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## The Effects of Continuous and Interrupted Intestinal Sutures on Anastomotic Stricture Formation in Growing Rats

### Wpływ ciągłych i przerywanych szwów jelitowych na powstawanie zwężeń zespołań u rosnących szczurów

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#### Abstract

**Background.** Stricture formation after intestinal anastomosis is important in the pediatric age group because of their small anatomic size and growing potential.

**Objectives.** This study was designed to compare continuous and interrupted intestinal suture techniques in terms of stricture formation in growing rats.

**Material and Methods.** Twenty-four rats aged 4 weeks were used for the investigation. The rats were divided into two groups of twelve rats each. After dividing the transverse colon, anastomosis was performed in a single layer, either continuous or interrupted manner. The anastomotic site was resected on the 21<sup>st</sup> postoperative day to assess the anastomotic diameter, histopathological grading of inflammation, and collagen deposition.

**Results.** Measurement of the anastomotic diameter and histopathological scoring revealed no statistically significant differences between the two groups ( $p > 0.05$ ).

**Conclusions.** These findings indicate that continuous and interrupted sutures do not influence the formation of anastomotic stricture in immature rat intestine. Continuous monolayer anastomosis with absorbable suture material is as safe as interrupted anastomosis in growing subjects (*Adv Clin Exp Med* 2010, 19, 2, 151–154).

**Key words:** surgical technique, anastomosis, stricture.

#### Streszczenie

**Cel.** Rozwój zwężeń w miejscu zespołań jelitowych u dzieci jest istotnym problemem ze względu na małą wielkość anatomiczną i potencjał wzrostowy. Celem badania było porównanie wpływu ciągłych i przerywanych szwów na powstawanie zwężeń u rosnących szczurów.

**Materiał i metody.** Grupę badaną stanowiły 24 szczury w wieku 4 tygodni. Szczury były podzielone na dwie grupy, każda licząca 12 szczurów. Po przecięciu poprzecznicy wykonywano zespolenie jednowarstwowe w sposób ciągły lub przerywany. Miejsce zespolenia było resekowane w 21. dniu po zabiegu operacyjnym w celu oceny średnicy zespolenia oraz histopatologicznej oceny nasilenia zespolenia i odkładania kolagenu.

**Wyniki.** Średnica zespolenia oraz histopatologiczne nasilenie zapalenia nie różniło się istotnie statystycznie między obiema grupami ( $p > 0,05$ ).

**Wnioski.** Uzyskane wyniki wskazują, że rodzaj zastosowanego szwu, szew ciągły lub przerywany, nie wpływa na tworzenie zwężeń zespołań w niedojrzałym jelicie szczura. W okresie rozwoju ciągłe jednowarstwowe zespolenie wykonane z użyciem wchłaniającego materiału jest tak samo bezpieczne jak zespolenie przerywane (*Adv Clin Exp Med* 2010, 19, 2, 151–154).

**Słowa kluczowe:** technika chirurgiczna, zespolenie, zwężenie.

Operations on the gastrointestinal tract are among the most frequent surgical procedures in adults and children. Although intestinal anastomosis is practiced for the treatment of many surgical pathologies, the best technique is still controversial. The subject of healing intestinal anastomosis has received great attention from investigators and it remains a topic of research interest. There are many experimental and clinical studies comparing different anastomotic techniques, suture materials, and the number of layers [1–5].

Complications of anastomotic healing are not rare and can be summarized as insufficient healing, such as anastomotic leak and fistulas, or exuberant healing, such as stricture formation and intestinal obstruction. Stricture formation is especially important in the pediatric age group because of their small anatomic size and growing potential. Very few data are available concerning the effects of age on anastomotic stricture formation. As the intestinal lumen is small in growing subjects, an interrupted suture is widely preferred by pediatric surgeons to anastomose the bowels of children in order to prevent stenosis. As an alternative, the continuous anastomotic technique has many advantages. It can be performed in a shorter time and the risk of anastomotic leakage is low. Also, the amount of implanted suture material, which is responsible for tissue reaction, is minimal [6].

This experimental study was designed to compare continuous and interrupted intestinal suture techniques in terms of stricture formation in growing rats.

## Material and Methods

Twenty-four Wistar Albino rats aged 4 weeks with a median weight of 70 g (range: 53–88 g) were used for the study. All the animals were cared for in accordance with the institutional animal care and use committee guidelines.

The rats were divided into two equal groups of twelve rats. Surgery was conducted under intramuscular one-shot ketamine (50 mg/kg) anesthesia after 4 hours of fasting. The animals received intramuscular antibiotic prophylaxis (ceftriaxone 50 mg/kg) immediately prior to surgery and on the first postoperative day.

The operations were performed using a surgical loupe with four-fold magnification under aseptic conditions. All the procedures were carried out by one surgeon. The abdomen was opened through a midline incision. After dividing the transverse colon, primary end-to-end intestinal anastomosis was performed in a single layer, seromuscular, in either a continuous (group A) or interrupted

(group B) manner. In both groups, monofilament polyglyconate, an absorbable suture material (6/0 Maxon), was used for the anastomosis. The anastomotic site was marked with a single non-absorbable stitch. The abdomen was closed in one layer with a continuous suture using 3/0 silk. The animals were allowed to recover spontaneously from anesthesia and were fed regular diets starting at the 8<sup>th</sup> postoperative hour.

The rats were weighed and then killed by means of an overdose of ketamine on the 21<sup>st</sup> postoperative day. Then a 2-cm segment of colon including the anastomotic site was resected and fixed in 10% buffered formalin. The inner diameter of the anastomotic site was measured by light microscopy with 40× magnification. After hematoxylin and eosin staining, a pathologist who was blind to the groups graded the amounts of fibrosis and inflammation in each specimen using a semi-quantitative scoring system. Collagen deposition was graded as mild, moderate, and severe. An inflammation score was also assigned according to severity (mild: occasional lymphocytes and plasma cells, moderate: plasma cells, eosinophils, and neutrophils, and severe: many inflammatory cells and microabscess formation).

Statistical analysis was performed using SPSS Software (SPSS 9.0, SPSS Inc., Chicago, IL, USA). The Mann-Whitney *U* and chi-squared tests were performed as appropriate. A *p*-value < 0.05 was considered significant.

## Results

One rat died of anastomotic leakage in group B. This was not statistically significant. Three weeks after surgery, body weight gain was similar in both groups, with mean weights of  $138.4 \pm 14.5$  and  $137.5 \pm 15.6$  g in groups A and B, respectively ( $p > 0.05$ ). The increase was nearly two fold compared with the time of anastomosis. No apparent stricture or dilatation was noticed in gross examination of the colonic segments. The mean anastomotic diameter was  $5.3 \pm 0.9$  mm in group A and  $5.4 \pm 0.7$  mm in group B ( $p > 0.05$ ). The analysis of the microscopic inflammation and collagen deposition scores revealed no statistically significant differences between the two groups (Table 1).

## Discussion

Intestinal anastomosis has been intensely studied and many comparisons between alternative techniques and suture materials have been made. After surgery, proper healing of the alimen-

**Table 1.** Histopathological assessment of anastomotic site ( $p > 0.05$ )**Tabela 1.** Histopatologiczna ocena miejsca zespolenia ( $p > 0,05$ )

	Inflammation score (Nasilenie zapalenia)			Collagen deposition (Odkładanie kolagenu)		
	mild	moderate	severe	mild	moderate	severe
Group A (Grupa A)	2	8	2	11	1	–
Group B (Grupa B)	3	7	1	9	2	–

tary tract is essential for the prevention of the significant morbidity and mortality associated with complications [7]. Anastomotic complications such as stricture and leakage are serious problems in gastrointestinal surgery. Many of the studies focused on anastomotic leak. However, little has been written dealing with stricture formation after intestinal anastomosis, especially in the pediatric population, which is more prone to anastomotic stricture.

Wound healing in the gastrointestinal tract proceeds through the same stages as wounds elsewhere in the body. The collagen content of the wound is a function of the breakdown of mature collagen and the synthesis of new collagen. At the anastomotic site, the collagen concentration drops to a low level at about three days following surgery, but returns to normal levels within two weeks of an operation [8]. During this period, an equilibrium is reached between collagen production and collagen degradation so that no net increase in collagen content occurs thereafter [9]. Variations in the collagen content of the intestinal wall after operations is of great importance in the healing of intestinal anastomosis and it is a potential cause of complications [2]. Thus studies of collagen in the bowel wall should be of major interest for understanding the intestinal healing process and thus the underlying mechanisms of complications [10].

Patient age is one of the many predetermined conditions as well as nutritional status, metabolic abnormalities, and application of some drugs that influence the safety of intestinal anastomosis. Although anastomotic leaks occur more frequently in the elderly, controlled comparisons of young and old rats failed to demonstrate any difference in colonic anastomotic healing [11]. Comparison of anastomotic techniques at a younger age is limited. In the current study, intestinal anastomoses were performed on four-week-old rat pups and final assessment was done after three weeks, when their weight had almost doubled. This three-week period is also sufficient for the period of collagen remodeling to evaluate the anastomotic diameter and stricture formation.

The observations indicate that anastomotic

suture support is of minor or no importance 1 to 2 weeks after the procedure. Thus modern, synthetic, absorbable suture materials can be used safely for intestinal anastomosis [10]. Sutures act as foreign bodies in the anastomosis, producing inflammation which persists for two or three weeks [1]. Inflammation seems to delay the healing of an intestinal anastomosis. The ideal suture provokes a minimal inflammatory response. Absorption of the suture material eliminates the foreign body residue seen with nonabsorbable sutures that induces a strong tissue reaction. Jiborn et al. reported that continuous sutures in colonic anastomosis result in functional obstruction during the first week of healing even though great care is taken to prevent narrowing of the lumen when the anastomoses are constructed [2]. However, non-absorbable suture material (polypropylene) was used in this study and this may limit the anastomotic site in a rapidly growing host. Clinical and experimental studies have shown that synthetic absorbable suture materials are superior to non-absorbable suture materials in the prevention of strictures after tracheal anastomosis [12, 13]. In the present study, histopathological examination revealed that both of the anastomotic techniques lead to similar degrees of inflammation without significant effects on the quality of healing. Using absorbable suture material seems to be more important than the suturing style in avoiding anastomotic stricture.

The surgical technique is important for successful operations. Every technique has its particular advantages and disadvantages. The fact that knotting is not necessary after each stitch strongly reduces the bacterial contamination of the operative field in continuous anastomosis [6]. The minimal amount of implanted suture material and shorter anastomosis time are other aspects that favor the single-layer continuous suture technique [6]. Harder and Vogelbach showed that single-layer continuous bowel anastomosis with absorbable suture is as safe as the single-layer interrupted suture technique in adults [6]. In an experimental study in rats using microangiographic techniques and histopathological examination, no difference was found between

continuous and interrupted suturing [14]. In the present study, one-layer anastomosis was preferred because it is advantageous to obtain a larger lumen. Two-layer anastomosis increases the inflammatory response owing to the extra suture material and the ischemia of the inverted tissue and cause weaker anastomoses [7].

Anastomosis of hollow viscera other than the gastrointestinal system also may cause fibrosis and scar formation, leading to stricture and obstruction in growing subjects. Animal studies showed that the continuous suture technique with absorbable suture material for bronchial and vascular

anastomosis in growing animals did not cause anastomotic stricture [12, 15]. Non-absorbable sutures may limit the anastomotic site in the rapidly growing host, even with the interrupted technique, and may cause stenosis [15].

In conclusion, these findings indicate that continuous and interrupted sutures with synthetic absorbable material result in a similar mode of healing in the growing rat colon. These two techniques do not influence the formation of anastomotic stricture. Continuous monolayer anastomosis with absorbable suture material is as safe as interrupted anastomosis in growing subjects.

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