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Original Research Article

Comparison of non-absorbable (polypropylene) versus delayed absorbable (polydioxanone) suture material for abdominal wound closure after laparotomy

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ABSTRACT

Background: Type of suture material used for fascial closure in laparotomies influences the incidence of post-operative complications. Currently there is no consensus on the superiority of either absorbable or non-absorbable suture materials for abdominal fascial closure. Aim of this study was to determine the superior suture material for abdominal wall closure after elective laparotomy among polypropylene and polydioxanone based on the occurrence of specific post-operative complications.
Methods: A prospective observational study was conducted at Kasturba hospital, Manipal from September 2014 to August 2016. Patients admitted under General surgery, who underwent midline laparotomy were included in the study. Polydioxanone and Polypropylene suture materials were used for mass closure and post-operative complications were compared.
Results: Hundred patients were included. The two study groups (Prolene and Polydioxanone) were homogenous, with no significant difference between age, BMI, co-morbidities and indication for surgery. Surgical site infection was significantly more in prolene group (p=0.031). Duration of surgeries was longer in prolene group (p=0.020), hence, a subgroup analysis was done and only surgeries under 4-hour duration were analysed. It showed no difference between the two groups with respect to surgical site infection (p=0.320). There was no significant difference between the two groups in burst abdomen and incisional hernia.
Conclusions: There was no significant difference between Prolene and Polydioxanone when early and late post-operative complications were compared. Hence, either of the two suture materials can be used for abdominal wound closure in elective midline laparotomies.

Keywords: Abdominal closure, Polypropylene, Polydioxanone, Suture material

INTRODUCTION

The technique of closure of the abdomen after a surgery has often been a topic of debate. An ideal closure should be easy, provide adequate strength and act as a barrier for the infection. It should be tension free, to avoid ischemia and the closure should be comfortable for the patient.

Laparotomy wound related complications are a major source of post-operative morbidity. These include wound infections, incisional hernias and burst abdomen (wound dehiscence). Many factors influence the occurrence of these complications. A study was done to compare large bites suture technique with the small bites technique for fascial closure of midline laparotomy incisions and the

latter was found effective.[1] Another study showed that continuous closures with nonabsorbable suture was effective to close abdominal wounds. However, if infection or distention is anticipated, interrupted absorbable sutures are preferred.[2] Another study emphasised on the type of suture material and compared polydioxanone (PDS) and prolene and showed that PDS was effective.[3] Thus the choice of suture material used for the fascial closure is thought to be a major factor.

The most important debate in choosing suture material for fascial closure after a laparotomy is between non-absorbable and delayed absorbable suture materials. There are proponents of both absorbable and non-absorbable suture materials for abdominal wall closure. Though non-absorbable sutures (nylon and polypropylene) have been the preferred choice traditionally, the advent of polydioxanone has brought a wave of popularity for absorbable sutures. Nowadays, the most common closure technique for midline laparotomy is a mass closure using delayed absorbable suture (polydioxanone- PDS) (Figure 1).

Figure 1: Commercially available packs of no.1 prolene and no. 1 PDS (loop).

Complications following a laparotomy closure can be grouped as early post-operative complications and long-term complications. Early complications would be surgical site infection and wound dehiscence or suture sinus formation. Whereas, long-term complication includes incisional hernia. The rate of incidence of these complications decides which suture material is better than the other for the closure of midline incision laparotomy.

In this study, author compare two types of suture materials, delayed absorbable (polydioxanone) and non-absorbable (polypropylene), the two commonly used suture materials for rectus sheath closure after a midline laparotomy. The comparison would be done on the basis of incidence of post-operative complications.

Aim of this study was to determine the superior suture material for abdominal wall closure after elective laparotomy among polypropylene and polydioxanone. Objectives of this study was to compare the rate of occurrence of the following post-operative complications after abdominal wall closure using polypropylene or polydioxanone-Surgical site infection, burst abdomen and incisional hernia.

METHODS

Prospective observational study was conducted at Department of General Surgery, Kasturba Hospital, Manipal between September 2014 to August 2016.

Patients undergoing elective laparotomies with midline vertical incisions under department of General Surgery, Kasturba Hospital, Manipal during the study time period and who could be followed up for 6 months during the study period.

Exclusion criteria

- Patients with age <18 years
- Patients with history of previous abdominal surgery
- Pregnant patients
- Emergency surgeries
- Sample size: 100

Data collection and management

After obtaining consent for participation in the study, the nature of disease, type of surgery planned, comorbidities etc. of the subjects were collected in a proforma and later tabulated in SPSS software version 15.0.

Surgical technique

At the end of each laparotomy, the abdominal closure was done using a continuous mass closure technique. Two size #1 looped PDS or #1 non-looped Prolene were used for fascial closure (4:1 suture to incision length ratio). One suture was anchored at the upper extent and one at the lower extent of the wound. The suture was run in a continuous manner, taking full-thickness bites of the linea alba fascia incorporating both anterior and posterior rectus sheaths (Figure 2).

Sutures were passed through the fascia a minimum of 1cm from the wound edge and at 1cm intervals. The suture was held with minimal tension by an assistant to prevent it from getting loose, while at the same time avoiding tissue strangulation. The two sutures were run towards each other and tied together in the center of the wound using either square knots with 6 throws. In case of smaller incisions, a single suture was used and an Aberdeen knot was used at the end of the incision.

Skin closure was done using either interrupted mattress sutures with 2-0 Nylon (Ethilon) or skin clips. Wound drains were not used. Patients were followed up during the admission for early post-operative complications

(surgical site infection and burst abdomen) and at 6 months after surgery to look for late complications (incisional hernia).

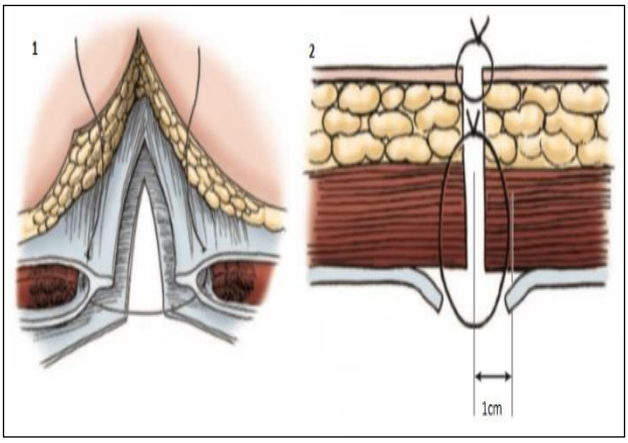

Figure 2: Mass closure technique 1-incorporating anterior and posterior rectus sheaths; 2-1cm thick bites.

Definitions

For the purpose of this study, surgical site infection was defined as purulent discharge from the surgical site, or serous discharge if it shows any growth on culture, up to 1 month after the surgery.

Burst abdomen (wound dehiscence) was considered as partial or complete dehiscence of abdominal wound, with protrusion of intra-abdominal contents.

Definition of incisional hernia in the study was a hernia occurring at the site of midline vertical laparotomy incision, detected either clinically, or radiologically. An incisional hernia from other sites such as drain site or stoma site were not included.

Statistical analysis

All the recorded data was analyzed using SPSS software version 15.0. The $\chi 2$ test and Fischer's exact t-test were used to test for homogeneity of the test population and for significance of results. Significant p-value was defined as <0.05.

RESULTS

Total of 100 patients were included in the study, as per the inclusion criteria. Each one of them underwent an elective laparotomy using a midline incision. The closure of the wound after laparotomy was done using a continuous mass closure technique in all patients, albeit with different suture materials. 44 patients underwent closure using No. 1-polypropylene (prolene) suture. Whereas, 56 patients underwent closure using loop No. 1-polydiaxone (PDS) suture (Figure 3).

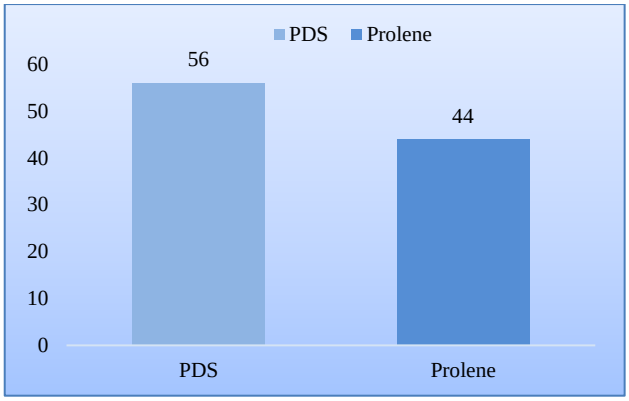

Figure 3: Suture materials used and number of patients.

Table 1: Indications for surgery.

Indication	Suture material		Total
	PDS [No. (%)]	Prolene [No. (%)]	
Carcinoma stomach	16 (28.6)	9 (20.5)	25 (25.0)
Carcinoma colon	11 (19.6)	12 (27.3)	23 (23)
Carcinoma rectum	5 (8.9)	5 (11.4)	10 (10)
Carcinoma oesophagus	4 (7.1)	3 (6.8)	7 (7.0)
Ileocaecal tuberculosis	5 (8.9)	2 (4.5)	7 (7.0)
Retroperitoneal tumour	2 (3.6)	2 (4.5)	4 (4.0)
Adhesive intestinal obstruction	2 (3.6)	1 (2.3)	3 (3.0)
Carcinoma hypopharynx	1 (1.8)	1 (2.3)	2 (2.0)
GIST jejunum	1 (1.8)	1 (2.3)	2 (2.0)
Carcinoma GE junction	0 (0.0)	2 (4.5)	2 (.02)
Inflammatory bowel disease	0 (0.0)	2 (4.5)	2 (2.0)
Sigmoid diverticulitis	2 (3.6)	0 (0.0)	2 (2.0)
Pelvic tumour	2 (3.6)	0 (0.0)	2 (2.0)
Post bulbar stenosis	1 (1.8)	0 (0.0)	1 (1.0)
Jejunal Lipoma	1 (1.8)	0 (0.0)	1 (1.0)
Neuroendocrine tumour- ileocaecal	0 (0.0)	1(2.3)	1 (1.0)
Rectal prolapse	0 (0.0)	1 (2.3)	1 (1.0)
Retroperitoneal cyst	0 (0.0)	1 (2.3)	1 (1.0)
GIST stomach	1 (1.8)	0 (0)	1 (1.0)
Chronic calcific pancreatitis	0 (0.0)	1 (2.3)	1 (1.0)
Non-Hodgkin's lymphoma	1 (1.8)	0 (0.0)	1 (1.0)
Mesenteric cyst	1 (1.8)	0 (0.0)	1 (1.0)
Total	56 (100)	44 (100)	100 (100%)

There were 62 males and 38 female patients included in the study. There were 34 males (60.7%) and 22 females (39.3%) in the PDS group. While there were 28 males (63.6%) and 16 females (36.4%) in the prolene group. With a p-value of 0.837, there was no significant difference with regard to gender distribution between two

groups. The mean age of the patients in prolene group was 52.52 years (Standard deviation of 11.72 years) and in the PDS group, it was 51.86 years (Standard deviation of 12.39 years). Using independent samples t-test, the difference in the age between the two groups was not statistically significant (p value= 0.784).

The mean BMI of the patients in the prolene group was 21.34kg/m^2 (Standard deviation of 4.07kg/m^2) and it was 21.46kg/m^2 (Standard deviation of 4.94kg/m^2) in the PDS group. The difference in the BMI of the two groups was not statistically significant (p value= 0.890).

Among the PDS group, 7 patients had diabetes mellitus, whereas, in the prolene group, 4 patients had diabetes mellitus. This difference was not statistically significant.

Only one patient in the PDS group had COPD, whereas no patients had COPD in the prolene group. Two patients, one in each group, had bronchial asthma. 3 patients in the PDS group were smokers, whereas only one patient in the prolene group was a smoker.

The indications for the surgeries were varied, including upper GI, lower GI and non-GI pathologies. These are detailed and further grouped according to the suture material used in Table 1. Overall, colorectal malignancies were the most common indications for surgery, followed by carcinoma stomach, carcinoma oesophagus and ileocaecal tuberculosis. Despite the varied indications for surgeries, the most common indications among the two groups (prolene and PDS) were similar and the differences were not statistically significant.

The mean duration of the surgery in the prolene group was 4 hours, whereas in the PDS group it was 3 hours 10 minutes. The difference in the average duration of surgery between the two groups was statistically significant with a p value of 0.020. Figure 4 shows the mean duration of surgeries in the 2 groups along with ±2 standard deviation range on an error bar.

In the prolene group, bowel was opened during surgery in 47 patients (83.92%). In the PDS group, bowel was opened in 39 patients (88.63%). This difference was not statistically significant (p value= 0.572). The same data has been shown in Table 2.

Table 2: The bowel opening during surgery with different suture material.

	PDS	Prolene	Total
Bowel opened	47	39	86
Bowel not opened	9	5	14
Total	56	44	100

Among the patients in whom the bowel was opened, the large bowel was opened in 21 patients in the Prolene group and 22 patients in the PDS group. This difference was found to be not statistically significant (p value= 0.577).

Table 3: Surgical site infection.

Surgical site infection	PDS	Prolene	Total
Yes	13 (23.2%)	20 (45.5%)	33
No	43 (76.8%)	24 (54.5%)	67
Total	56	44	100

Next, author compared the post-operative wound related complications among the two groups (Prolene and PDS). 13 patients (23.2%) in the PDS group developed a surgical site infection and 20 patients (45.5%) in the Prolene group developed a surgical site infection. This difference was found to be statistically significant (p value= 0.031). The same has been shown in Table 3.

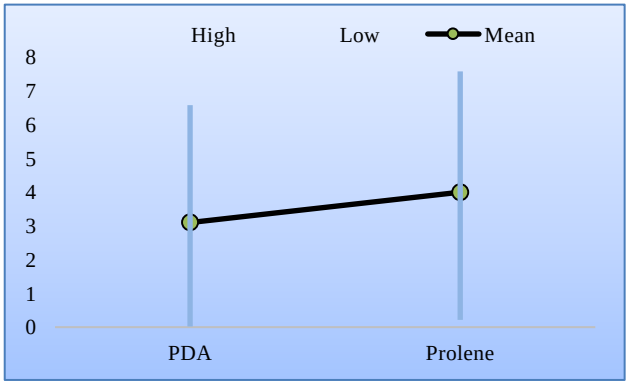

Figure 4: Mean duration of surgeries in the 2 groups along with ±2 standard deviation range on an error bar.

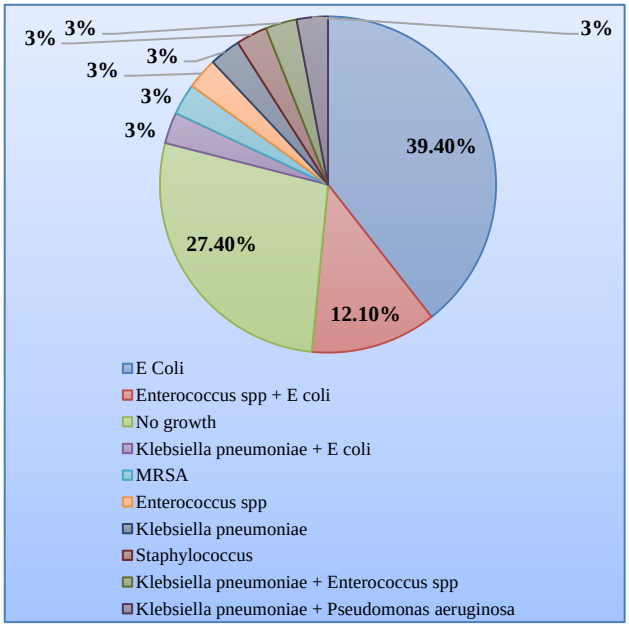

Figure 5: Various culture reports in patients with surgical site infection.

The culture patterns were similar in both the groups. *E. coli* was by far the commonest organism grown in culture from the surgical wound swabs in patients with surgical site infection. It was present in 18 of the 33 patients with surgical site infection (total). Figure 5 shows the different culture reports obtained from patients with surgical site infection.

Table 4: Surgical site infection with patient's surgery duration less than 4 hours.

Surgical site infection	PDS	Prolene	Total
Yes	6 (16.2%)	6 (28.6)	12
No	31 (83.8%)	15 (71.4%)	46
Total	37	21	58

There was a significant difference between the duration of surgery, which itself could be a risk factor for surgical site infection. Hence, a subgroup analysis was done, including only patients whose duration of surgery was less than 4 hours. An independent samples t-test showed that in the subgroup, there was no significant difference in the surgery duration between prolene and PDS groups (p value= 0.380). Further analysis in this subgroup showed that there was no significant difference between the occurrence of surgical site infection between prolene and PDS groups (p value= 0.320). Same is shown in Table 4.

Table 5: Comparing surgical site infection when bowel was opened.

Surgical site infection	PDS	Prolene	Total
Yes	12	17	29
No	35	22	57
Total	47	39	86

Another subgroup analysis was done to see if there was any difference in rate of the surgical site infection between prolene and PDS depending on whether or not bowel was opened. All the subjects were divided on the basis of whether or not the bowel was opened during the surgery. An independent samples t-test showed that there was no significant difference between prolene and PDS groups with respect to surgical site infection, irrespective of whether bowel was opened (p=0.109) or not opened (0.095). The same is shown in Table 5 and Table 6.

Table 6: Comparing surgical site infection when bowel was not opened.

Surgical site infection	PDS	Prolene	Total
Yes	1	3	4
No	8	2	10
Total	9	5	14

Two patients (3.6%) in the PDS group had a burst abdomen. Whereas only 1 patient (2.3%) in the prolene group had a burst abdomen. While no one in the prolene group developed incisional hernia after the surgery, 4 patients in the PDS group had incisional hernias at the laparotomy site.

Due to the very low incidence of these two post-operative complications, the statistical significance of difference between the 2 groups could not be calculated very accurately. Yet, when tested, the difference in occurrence of burst abdomen and incisional hernia between the two groups was not statistically significant.

DISCUSSION

The debate for the ideal suture material and technique for closure of a laparotomy wound still continues. Previous randomized controlled trials of abdominal fascial closure have failed to determine the best technique and the ideal suture. Many of these trials had a small sample size and lacked sufficient power to show significant treatment differences. Results were often conflicting and have left many surgeons uncertain about the ideal suture and technique for abdominal fascial closure. Although a recent study has proposed a change in the technique of abdominal fascial closure, conventional techniques of closure (mass closure and layered closure) are still more popular.[1] Mass closure is the preferred technique of many surgeons, including those at our centre.

Author attempted to compare two suture materials, absorbable - Polydioxanone (PDS) and non-absorbable - Polypropylene (Prolene), to determine which one is superior for abdominal closure. To determine the superiority, we compared the occurrence of specific post-operative complications.

The two groups (prolene and PDS) were well matched with respect to age of the patient, sex distribution, BMI and comorbidities. The only variable where there was a significant difference between the two groups was duration of surgery, which was significantly longer in the prolene group. A subgroup analysis was later done to eliminate the difference.

Table 7: Comparison of sample size of present study to other studies.

Author	Sutures compared	Year published	Sample size
Bloemen et al	PDS Prolene	2011	456
Diener et al	Absorbable Non-absorbable	2010	6752
Van't Riet et al	Absorbable Non-absorbable	2002	2669
Sajid et al	PDS Prolene/Nylon	2011	1728
Present study	PDS Prolene		100

The objectives of this study were to compare the incidence of specific post-operative complications after a laparotomy among two groups in which different suture materials were used for abdominal fascial closure. Numerous studies in the past have found varied results (Table 7, 8).

Table 8: Comparison of present study to other studies.

Author	SSI	Burst abdomen	Incisional hernia
Bloemen et al	No difference	No difference	No difference
Diener et al	No difference	No difference	Non-absorbable suture has higher incidence (p-value: 0.02)
Riet V et al	No difference	No difference	No difference
Sajid et al	No difference	No difference	No difference
Present study	Prolene has higher incidence (p-value: 0.031)	No difference	No difference

In this study, the rate of surgical site infection was significantly higher in the Prolene group than in PDS group. Similar results have been obtained in studies by Weiland et al, Cameron et al and Krukowski et al.[2-4] They also found that the rate of surgical site infection was much higher when Prolene was used for abdominal fascial closure rather than PDS. Similarly, Chalya et al reported a higher incidence of stitch sinus formation with use of Prolene compared to PDS for abdominal fascial closure.[5] Agarwal et al in their studies also reported a higher incidence of stitch sinus formation after using Prolene (but they compared Prolene with Polyglactin for abdominal fascial closure).[6] Bucknall et al reported a higher rate of surgical site infection with non-absorbable (nylon) suture when compared to absorbable (Polyglycolic acid) suture.[7]

Other studies, like the ones by Gaikwad et al, Bloemen et al found no difference in the incidence of surgical site infection between Polydioxanone and non-absorbable suture materials.[8,9] Gaikwad et al compared it with nylon, whereas, Bloemen et al compared it with polypropylene.

Hence, the data available regarding which suture material is superior with regard to occurrence of surgical site infections is conflicting. However, in the current study, the only other significantly different variable among the two groups was the duration of surgery (Mean of 4 hours for Prolene group compared to 3 hr 10 mins for PDS group). The longer duration of surgery could be a factor resulting in higher wound infection in the Prolene group. To test this, a subgroup analysis was done. A subgroup of patient was created where the duration of surgery was less than 4 hours. Now, the mean duration of surgery was not statistically significant between the Prolene and PDS groups. When analysing for surgical site infections, it was found that now there was no significant difference in the occurrence of surgical site infection between Prolene and PDS group.

As the opening of the bowel during the surgery can introduce contaminants which might cause wound infection, another subgroup analysis was done to find out the difference between PDS and Prolene groups with respect to surgical site infection when bowel was opened during the surgery. The difference was found to be statistically insignificant.

Among the patients who did develop a surgical site infection, the commonest organism found in the wound cultures was *E. coli*. It was grown in more than half of the patients with a surgical site infection. The conventional aerobic culture showed 'No growth' in 27.4% patients. The reasons for this could include - anaerobic infection, use of antibiotics prior to taking culture specimen or incorrect technique of obtaining culture specimen.

The high incidence of *E. coli* in wound cultures indicates that empirical use of antibiotics targeting *E. coli* may be justified (after collecting the specimen for appropriate culture) in patients with post-laparotomy surgical site infection.

Regarding burst abdomen (wound dehiscence), the incidence was quite low. Only 2 patients had burst abdomen in the PDS group and 1 patient had burst abdomen in the Prolene group. This data was insufficient to draw any significant conclusions. Some studies have reported a higher incidence of wound dehiscence with the use of Polydioxanone for abdominal fascial closure over non-absorbable sutures (polypropylene or nylon).[2,3,8,10] Others have reported no difference in the occurrence of wound dehiscence between absorbable and non-absorbable suture materials.[5,6,9,11-13]

In this study, there was no incidence of incisional hernias with the use of prolene. However, there were 4 cases of incisional hernias in the PDS group. The overall incidence of incisional hernia in the study was 4%, whereas the incidence within the PDS group was 7.14%. This is within the range of 2-20% incidence of incisional hernia which is mentioned in literature.[14-17]

The data here was insufficient to calculate statistical significance, but the trend appears to show a higher incidence of incisional hernias with the use of PDS. Some studies haveshown that absorbable suture materials (polydioxanone) are associated with higher incidence of incisional hernia than non-absorbable suture materials like polypropylene and nylon. [2,14]

This is in contrast to most studies, which have shown that incisional hernia rates among absorbable and non-

absorbable suture materials are equal. [3,5,6,9,11,13] One study even found absorbable suture materials to be superior to non-absorbable suture materials in preventing the incisional hernia.[10]

Limitation of present study was that the results may not be applicable on emergency cases as we only included elective cases. Another shortcoming is that there was no randomisation or blinding in the study which might have led to some amount of bias in selection of cases. Also, the closures included in the study were performed by various surgeons with different levels of expertise and training, ranging from residents to senior professors. One very important drawback of the study is that since cases were taken from various units in the department of surgery, perioperative antibiotic regimen could not be standardized.

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