COMPARATIVE EVALUATION OF THE EFFECTS OF A NEW BIOLOGICAL ADHESIVE (COLAGEL) ON THE TENSILE STRENGTH AND HEALING OF INTESTINAL ANASTOMOSES. EXPERIMENTAL STUDIES ON DOGS

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SUMMARY: The effects of a new biological adhesive based on a mixture of gelatin-resorcin and formaldehyde (Colagel) for use as an adjuvant in the reinforcement, impermeabilization and healing of intestinal anastomoses were evaluated and compared to those obtained with omentum fixation, the standard procedure used for this purpose. Two ileal anastomoses were performed in each of 12 experimental dogs using an extramucosal technique and single plane sutures. One of the anastomoses in each animal was covered with adhesive and the other with omentum, in random order. The anastomosed intestinal segments were tested for tensile strength and analysed histopathologically 1, 3, 7, 14, 21 and 28 days after surgery. The tensile strength of the anastomoses treated by the two different procedures was statistically identical. Histopathology revealed normal healing evolution for both procedures on days 1, 3 and 7, and greater exudation in the adhesive group on days 14, 21 and 28 after surgery.

UNITERMS: Experimental surgery of dogs; Intestines surgery, repair

INTRODUCTION

The most varied types of adhesive and suture materials for surgical closure have been tested over the years. Cotton and linen sutures were gradually replaced with synthetic material such as nylon, dacron and polyglycolic acid and polyglactin derivatives (CORREA NETTO [8], 1968; CATTELAN et al. [6], 1980; BARROS [1], 1983). Adhesive materials have also been studied (INOU [10] 1962; O'NEILL et al. [19], 1962; SEINDENBERG et al. [20], 1963; WEILBAECHER et al. [22], 1964; LINN et al. [13], 1966).

Biological adhesives based on gelatin-resorcin and formaldehyde (GRF) have motivated researchers to investigate their applications in surgery. BRAUNWALD; TATOOLES [3] (1965) and BRAUNWALD et al. [2] (1966) noted good adhesive properties which, however, were associated with strong reaction due to the direct aplication of formaldehyde to tissue. In 1968, Cooper and Falb proposed the use of GRF adhesives as an alternative in surgical sewing procedures and reported their hemostatic and adhesive qualities. Later studies aiming at better formulations and ways of applying the adhesive were conducted by LAURIAN et al. [11,12] (1979, 1977) who obtained satisfactory results for application in vascular surgery. Similar results were reported by PAULISTA et al. [18] (1988) for the surgical treatment of aortic dissections.

Application of the material for hemostasis in hepatic injuries was studied by MARGARIT et al. [14] (1987) with poor results, whereas SOUZA et al. [21] (1989) recommended the use of the material

The effectiveness of GRF adhesives for suture reinforcement was investigated in intestinal surgery. MEDEIROS et al. [16] (1989), in a study of the tensile strength of enteral anastomoses protected or not with the adhesive, detected a significantly better performance of the protected preparations. However, in a subsequent similar study, the same authors (MEDEIROS et al. [17], 1990) did not recommend the use of the adhesive due to the high incidence of fistulae, dehiscence and intestinal obstruction.

The well-known objectives of the search for new materials and techniques for surgical sewing are to decrease the time of patient exposure to anesthesia and to guarantee safe sutures and hemostasis, which are fundamental for successful operations. In this respect, a classical and unprecedented proposition was the use of omentopexy, which offers important substrates for tissue repair in the healing of anastomoses and of many other conditions (HOSGOOD [9], 1990).

In view of the above considerations, the objective of the present study was to evaluate the performance of a new mixture based on gelatin-resorcin and formaldehyde (Colagel) in terms of suture reinforcement in enteral anastomoses and to compare it to omentum fixation, which is considered by many to be the standard procedure.

MATERIAL AND METHOD

Twelve mongrel dogs of both sexes were divided into 6 groups of 2 animals each. After a 12 hours period of water and food deprivation, the animals were shaved, preanesthetized with 2 mg/kg chlorpromazine hydrochloride (Amplictil), *iv*, and fully anesthetized with 15 mg/kg sodium pentobarbital (Nembutal), *iv*. After antisepsis and routine preparation of the surgical field, the animals were submitted to longitudinal median retroumbilical laparotomy. The intestinal loops were exposed and the segments for study were selected using the ileocolic junction as reference. The ileal portions were individualized and transversal incisions were made from the antimesenteric to the mesenteric surface of the loops to fully separate the intestinal cylinders.

Single separate extramucosal stitches were made at 2.0-mm intervals using nº 3 natural absorbable sutures and an atraumatic needle. The ileal segments were systematically hydrated with physiological saline heated to 37 °C throughout the operation. After drying, one of the two anastomoses was selected at random in each animal and covered with a thin layer of adhesive. A polymerizing agent was applied to the adhesive at the proportion of 3 drops of solution for 1 cm of adhesive (Colagel, Cirumédica) and the preparation was allowed to dry for 1 to 2 min. as recommended by the manufacturer (Fig. 1). The other anastomosis was wrapped with omentum and used as control of the first.

During the first 48h after surgery, the animals were submitted to parenteral hydration and feeding. On the subsequent days, the animals were allowed free access to water and to food of pasty to solid consistency.

During the evaluation period, consisting of 1, 3, 7, 14, 21 and 28 days after surgery, the animals were followed clinically and sacrificed at the end of each period. The abdominal cavity was opened and the intestinal segments containing the sutures were washed in saline solution and submitted to the tensile strength test by insufflation of compressed air at constant pressure and flow. The values needed for one or more stitches to rupture were determined using a mercury manometer coupled to the system, with a maximum recording capacity of 300 mmHg (CARRIL [5], 1970; MARTINS JÚNIOR [15], 1987).

For histopathological examination, the ileal segments containing the anastomoses were reduced, identified and fixed in 10% formaldehyde. The material was then embedded in paraffin and cut with a standard microtome and the sections were stained with Masson trichrome and hematoxylin-eosin and examined under the light microscope.

The tensile strength values were submitted to the statistical sign test, with the level of significance set at 4% (CAMPOS [4], 1983).

RESULTS

All animals evolved satisfactory, except for one of them (sacrificed on the 14th day) which presented symptoms indicative of partial obstruction of the enteric lumen. Inspection of the abdominal cavity of all animals showed that the adhesive, which was light in color when first applied, had turned dark, showing good adhesion to the sutures and little elasticity. Although specific measurements were not made, macroscopic inspection showed greater constrictions in the anastomoses covered with Colagel. The tensile strength data revealed that, in general, rupture of the coaptation lines occurred only after the initial observations periods (1, 3 and 7 days), whereas the phenomenon was not observed after 14, 21 and 28 days. Statistical analysis of the data showed the absence of differences between techniques at the 4% level of significance.

In terms of adhesiveness, the histological data confirmed the macroscopic observations (Fig. 2). The

microscopic aspect of the anastomoses on days 1, 3 and 7 after surgery revealed a normally envolving inflammatory process and similar initial exudation for the two procedures. When the late groups (14, 21 and 28 days) were compared, the omentum-covered anastomoses were found to follow the normal pattern of exudation and fibroplasty, whereas the adhesive-covered anastomoses showed more marked cellular infiltration in the serosal and mucosal layers (Fig. 3). In addition, the adhesive-covered anastomoses showed earlier joining of the mucosal layer.

DISCUSSION

Evaluation of macroscopic aspects such as adhesiveness and elasticity, important properties for surgical material (COOPER; FALB [7], 1968; LAURIAN et al. [11,12], 1979, 1977; SOUZA et al. [21], 1989), showed that Colagel presented good adherence to tissue but low elasticity.

With respect to epiploic adherences, spontaneous migration of the omentum to the lesioned structures after surgical repair of abdominal organs is almost a constant event, with quite beneficial effects. Early revascularization of healing coaptation lines and impermeabilizing effects, among others, have been frequently attributed to the omentum, thus justifying its fixation during surgery (HOSGOOD [9], 1990). In the present study, non-epiploic adhesions were more prevalent in Colagel-covered sutures, indicating that they may have started before the epiplon itself reached the lesioned area, as is usually the case (HOSGOOD [9], 1990).

In terms of tensile strength, the results obtained with the two techniques were identical. MEDEIROS et al. [16] (1989) first reported advantages for the adhesive-covered anastomoses, but paradoxically obtained opposite results in a subsequent study (MEDEIROS et al. [17], 1990).

With respect to the numerical pressure values, the tensile strength of the anastomoses was greater on the 1st and weaker on the 3rd and 7th day after surgery for both techniques. This is justified by the fact that absorbable sutures, especially those made of natural materials, loose their tensile strength rapidly and gradually, with a consequent reduction in suture resistance. In parallel, there have been reports of phenomena of delayed healing of surgical lesions repaired with organic absorbable sutures which are known to cause an intense exudative reaction and a delay in fibroblast proliferation (CORREA NETTO [8], 1968). At later evaluation times (14, 21 and 28 days), the tensile strength of the anastomoses was sufficient to maintain the coaptation lines stable, with no rupture when a maximum of 300 mmHg of pressure was applied. It should be pointed out that, under non-experimental conditions, intraluminal pressures would never reach the intensity of 300 mmHg in the species (MARTINS JÚNIOR [15], 1987).

The exudative phenomena observed microscopically 1, 3 and 7 days after surgery and their comparison with gas insufflation data led us to believe that, since healing was in the initial stages, the resistance of the anastomoses was due to suture integrity more than to protection with the adhesive or with omentopexy.

The data obtained during the late phases of the study, although revealing less exudation in the groups submitted to omentum fixation, showed that tensile strength did not differ from that observed in the adhesive group. These data suggest that the changes occurring in the adhesive-covered anastomoses were not sufficiently important to impair the quality of fibrosis in the coaptation lines. We were unable to determine whether the greater intensity of the exudative process during the late phases of the study was due to a natural mechanism of material reabsorption or to an irritating process caused by such a mechanism. The quality and the presentation of the cell infiltrate did not permit us to opt for one of these possibilities.

Thus, under the experimental conditions employed, the results permitted us to conclude that the gelatin-resorcin and formaldehyde mixture, when compared with omentopexy, 1) did not alter the tensile strength of the intestinal anastomoses, 2) did not interfere with the healing process on days 1, 3 and 7 after surgery, 3) caused a more intense exudative reaction on days 14, 21 and 28 after surgery, although this could not be described as an irritating or material reabsorption process.

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LAUS, J.L.; MORALES, A.; FERREIRA, A.L.; SOBREIRA, L.F.R.; VICENTE, W.R.R.; TONIOLLO, G.H. Avaliação comparativa nos efeitos de um novo adesivo biológico (Colagel) sobre a resistência tênsil e a cicatrização de anastomoses intestinais. Trabalho experimental em cães. *Braz. J. vet. Res. anim. Sci.*, São Paulo, v.29, n.1, p.83-91, 1992.

RESUMO: Os efeitos de um novo adesivo biológico a base de gelatina - resorcina e formaldeído (Colagel),

como adjuvante no reforço, impermeabilização e cicatrização de anastomoses intestinais, foram avaliados e comparados com a omentopexia, procedimento padrão em cirurgias dessa natureza. Duas anastomoses ileais foram realizadas em 12 cães de experimentação empregando-se, como sutura, técnica em pontos simples separados extramucosos em plano único. Para a avaliação comparativa, estas receberam, respectivamente, o adesivo e a omentopexia. Os segmentos intestinais que receberam as anastomoses foram avaliados segundo a força tênsil e histopatologia aos 1, 3, 7, 14, 21 e 28 dias de pós-operatório. O estudo da força tênsil das anastomoses tratadas pelos procedimentos não mostrou diferenças estatisticamente significativas. A histopatologia revelou evolução normal da cicatrização em ambas as técnicas, nos dias 1, 3 e 7 e maior exudação no grupo cola aos 14, 21 e 28 dias de pós-operatório.

UNITERMOS: Cirurgia Experimental, cães; Intestinos, cirurgia, reparação

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FIGURE 1 — Aspect of the anastomosis after application of the biological adhesive.

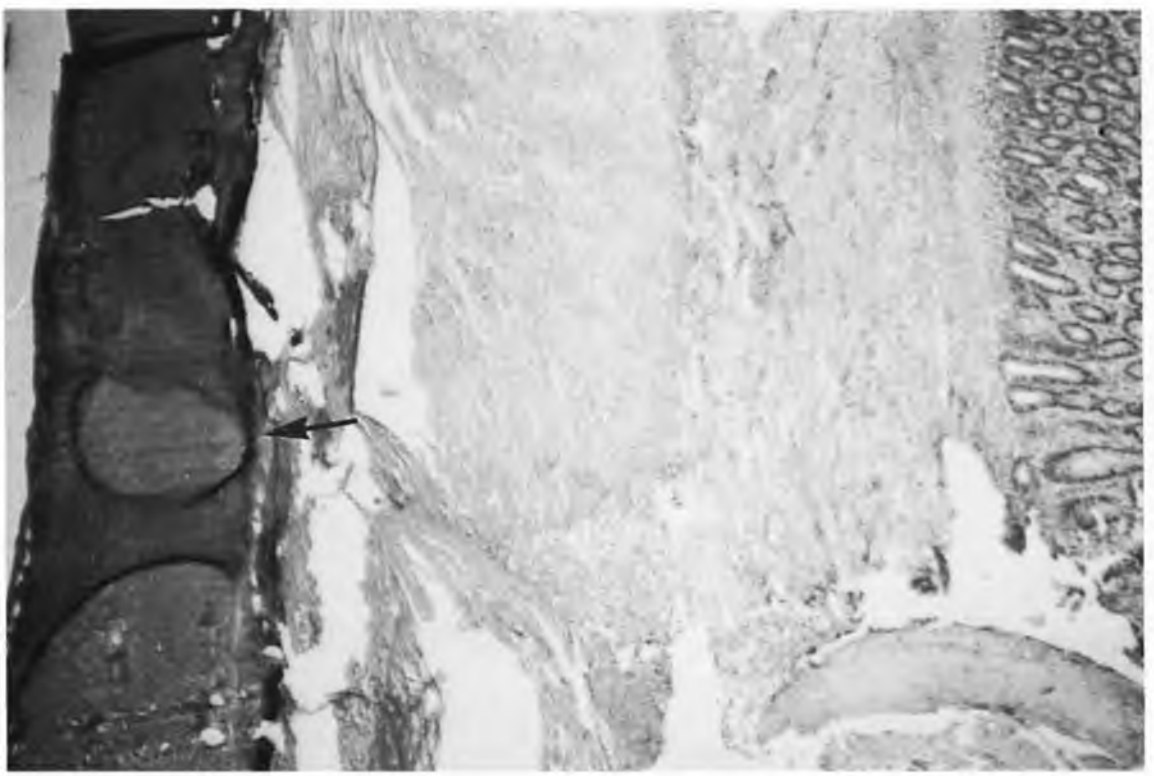

FIGURE 2 — Photomicrograph of an anastomosis examined 1 day after surgery. Appearance of the adhesive after treatment for embedding in paraffin. Note the adhesiveness of the material to the serosal surface. Hematoxylin-eosin. 52X.

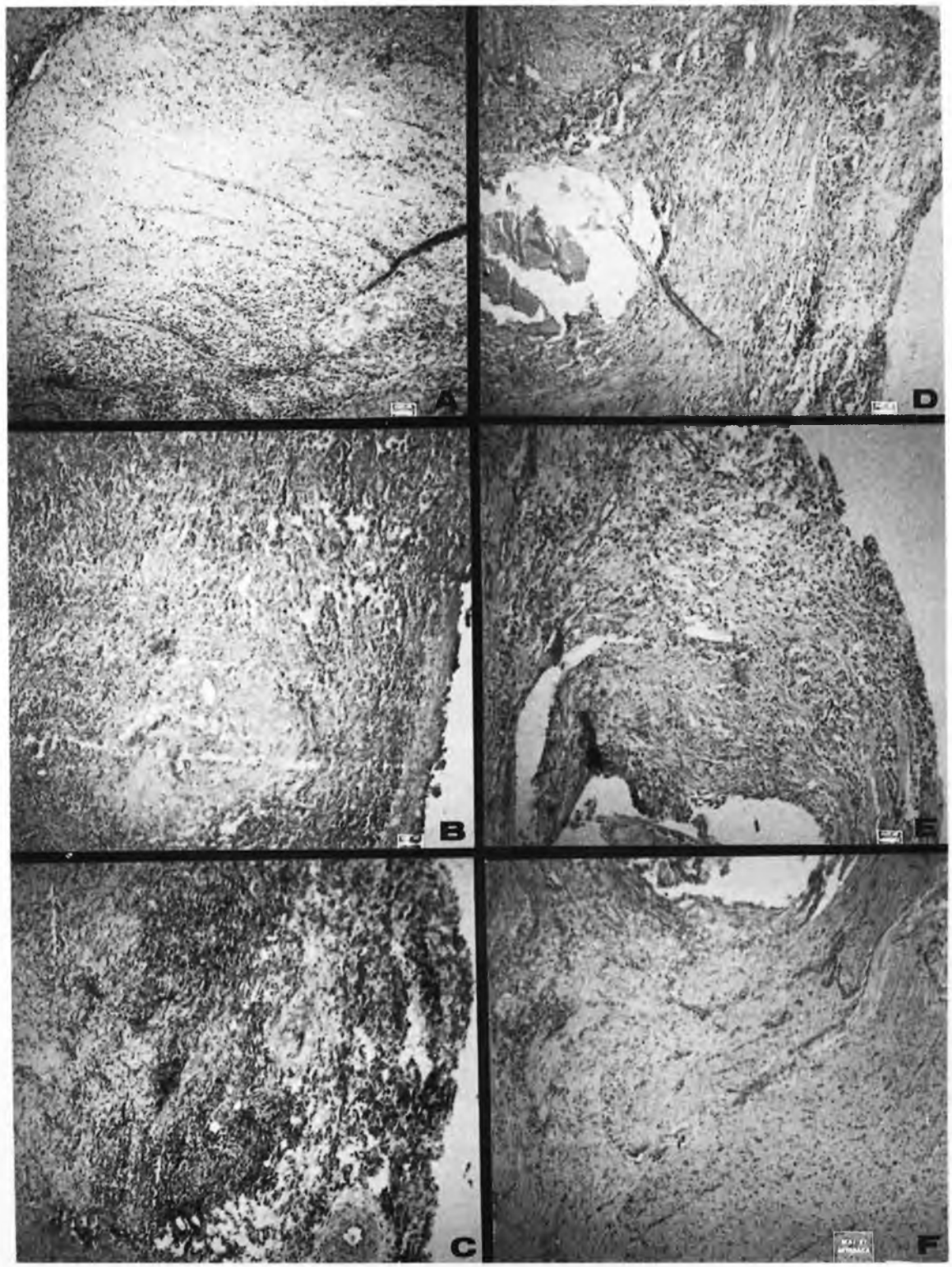

FIGURE 3 – Photomicrograph of anastomoses examined 14, 21 and 28 days after surgery. The images on the left (A, B and C) correspond to anastomoses covered with the biological adhesive and are compared with anastomoses submitted to omentopexy (right). A, Permanence of a "chronic" mononuclear infiltrate; B and C, serosal area and areas of contact with the adhesive showing thickening of the tunica and a marked juxtaserosal infiltrate, not observed in the images on the right. The fibroblast proliferation and fibrosis near and around the sutures do not differ markedly between techniques. Hematoxylin-eosin, 190X.