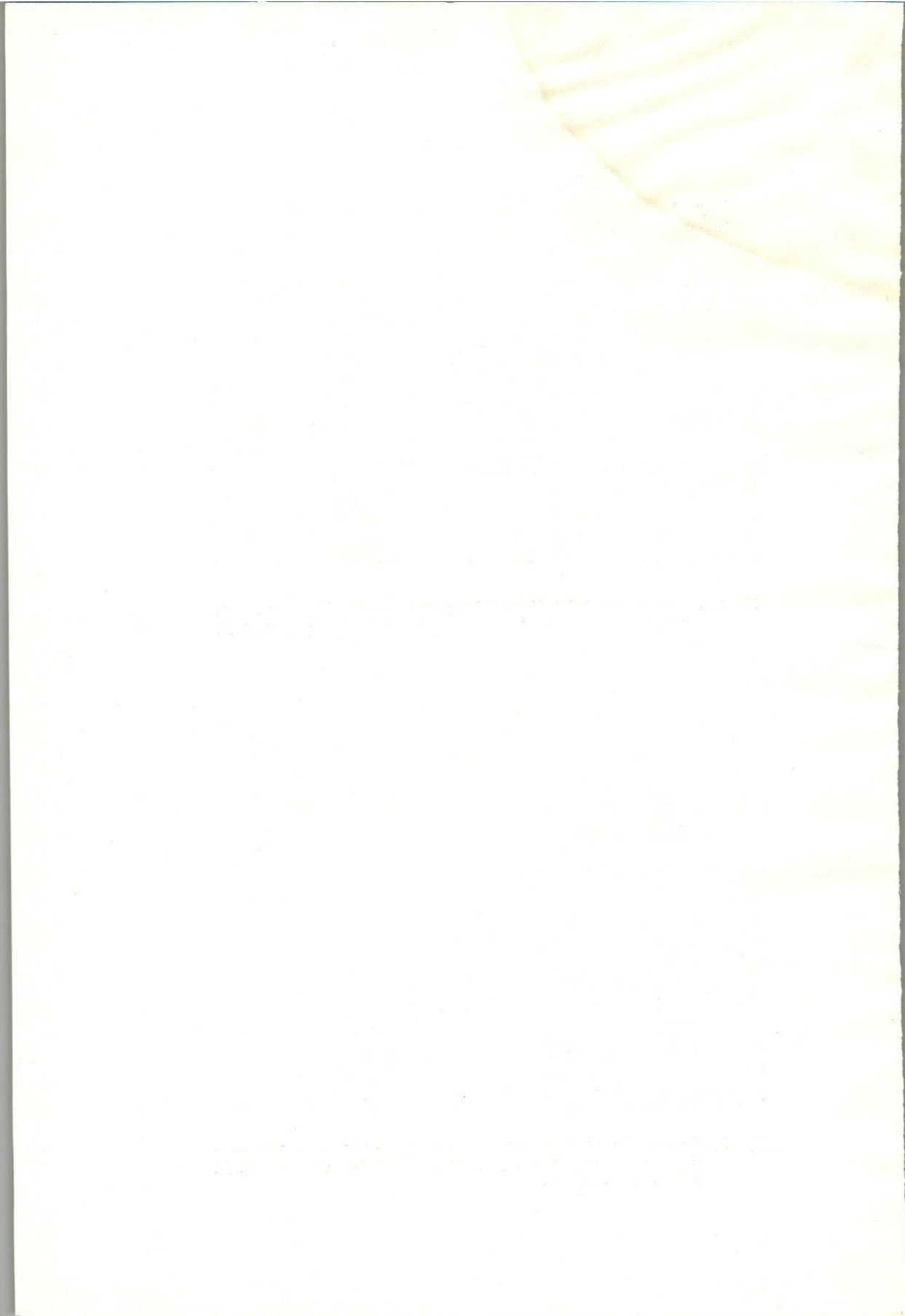


Fig. 2.—Regeneration of simple columnar epithelium which crept to cover the intestinal surface, 7 days after the operation using catgut. H. and E. (10×12.5).



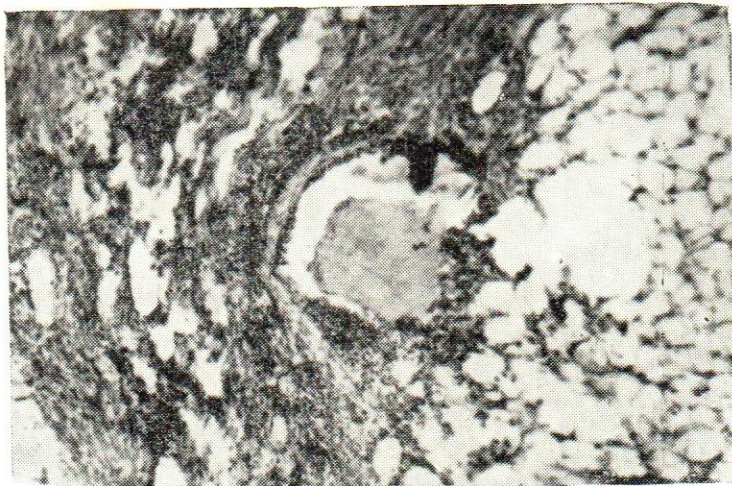


Fig. 3.—Serosal catgut stitch. The serosa is heavily infiltrated by polymorphonuclear cells. 7 days postoperatively. H. and E. (10×12.5).



Fig. 4.—Cystic glandular inclusions in the submucosa. 15 days following the operation using Catgut. H. & E. (2.5 × 12.5)

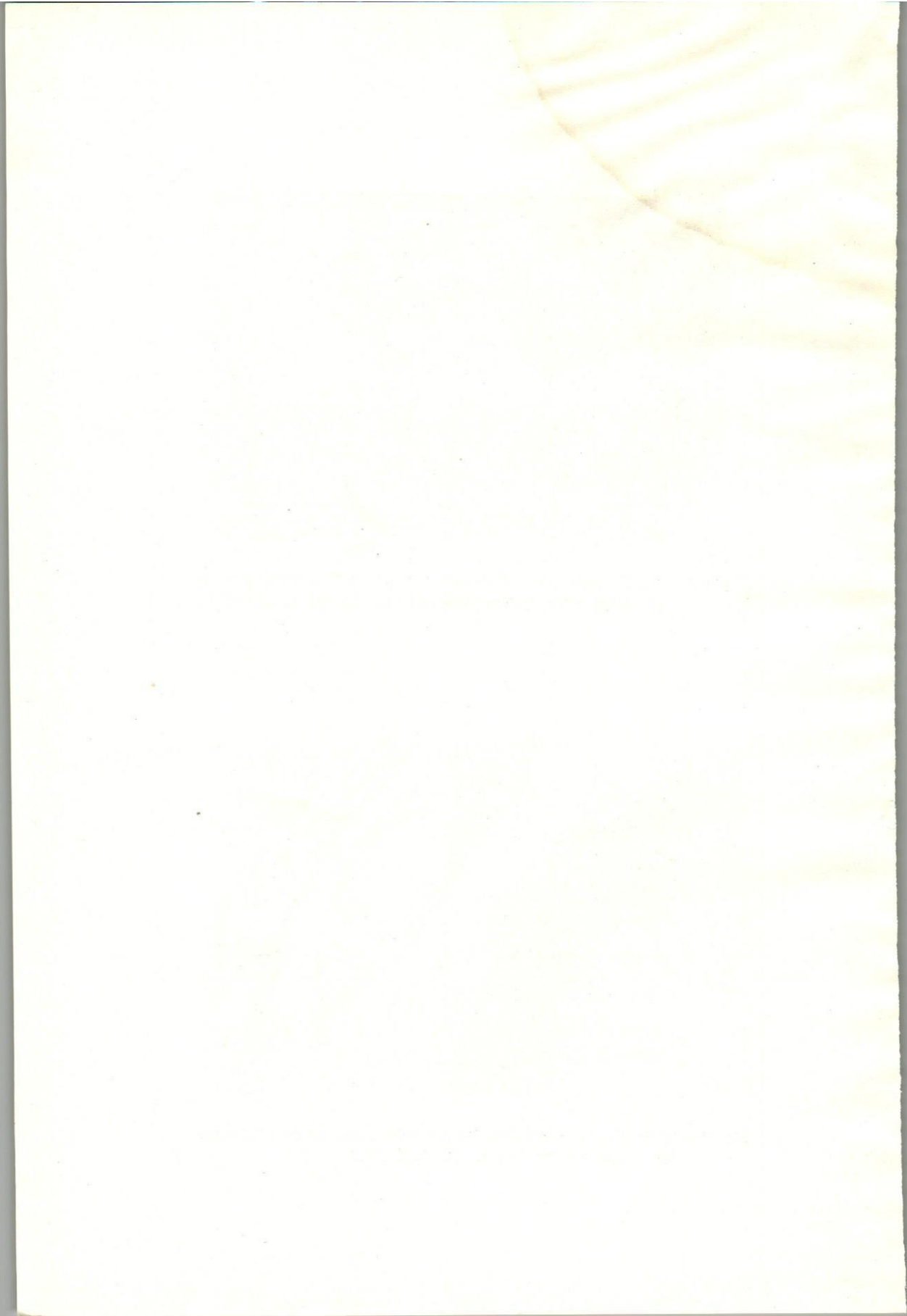




Fig. 5.—A typical reconstruction of the mucosa. The epithelium is regenerated with the formation of simple squamous type. Degeneration of the gland. H. and E. (10×12.5).

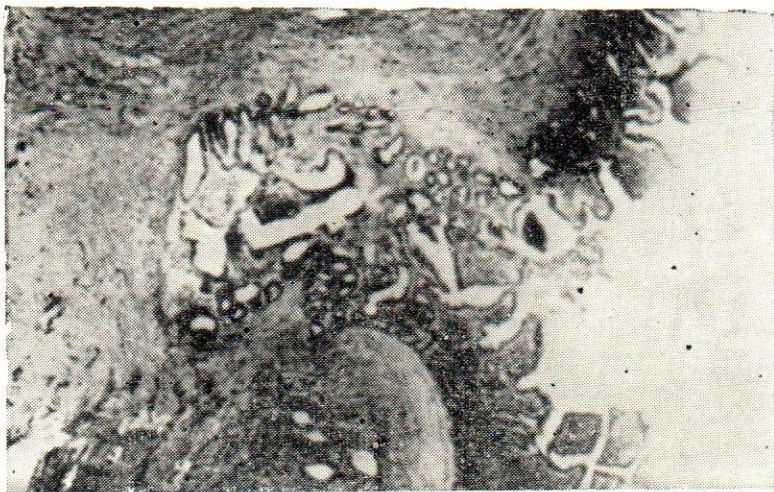


Fig. 6.—Mucosal inversion at the tip of the flange. 30 days following the operation. H. and E. (2.5×12.5).

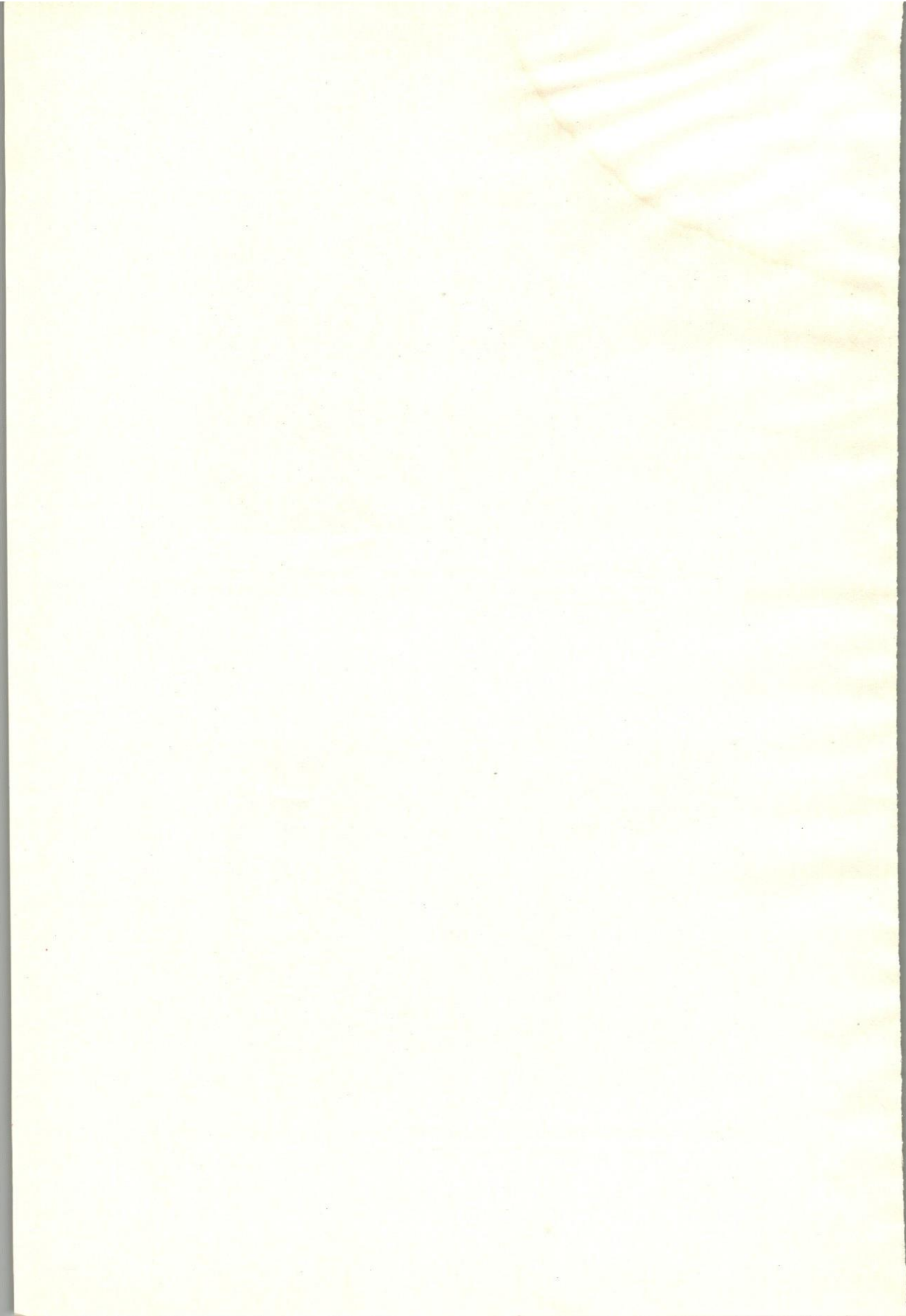




Fig. 7.—Encapsulation of the nylon stitches by fibrous connective tissue. Dystrophic changes of the proliferated granulation. 30 days postoperatively. H. and E. (2.5 × 12.5).



Fig. 8.—Microabscesses surrounding the silk stitches. 7 days following the operation. (H. and E.) (2.5 × 12.5).

