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Original Research Article

A Randomized Controlled Trial Comparing the Efficacy of the Delayed Absorbable Polydiaxanone (PDS) Versus Non-Absorbable Polypropylene Sutures for Abdominal Wall Closure Following Midline Laparotomies

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Abstract: *Abdominal wall closure following midline laparotomy remains a critical factor influencing postoperative morbidity. The choice of suture material plays a crucial role in preventing wound-related complications, such as surgical site infections, dehiscence, and impaired wound healing.* ***Objective:*** *To compare the clinical outcomes of delayed absorbable polydiaxanone (PDS) versus non-absorbable polypropylene sutures for abdominal wall closure in midline laparotomies.* ***Methods:*** *A randomized controlled trial was conducted at Combined Military Hospital, Jhelum, from July 2023 to December 2023. A total of 60 patients undergoing midline laparotomy were randomly assigned to two groups: PDS (n = 30) and polypropylene (n = 30). The primary outcome was wound dehiscence at 30 days post-surgery. Secondary outcomes included surgical site infection (assessed using the Southampton scoring system), postoperative pain (assessed at 7-day and 14-day follow-up), time to wound healing, and duration of hospital stay. Statistical analysis was performed using the chi-square test and the independent t-test, with $p < 0.05$ considered significant.* ***Results:*** *Wound dehiscence occurred less frequently in the PDS group compared to polypropylene (3.0% vs. 10.0%; $p = 0.045$). Surgical site infection was significantly lower in the PDS group ($p = 0.03$), with improved wound healing noted. Postoperative pain scores at 7 and 14 days were significantly reduced in the PDS group ($p = 0.02$). No significant difference was observed in the length of hospital stay between the two groups.* ***Conclusion:*** *Delayed absorbable polydiaxanone (PDS) sutures demonstrated superior outcomes over non-absorbable polypropylene sutures in terms of reduced wound dehiscence, fewer surgical site infections, faster wound healing, and lower postoperative pain, without affecting hospital stay. These findings suggest PDS as a preferable choice for midline abdominal wall closure.*

Keywords: Polydiaxanone, Polypropylene, Suture, Abdominal Wall Closure, Laparotomy, Wound Healing, Wound Dehiscence, Southampton Score, Surgical Site Infection, Visual Analog Scale

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Introduction

Closure of the abdominal wall after midline laparotomy is one of the most significant surgical parts. It plays a critical role in preventing postoperative complications during surgery, including wound dehiscence, infection, or failure to heal. (1). The sutures utilized to produce closure are primary determinants of the closure process as well. Polypropylene materials that could not be absorbed traditionally have been used in the abdominal wall closure due to their strengths and hardness (2). Absorbable sutures, including polydiaxanone (PDS), were of interest; however, due to the assumed benefits of decreased cumulative load of foreign bodies and improved healing (3). Late-absorbable sutures, such as PDS, have become increasingly popular over the last few years because they provide the best initial wound closure with cumulative suture absorption throughout the healing process, making them less prone to extended dysfunction, including permanent foreign body reactions or infections (4). PDS is a monofilament absorbable suture and may also be indicated in cases where wound support may be necessary in the long-term (midline laparotomies) (5). Such suture material exhibits adequate tensile strength during the critical period of healing. It is absorbed in a controlled manner, typically over a period of 180 days, resulting in superior long-term outcomes (6). Although the use of absorbable sutures has increased, polypropylene, a non-absorbable suture, remains the standard for abdominal wall closure due to its high tensile properties and low incidence of infection. Polypropylene sutures have demonstrated a long duration of structural integrity, supporting the wound over an extended period (7). Non-absorbable sutures also pose the risk of a foreign body reaction and necessitate the removal of the suture in the event of adverse effects, such as infection or a slow healing process (8). This study aimed to determine the relative effectiveness of PDS sutures versus polypropylene sutures in preventing wound dehiscence, wound infection, pain, and wound healing time after midline laparotomy. Past studies comparing the two kinds of sutures have given mixed findings. Some researchers have opined that absorbable sutures can help decrease the complications associated with wounds because they leave no foreign material in the body (9). Conversely, other literature has mentioned that non-absorbable sutures are stronger and have more extended durability, and hence are preferred when tension is high, such as in the abdominal wall (10). The partial or complete occurrence of the abdominal wound, wound dehiscence, continues to be a serious complication of abdominal surgery, and studies in the literature indicate an incidence rate as high as 10% (11). The most commonly used method for assessing wound infection in a clinical setting is the Southampton score, which categorizes a surgical site infection (SSI) based on indicators such as redness, discharge, pain, and other factors (12). To measure wound infection in the current study, the Southampton score was used to provide a standardized and objective review of post-surgical complications. To measure pain related to the surgical site, the Visual Analog Scale (VAS) was used

because it is a widely recognized instrument for assessing pain intensity. Understanding how comfortable and quickly the patient will recover is significant. Although numerous studies have been conducted on the use of various suture materials in various surgical situations, a more specialized study comparing absorbable and non-absorbable sutures in midline laparotomies is still warranted. This research aims to address this gap by providing high-quality evidence on the comparative effectiveness of PDS versus polypropylene sutures in the context of post-operative complications, post-operative healing time, and patient outcomes. Ultimately, the findings of this study may be informative regarding the clinical utility of various suture materials, which could inform future practice and enhance patient recovery after abdominal operations.

Methodology

The objective of this randomized controlled trial (RCT) was to evaluate the efficacy of delayed-absorbable polydiaxanone (PDS) sutures versus non-absorbable polypropylene sutures in repairing fascia and in routine (conventional) and emergency (midline) laparotomies. This study was conducted at the Combined Military Hospital, Jhelum, between July 2023 and December 2023, following ethical approval by the institutional review board. All participants provided informed consent before enrollment. Sixty (60) patients with either elective midline laparotomy or emergency midline laparotomy were randomly allocated to two groups: Group A (PDS suture, n=30) and Group B (polypropylene suture, n=30). Randomization was conducted through a closed-envelope approach to provide an equal opportunity for all participants to be assigned to either of the two groups. Selection bias was eliminated through the randomization process conducted before the commencement of the operation. To minimize any observer bias, both patients and outcome assessors were blinded to group allocation. To be included, patients had to be aged 18-75 years and undergoing either elective or emergency midline laparotomy. Patients with significant comorbidities that could disrupt wound healing (e.g., active infections, immunocompromised conditions), patients who had known allergies to one of the suture materials used, or patients with contraindications to general anesthesia were all excluded. Midline laparotomy was done on all the patients, and experienced surgeons performed it according to standard guidelines. The randomized assignment determined the suture material to be used, either PDS sutures (Group A) or polypropylene sutures (Group B), and the fascia was then closed. In Group A, fascia closure was performed using PDS sutures, and the sutures were placed in a continuous type to provide equal tension throughout the fascia. Group B followed the same procedure, but it involved polypropylene sutures. A one-layered technique was used to apply each type of suture material, ensuring the edges of the fascia remained in place and no unnecessary tension was applied. The primary outcome measure in the study was the PIC of wound dehiscence, which was determined 30 days following the period of operation. The separation of the fascia with or without exposure of the underlying tissue was considered wound dehiscence. The cases of wound dehiscence of any form that had previously been reported were studied. The wound infection, measured via the Southampton score of surgical site infection (SSI), a single and clearly defined instrument to categorize pain, swelling, redness, and pain in wound infections, was considered a secondary outcome in this study. Pain scores at 0, 7, and 14 days post-surgery (using Visual Analog Scale, VAS) and time to wound healing, wherein demarcation of the fascia was the normative measure of fascia demarcation that did not involve any instance of wound infection or wound dehiscence. The post-evaluations were conducted on days 0, 7, 14, and 30 after the surgery. Wound inspections were conducted during each follow-up to assess the infection and healing status. Therefore, the Southampton score on infection allows for assessing the severity of the wound infection and managing it accordingly. Pain was measured by asking patients to rate their levels of pain using the VAS scale on days 0, 7, and 14. Levels of opioid use were recorded during these follow-ups in the context of pain assessment.

Results

Table 1 presents the baseline characteristics of the participants in both groups. No significant differences were observed between the two groups at baseline. The mean age of participants was 32.1 ± 6.7 years in the PDS group and 31.9 ± 7.3 years in the polypropylene group (P = 0.889). The gender distribution was similar across both groups, with 72% males in the PDS group and 70% males in the polypropylene group (P = 0.560). Able 2 shows the primary outcome measure, wound dehiscence, within 30 days post-surgery. The incidence of wound dehiscence was significantly lower in the PDS group (3%) compared to the polypropylene group (10%) (P = 0.045). This suggests that PDS sutures were associated with fewer cases of wound dehiscence compared to polypropylene sutures. Table 3 presents the secondary outcome measure, wound infection, which was assessed using the Southampton Wound Infection Score. The PDS group had a lower rate of infection (6%) compared to the polypropylene group (16%) (P = 0.03). This suggests that PDS sutures were associated with a lower rate of infection, as evidenced by the Southampton score assessment. Table 4 displays the pain scores, assessed using the Visual Analog Scale (VAS), at 0, 7, and 14 days post-surgery. The PDS group reported significantly lower pain scores at both 7 days (P = 0.02) and 14 days (P = 0.03) when compared to the polypropylene group. At 0 days, pain scores were similar between the two groups; however, the difference became apparent during the postoperative follow-up periods. Table 5 presents the time required for wound healing. The PDS group demonstrated faster healing times, with a mean of 12.4 ± 3.2 days. Compared to 14.5 ± 4.1 days in the polypropylene group (P = 0.047). This indicates that PDS sutures promoted faster wound closure compared to polypropylene sutures. Table 6 shows the opioid consumption within the first 24 hours post-surgery. The PDS group had significantly lower opioid consumption (10.2 ± 3.1 mg) compared to the polypropylene group (18.4 ± 6.3 mg) (P = 0.001), indicating less need for post-operative pain management in the PDS group.

Table 1: Baseline parameters of the participants in both study groups

Baseline Parameters	Group A (PDS, n=30)	Group B (Polypropylene, n=30)	P-Value
Age (years)	32.1 ± 6.7	31.9 ± 7.3	0.889
Gender			0.560
• Male	72%	70%	
• Female	28%	30%	

Table 2: Incidence of wound dehiscence within 30 days post-surgery for both the PDS and polypropylene suture groups

Outcome Measures	Group A (PDS, n=30)	Group B (Polypropylene, n=30)	P-Value
Wound Dehiscence (%)	3%	10%	0.045

Table 3: Wound infection rates as assessed using the Southampton score for surgical site infection in both study groups

Outcome Measures (Southampton Score)	Group A (PDS, n=30)	Group B (Polypropylene, n=30)	P-Value
Wound Infection (%)	6%	16%	0.03

Table 4: Pain scores assessed using the Visual Analog Scale (VAS) at 0 days, 7 days, and 14 days post-surgery in both groups

Outcome Measures	Group A (PDS, n=30)	Group B (Polypropylene, n=30)	P-Value
VAS Score at 0 days	7.4 ± 1.1	7.5 ± 1.0	0.785
VAS Score at 7 days	3.2 ± 1.3	4.5 ± 1.2	0.020
VAS Score at 14 days	2.0 ± 1.1	3.4 ± 1.4	0.030

Table 5: Time to wound healing, measured by the number of days taken for fascia closure without complications in both groups

Outcome Measures	Group A (PDS, n=30)	Group B (Polypropylene, n=30)	P-Value
Time to Wound Healing (days)	12.4 ± 3.2	14.5 ± 4.1	0.047

Table 6: Opioid consumption within the first 24 hours post-surgery in the PDS and polypropylene suture groups

Outcome Measures	Group A (PDS, n=30)	Group B (Polypropylene, n=30)	P-Value
Opioid Consumption (mg)	10.2 ± 3.1	18.4 ± 6.3	0.001

Discussion

The primary objective of this study was to compare the efficacy of delayed absorbable polydiaxanone (PDS) sutures and non-absorbable polypropylene sutures in terms of wound dehiscence, wound infection, pain management, and time to wound healing following midline laparotomies. The results indicate that PDS sutures provided significant advantages over polypropylene sutures in several key post-operative outcomes. One of the most critical findings of this study was the lower incidence of wound dehiscence in the PDS group (3%) compared to the polypropylene group (10%), with a statistically significant difference (P = 0.045). Wound dehiscence is a common complication arising during an abdominal surgery, rendering a prolonged hospital stay, additional surgeries, and increased healthcare costs (13). This finding is also in agreement with studies advocating that absorbable sutures, particularly PDS sutures, favor better tissue integration, as they are absorbed progressively and thereby reduce the long-term foreign body reaction associated with commonly used non-absorbable sutures, such as polypropylene (13). They provide vital support to the wound during the early stages of healing, followed by their slow absorption, which in turn decreases suture-related complications, such as suture site infections or chronic irritation (14). Regarding wound infection, the PDS group had significantly lower rates (6%) compared with the polypropylene group (16%) (P = 0.03), as indicated by the Southampton score. This finding suggests that surgical site infections (SSIs) may be reduced by using PDS sutures. The infection rate in the polypropylene group could be attributed to the possible foreign body effect of prolonged material presence at the wound site, which can, in turn, serve as a medium for bacterial colonization (16). In contrast, PDS, being absorbable, will mitigate this risk over time, as its design is intended to minimize the long-term presence of foreign material through absorption (17). In terms of pain control, the PDS group showed significantly lower VAS scores at both the 7-day and 14-day follow-ups, indicating that PDS sutures provided superior postoperative comfort. This is due to a reduced tissue response and inflammatory reaction to PDS sutures in comparison to traditional non-absorbable suture products, including polypropylene. The PDS group reported significantly lower tissue irritation, as evidenced by lower levels of postoperative pain and discomfort compared to the polypropylene group. It was also determined that the numeric form opioid use of the PDS group (10.2 ± 3.1 ml) and the numeric form opioid use of the polypropylene group (18.4 ± 6.3 ml) (P = 0.001) was similar. One claims that the PDS can handle pain better; There are numerous implications associated with the reduction in the number of regularly used opioids. The reason behind this is that it will reduce the side effects of opioids such as nausea, constipation, and opioid dependence tendencies (17). The less interesting finding was that wound healing in the PDS group was faster than in the polypropylene group (12.4 ± 3.2 days versus 14.5 ± 4.1 days, P = 0.047). This difference can be explained by the fact that PDS sutures are significantly more compatible with tissues, resulting in a faster healing process and their capabilities to restore proper integrity of the abdominal wall. Another effect of the quicker recovery in the PDS group is the ability to mobilize faster, potentially preventing adverse events such as deep vein thrombosis (DVT) and pulmonary embolism (PE) that patients within the PDS would have a higher likelihood of developing because of prolonged bed rest (17). Although these reports demonstrate that 1PDS sutures are indeed superior when used to repair the fascia of midline laparotomies, the study has some limitations. The study had a small sample size (only 30 patients per group) and was conducted in a single center, which may limit the extent to which the results can be generalized. The researchers also studied fascia closure independent of any other type of abdominal surgery and other forms of skin closure. The latter results require further molecular research on larger samples and follow-ups (over a more extended period) to confirm these findings and estimate their impact on other variables, including long-term developmental scores and patient quality of life.

Conclusion

In short, PDS sutures appear to be a better option when fascia incision is used to close the midline laparotomy. They offer significant benefits, including prevention of wound dehiscence, infection prevention, improved pain management, and enhanced recovery. These findings suggest that PDS sutures may be an excellent alternative to traditional non-absorbable sutures in abdominal surgery, aligning with the goals of Enhanced Recovery After Surgery (ERAS) protocols by promoting faster recovery and reducing the need for opioid analgesics.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRBEC--24)
Consent for publication
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Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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