

Gastrointestinal anastomosis using one layer of absorbable Polydioxanone suture material.

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A prospective study was conducted on the use of absorbable Polydioxanone (PDSR) suture material in a one-layer continuous technique for gastrointestinal anastomosis. Sixty-two anastomoses were performed in 49 adults; there was no clinical evidence of leakage or other complication attributable to the anastomotic technique or to the suture materials. The starvation period was 3.16 ± 0.9 days compared with 3.46 ± 1.0 days in the control group. The rate of complications and the function of the gastrointestinal tract after surgery were not significantly different from those using conventional two-layer anastomosis. The technique for one-layer continuous suture is simple and the operations are easy and take less time to perform than the conventional method. This technique also provides theoretically better post-operative conditions in which bowel anatomy physiology can return to normal earlier, with minimal tissue trauma and less narrowing of the lumen, although these aspects cannot be supported by this study. The Polydioxanone suture material is biodegraded over time, and hence allows normal growth of the anastomosed bowel; it is therefore suitable for use in children and adults.

Key words: One-layer continuous anastomosis, Suture techniques, Absorbable suture, Polydioxanone.

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ได้ทำการศึกษาทดลองแบบไปข้างหน้าเพื่อศึกษาผลการใช้วัสดุเย็บชนิด *Polydioxanone* เย็บต่อลำไส้ชั้นเดียวแบบต่อเนื่อง โดยเพื่อศึกษาผลนำเอาวิธีเย็บต่อลำไส้ 2 ชั้น แบบมาตรฐานมาเปรียบเทียบ โดยเฉพาะในแง่ของข้อแทรกซ้อนที่สำคัญ ได้แก่ การรั่วของรอยต่อ จากการศึกษา รอยต่อ 62 รอยต่อในผู้ป่วย 49 รายที่ใช้วิธีเย็บชั้นเดียวด้วย *Polydioxanone* และ 56 รอยต่อในผู้ป่วย 36 รายที่ใช้วิธีเย็บ 2 ชั้น ต่างก็ไม่พบข้อแทรกซ้อนเกี่ยวกับรอยต่อทั้ง 2 วิธี ระยะเวลาที่คนไข้คอดอาหารเมื่อใช้วิธีเย็บชั้นเดียวเท่ากับ 3.16 ± 0.9 วัน ซึ่งไม่มีความแตกต่างอย่างมีนัยสำคัญกับกลุ่มที่เย็บ 2 ชั้น (3.46 ± 1.0 วัน) ดังนั้นจึงแสดงให้เห็นว่าการเย็บชั้นเดียวด้วย *Polydioxanone* ไม่มีความแตกต่างกับการเย็บ 2 ชั้น แต่มีข้อดีซึ่งสามารถทำได้ง่ายกว่า รวดเร็วกว่า และพิจารณาจากทฤษฎีพื้นฐานการเย็บชั้นเดียวน่าจะทำให้เกิดความชอกช้ำต่อเนื้อเยื่อน้อยกว่า นอกจากนี้ *Polydioxanone* เป็นวัสดุเย็บชนิดละลายได้ทำให้สามารถนำไปใช้ทั้งในเด็กซึ่งลำไส้ยังต้องมีการเจริญเติบโตต่อไป

The aim of anastomosis is to create a sound joining of the bowel through which the contents will be able to pass as soon as possible after its formation. One important complication is leakage. Most surgeons, therefore depend on the placement of a second row of sutures to preclude this complication. Even though the use of two-layer anastomosis is almost universal, gastrointestinal anastomosis has always been a surgical challenge. Various techniques have been devised for this operation; emphasis has been given to the technique of placement of sutures and the suture materials.

Our experience with more than 500 anastomoses with the single-layer continuous technique using non-absorbable suture (Prolene[®]) did not reveal a result different from the conventional two-layer technique. On the contrary, the operations were easily performed, particularly in a limited operative field, and the operating time was shorter than with the conventional technique.

In 1989, we started using absorbable suture material (Polydioxanone) for single-layer continuous anastomosis in gastrointestinal tract surgery. At that time we also launched a prospective study to evaluate the results.

A review of the literature shows that there have been only few reports of Polydioxanone being used in a continuous single layer for gastrointestinal anastomosis.

Materials and Methods

This is a prospective cohort study. All the patients admitted to the General Surgical Firm III of Chulalongkorn Hospital who were under the responsibility of the authors for gastrointestinal anastomosis were included as the "study group". For this group, one-layer continuous technique using Polydioxanone (PDS[®]) was used. The patients who underwent conventional two-layer gastrointestinal anastomoses of the same structures in other surgical firms during the same period of time were studied as the "control group".

Patients who required chemotherapy, radiotherapy or those with underlying disease or malnutrition which could affect the healing of the anastomoses were excluded.

Surgical technique:

After preparing both ends, the anastomoses were held together with stay sutures. The procedure started from the posterior edge using simple continuous suture (Polydioxanone 3/0) including all layers of the intestine. The suture ran through the circumference which converted to Connell's continuous technique on the anterior. The last knot was tied together while the stay sutures were held apart to prevent the purse-string effect at the anastomosis. The stay sutures were taken out after completion of the anastomosis.

Patients in both the study and control groups were evaluated before discharge and then one and three months post-operatively. Any complication related to the anastomosis, such as leakage, stricture, etc., was recorded.

The data recorded in both groups included age, sex, diagnosis, type of operation, number and type of anastomosis, starvation period, length of post-operative hospital stay and complications (if any). The data were then re-grouped according to the organs anastomosed. The differences between the two groups in terms of the starvation period, length of post-operative hospital stay and complications were analysed using the Chi-square (X^2) test.

Results

There were 49 and 36 patients with 62 and 56 anastomoses, respectively, in the study and control groups. All the patients in both groups were evaluated at one month post-operatively but only 70 per cent of the patients in the study group and 50 per cent of the patients in the control group were followed-up more than one month. Table 1 shows the number of anastomoses. The types of organs anastomosed are shown in Table 2. However, the most common types in both the study and control groups were anastomoses between the stomach and small bowel (28/49) and between the large bowel and large bowel.

The starvation period was 3.16 ± 0.9 days (range 2-8) and 3.46 ± 1.0 days (range 2-10) and the mean post-operative hospital stay was 7.84 ± 2.5 days (range 5-39) and 8.93 ± 2.3 days (range 6-30) in the study and control groups, respectively. There was no significant difference between the two groups with regard to complication rate, starvation period and length of post-operative hospital stay ($p < 0.05$).

Table 1. Number of anastomoses.

	No. of cases	
	Study group	Control group
1. anastomosis	37	18
2. anastomoses	11	16
3. anastomoses	1	2
Total cases	49	36
Total anastomoses	62	56

Table 2. Types of anastomoses (or organs) involved.

	No. of anastomoses	
	Study group	Control group
Large bowel to large bowel	10	10
Stomach to small bowel	28	27
Small bowel to small bowel	6	5
Large bowel to small bowel	10	5
Biliary tract to small bowel	6	7
Others to small bowel	2	2
Total anastomoses	62	56

Discussion

“In end-to-end anastomosis of the bowel, only one row of sutures should be taken.... I should regard a second row as a factor of danger rather than security.” Thus did Halsted summarized the reason for using the one-layer anastomosis technique more than one hundred years ago.⁽¹⁾ Other reports subsequently showed a lower or at least equal incidence of leakage when the single-layer techniques is used and stated that the bowel anatomy and physiology returned to normal earlier.⁽²⁻¹²⁾ Despite these comments, two-layer anastomosis “conventional technique” has been widely practiced by most surgeons. The reason for this may not the scientifically sound but due to habit, tradition and the sense of security the two-layer technique provides.

The aim of a gastrointestinal or intestinal anastomosis is to achieve sound joining of the bowel so that, its contents can pass through as soon as possible. Important complications include leakage, stricture and bleeding at the anastomotic site. The

important correlated factors are the blood supply of both ends, tension at the anastomosis and hematoma. The suturing technique is also claimed to be one of the predisposing factors to such complications. On the one hand missing a stitch in the bowel may lead to bleeding or leakage, on the other hand, tight suturing may cause stricture or stenosis of the anastomosis. Nevertheless, the suturing technique seems to be the least important factor in these complications.

Until the early 1970s, the only absorbable sutures available for intestinal anastomoses were the collagen sutures or surgical gut (plain and chromic catgut). Those materials are absorbed within about three weeks by enzymatic reaction, which evokes an inflammatory tissue reaction. The subsequent introduction of synthetic absorbable sutures, such as polyglycolic acid, polyglactin in the mid-1970s, led to a significant surgical advance because of their improved properties, such as minimal tissue reaction and longer duration before absorption.⁽¹³⁾ These sutures also have a more predictable and reliable profile with prolonged strength retention. Yet, most

surgeons still depend on conventional two-layer anastomosis using continuous chromic catgut for the inner layer and interrupted silk sutures for the outer layer.

Polydioxanone (PDS[®]) is a new monofilament synthetic absorbable suture composed of the hydrolysable, colourless, crystalline polymerisation. The two important characteristics described regarding its in vivo behaviour are better tensile strength retention and the longer absorption rate or loss of mass suture.⁽¹⁴⁾ In rats, 70% of original strength was measured 14 days after implantation; 50% and 14% remaining strength was observed 28 and 56 days post-implantation, respectively. This indicated as significantly longer period of wound support than any other previously absorbable suture known. Absorption of Polydioxanone is minimal until about 90 days after implantation. Degradation is by hydrolysis, which is complete within 180 days.⁽¹⁵⁾ Other good characteristics of the monofilament Polydioxanone include easy handling and tying. Braided sutures are associated with rough tissue passage and a higher incidence of infection than monofilament, especially in the bowel.⁽¹⁶⁻¹⁹⁾

One of the authors (P.K.) started a program for continuous one-layer bowel anastomosis using the one-layer continuous technique with polypropylene (Prolene[®]); more than 500 alimentary tract anastomoses were performed. In 1987, we reported our initial experience which showed good results, with no significant difference in anastomotic complications compared with the two-layer technique.⁽²⁰⁾

Continuous one-layer anastomotic technique has proven to be safe and new, improved, multipurpose absorbable sutures for bowel anastomosis have shown better results in abdominal wound closure,⁽²¹⁻²³⁾ vascular anastomosis⁽²⁴⁻²⁶⁾ and other fields such as orthopaedic surgery (for meniscus repair, for internal suspension and fixation, and for transosseous ligature),⁽²⁷⁻²⁹⁾ plastic surgery⁽³⁰⁾ and cataract surgery.⁽³¹⁾

Theoretically, anastomosis constructed by one-layer continuous technique causes less narrowing of the lumen and preserves more of the blood supply of both ends of the anastomosis. Return of function after completion of the anastomosis and the healing process are also more rapid for the reasons quoted. There have been many experiments that confirm this theory⁽⁹⁾ by using histopathological study, angiography and contrast radiological study, but it is difficult to find some clinical parameters to prove this. Some

authors used the length of time after operation that the first liquid or solid stool was passed, Others used the first audio evidence of bowel sounds.⁽⁶⁾ In this study, we used the time that we first fed the patients post-operatively and that usually started when bowel movement occurred. The post-anastomosis starvation period and the length of post-operative hospital stay for the patients who underwent this newly introduced technique were not significantly different from those who underwent conventional two-layer technique. This may be due to the number of cases studied and because there is no clinical parameter that can accurately demonstrate the return to normal function of the anastomosed bowel.

Leakage and stricture of the anastomosis have been studied experimentally using radiological means. However, for the clinical study, we thought that radiological study was unnecessary, since leakage was not clinically apparent (even when leakage was shown radiologically) and did not affect the recovery or treatment of the patients. Therefore, we reported only the clinical leakage or stricture rate. An acceptable rate for anastomotic complication has not been clearly defined so we decided to compare it with the conventional two-layer technique. Because of very low leakage and stricture rates, we also could not demonstrate any significant difference from the limited number of cases. Nevertheless, this indirectly showed that the placing of a second row of sutures did not provide any advantage in preventing leakage. In practical, terms, attempting to apply the second outer layer of sutures in an oedematous bowel increased bowel traumatization due to the cutting action of the sutures, thus further increasing the chances of leakage.⁽¹²⁾

Apart from the better results, using the one-layer continuous technique also had other advantages: less time for anastomosis and easier application in the limited operative field compared with the two-layer and the one-layer interrupted techniques.

The Polydioxanone suture also has the added advantages of its slow absorption, better retention of strength over time and its process of degradation all of which factors helps to achieves better anastomoses. In children, once healing and absorption of the suture occurred, the anastomosed bowel could grow normally, even when circular continuous suture was applied.

It has been a long time since the advantages of the single-layer technique for anastomosis of the alimentary tract was reported. We have confirmed

and supported the findings of others that this one-layer and continuous technique is safe, and that the introduction of a new improved absorbable suture gives better results with easier construction through which the "ideal" anastomosis could be created.

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