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Antibiotic coating of abdominal closure sutures and wound infection

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Background. *Poor wound healing and the development of infection in incisional wounds continue to be among the most common complications of open abdominal surgery. Various bacteria may contaminate not only the tissue in the operative wound, but also the actual suture material. To prevent the contamination of suture material in surgical wounds, triclosan-coated polyglactin 910 suture materials with antibacterial activity (Vicryl plus) was developed. The aim of this study was to ascertain if the use of Vicryl plus reduced the number of wound infections after midline laparotomy comparing to polydioxanon suture (PDS II).*

Methods. *We performed 2,088 operations in our department between October 2004 and September 2006 via midline incision. In the first time period (TP1), a PDS II loop suture was used. In the second time period (TP2), we used Vicryl plus. All variables were recorded prospectively in a database. The primary outcome was the number of wound infections. Risk factors for poor wound healing were collected prospectively to compare the 2 groups.*

Results. *Using a PDS loop suture for abdominal wall closure in TP1, 10.8% of patients with wound infections were detected. The number of patients with wound infections decreased in TP2 using Vicryl plus for abdominal wall closure to 4.9% (P < .001) despite no other changes in protocols of patient care. Other risk factors for the development of site infections were comparable in the 2 groups.*

Conclusion. *The use of antibiotic-coated loop suture for abdominal wall closure can decrease the number wound infections after abdominal surgery. (Surgery 2009;■:■-■.)*

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POOR WOUND HEALING AND THE DEVELOPMENT OF INFECTION IN INCISIONAL WOUNDS continue to be one of the most common complications in conventional abdominal surgery. In the literature, the incidence of infected wounds after midline laparotomy varies from 4 to 17%,[1,2] Operative wound infection may not only retard normal healing but also may induce life-threatening clinical situations, particularly in critically ill patients.[3,4] The probability of a postoperative surgical site infection developing in a patient is influenced by many intrinsic and extrinsic risk factors present at the time of operation.[3-6] Most important for decreasing the risk of surgical site infection seem to be effective and persistent skin antisepsis, meticulous operative technique, appropriate antimicrobial prophylaxis, and identification of strategies for decreasing wound contamination[6]; patient-related factors, such as age, gender, body mass index, underlying disease, comorbidities, prior operative procedures, and life-style factors (eg, smoking) cannot be controlled or standardized.

The role of suture material in the development of wound infections has been the subject of speculation among surgeons since the 1960s.[7,8] Various bacteria may contaminate not only the tissue in the surgical wound but, the actual suture material.[9,10] Once suture material becomes contaminated, local mechanisms of wound decontamination become ineffective.[9,10] To prevent microbial colonization of suture material in operative wounds, triclosan-coated polyglactin 910 suture materials with antibacterial activity (Vicryl plus; Ethicon GmbH, Norderstedt, Germany) was developed. Several studies showed a considerable decrease in bacterial adherence to triclosan-coated suture in vitro.[11,12] Using Vicryl plus in animal models, different study groups showed the antibacterial efficacy of these sutures.[13,14]

The aim of this study was to compare the incidence of wound infections after midline laparotomy

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using Vicryl plus versus polydioxanon suture (PDS II; Ethicon).

PATIENTS AND METHODS

A total of 6,192 operations were performed in the Department of General Surgery of the University Hospital of the Saarland between October 2004 and September 2006 (Table I). Nearly all major abdominal operations, except liver surgery, were done via midline incision.

Operative technique. The skin was incised with a scalpel; all other layers were transected with diathermy. All patients received intravenous antibiotic prophylaxis (Table II) 45–30 minutes before skin incision; the dose was repeated after 3 hours of operative time. Wound closure was achieved by the technique of continuous mass closure using loop suture and surgical staples for skin. The suture length to incision length ratio was at least 4:1. The running sutures were 1 cm apart and ≥1.5 cm from the wound edge. Between October 2004 and September 2005 (time period 1 [TP1]), a PDS loop suture (PDS II, 150 cm; Ethicon) was used. In the time period between October 2005 and September 2006 (TP2), we used a triclosan-coated polyglactin 910 loop suture (Vicryl plus, 150 cm; Ethicon). In both time periods, all patients were kept warm using a convective air warming system with upper body blanket (Warm-Touch; Mallinckrodt Medical, Hennef/Sieg, Germany) during anesthesia.

Data collection. Data were collected from chart review, including operation reports, nurses wound reports, wound documentation, and reports from the Department of Microbiology and from a department-specific database of complications (Mortality and Morbidity challenge database). All patients with wound infections and secondary wound healing were included, except patients with persistent open abdominal fascia and patients with >4 laparotomies through the same incision.

The primary outcome was the number of wound infections. Wound infection was identified by the presence of erythema, induration, pain, and discharge of serous or contaminated fluid. Risk factors for poor wound healing, such as operative time and patient age, gender, body mass index, blood loss, peritonitis, antibiotics, and performance level classified according to the American Society of Anesthesiologists,[15] were collected prospectively to compare the 2 groups.

Statistical analysis. Data from all patients were entered in a database on an ISH-Med SAP (St. Leon, Germany) platform. Differences between groups were calculated by the χ^2 or Fisher exact test for categorical variables, the Mann–Whitney *U* test for continuously variables, using the SPSS (Version 14, Chicago, Ill) software, and SAS Analytics (SAS Institute GmbH, D-69043; Heidelberg, Germany). Data included all biographic and perioperative data as well as postoperative outcome. Data are given as absolute numbers, mean and standard error of the mean, or as median (range), unless indicated otherwise.

Table I. Demographic data of 2,088 patients undergoing midline laparotomy

Parameters	*PDS II*	*Vicryl plus*	P
n	1,045	1,043	
Gender			.964
Male	625 (60%)	622 (60%)	
Female	420 (40%)	421 (40%)	
Age (yrs)	60.51 ± 15.91	61.52 ± 14.32	.744
0–29	35 (3%)	39 (3%)	
30–39	51 (4%)	49 (4%)	
40–49	133 (12%)	126 (12%)	
50–59	223 (21%)	217 (20%)	
60–69	279 (26%)	272 (26%)	
70–79	261 (24%)	269 (25%)	
80–89	67 (6%)	65 (6%)	
>89	6 (0.5%)	5 (0.5%)	
BMI			.217
<18	66 (6%)	53 (5%)	
18–25	504 (48%)	517 (49%)	
26–30	333 (31%)	335 (32.%)	
>30	140 (13%)	138 (13%)	
ASA class			.691
1	41 (3%)	49 (4%)	
2	394 (37%)	401 (38%)	
3	442 (42%)	428 (41%)	
4	165 (15%)	165 (15%)	
Diabetes mellitus			.588
Oral antidiabetics	80 (7%)	84 (8%)	
Insulin	39 (3%)	43 (4%)	
Immunosuppression	37 (3%)	50 (4%)	.156
Steroids	33 (3%)	46 (4%)	
Azathioprine	4 (0.4%)	3 (0.3%)	
MMF and steroids	0	1 (0.1%)	
Crohn disease	39 (3%)	46 (4%)	.441
Malignant disease	453 (43%)	419 (40%)	.156
Peritonitis	150 (14%)	159 (15%)	.579
Wound status			.601
Clean	416 (39%)	431 (41%)	
Clean contaminated	293 (28%)	305 (29%)	
Contaminated	246 (23%)	224 (21%)	
Dirty	90 (8%)	82 (7%)	
Emergency procedure	370 (35%)	366 (35%)	.927

ASA, American Society of Anesthesiologists; *BMI*, body mass index; *MMF*, mycophenolate mofetil.

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Table II. Antibiotics used as single-shot dosage perioperatively in 2,088 patients

Parameter	*PDS II*	*Vicryl plus*	P
Antibiotics			.337
Ceftriaxone and metronidazole	248 (24%)	282 (27%)	
Sulbactam and ampicillin	555 (53%)	521 (50%)	
Ciprofloxacin	93 (9%)	87 (8%)	
Ceftriaxone	91 (9%)	94 (9%)	
Others*	58 (6%)	59 (6%)	
Total	1045	1043	

*Others: carbapenems (TP1: 28, TP2: 24); glycopeptides (TP1: 5, TP2: 3); quinolones (not ciprofloxacin; TP1: 15, TP2: 18), quinolone + cephalosporin (TP1: 10, TP2: 13).
Oxazolidinones (TP2: 1).

RESULTS

During TP1 and TP2 3257 and 2935 operations were carried out in our department, respectively. About one third of all operations were done by midline laparotomy in both time periods (TP1, 1,045 [32.0%]; TP2, 1,043 [35.5%]). The types of operations are shown in Table III. The 2 time periods were comparable regarding to operation time, blood loss, mortality, median hospital stay, and days on ICU (Table IV).

Wound infections. Using a PDS II loop suture for abdominal wall closure in TP1, 113 patients (10.8% of midline laparotomy) with wound infections were detected. The number of patients with wound infections decreased ($P < .001$) in TP2 (using Vicryl plus for abdominal wall closure) to 51 (4.9% of midline laparotomy; Table IV).

Risk factors. The age of patients operated via midline incision was not different between time periods (60.5 ± 15.9 vs 62.3 ± 14.3; $P = .164$). In both groups, more male than female patients were operated (Table III). The mean operative times were comparable (153 ± 93 vs 161 ± 87 minutes; $P = .481$). Similarly, body mass index and the American Society of Anesthesiologists classification did not differ.

When analyzing specific risk factors for the development of wound infections, the 2 groups were comparable regarding number of revisions, patients with diabetes mellitus, malignancy, continuous immunosuppression therapy, emergency surgery, peritonitis, and number of patients with Crohn disease (Tables III and IV).

DISCUSSION

Poor wound healing and the development of infection in incisional wounds not only retard normal wound healing, but also may induce life-threatening clinical situations. Together with this impact on the patients' life, the morbidity from surgical wounds is very expensive because of the associated treatment costs for wound care, antibiotics, prolonged hospitalization, and loss of work productivity.[4,16] Many risk factors for poor wound healing are known. In this study, we examined the role of suture material in the development of poor wound healing.

To the best of the authors' knowledge, this is the first time that the effect of antibacterial-coated sutures for abdominal closure has been evaluated in a large cohort. Using the triclosan-coated suture material, we decreased the number of wound infections after midline incision in >2,000 patients. Our data suggest that contaminated suture material plays an important role in the development of wound infections. The presence of foreign materials in a wound enhances the susceptibility of surrounding tissues to infection. The number of bacteria needed to establish infection can be reduced 10,000-fold by the presence of a silk suture.[17,18] Microbial adherence to the surface of suture material has been reported in the surgical literature for many years.[19,20] Once suture material becomes contaminated, local mechanism of wound decontamination become ineffective.[9,10] Early studies demonstrated that adherence of bacteria to suture material is highly variable, and is dependent on the specific microbial species, and structure and chemical composition of the suture material.[21,22] Development of an antibacterial suture has been under consideration for about 20 years.[11-27] To prevent colonization of the suture material by bacteria in surgical wounds, triclosan-coated polyglactin 910 suture with antibacterial activity was developed. Several studies showed a considerable decrease in bacterial adherence to triclosan-coated suture in vitro.[11,12] Using triclosan-coated polyglactin 910 in animal models, different groups showed the antibacterial efficacy of these sutures.[13,14] Ford et al[28] reported in 2005 that triclosan-coated polyglactin sutures decreased postoperative pain in pediatric patients. Our data using triclosan-coated polyglactin 910 suture for abdominal wall closure in >2,000 patients suggest that the use of antibacterial-coated suture material decreases operative wound infections after a midline laparotomy. Together with effective and persistent skin antisepsis, meticulous operative technique, and appropriate antimicrobial prophylaxis, the use of antibiotic-coated suture material may help to prevent wound infections in different kinds of abdominal surgery, including colorectal,

Table III. Characteristics of the 2,088 midline laparotomies performed

Parameters	*PDS II*	*Vicryl plus*	P
Operative procedure			.089
Visceral surgery			
Foregut surgery	167 (16%)	145 (14%)	
Hepatopancreatobiliary surgery*	149 (14%)	172 (16%)	
Small bowl	178 (17%)	146 (14%)	
Colorectal surgery	365 (34%)	353 (34%)	
Multivisceral resection	12 (1%)	14 (1%)	
Splenectomy	14 (1%)	18 (1%)	
Adrenalectomy	9 (1%)	13 (1%)	
Appendectomy	33 (3%)	42 (4%)	
Explorative laparotomy	25 (2%)	34 (3%)	
Tumor resection (GIST, sarcoma)	4 (0.4%)	8 (0.8%)	
Abdominal lavation	7 (0.7%)	9 (0.8%)	
Vascular surgery			
Abdominal aorta	75 (7%)	80 (7%)	
Abdominal veins	2 (0.2%)	3 (0.2%)	
Intestinal arteries	5 (0.4%)	6 (0.5%)	
Total	1,045 (100%)	1,043 (100%)	

*Liver resections were performed via transverse abdominal incision.

Table IV. Special data of 2,088 patients undergoing midline laparotomy

Parameters	*PDS II*	*Vicryl plus*	P
n	1,045	1,043	
Blood loss (mL)	294.0 ± 491.3	318.0 ± 596.3	.952
Laparotomy			.136
First	806 (77.1%)	760 (72.8%)	
Second	141 (13.5%)	165 (15.8%)	
Third	59 (5.6%)	76 (7.3%)	
Fourth	39 (3.7%)	42 (4.0%)	
Mortality	36 (3.4%)	39 (3.7%)	.658
ICU (days)	4.2 ± 9.5 (0–65)	4.7 ± 10.0 (0–71)	.484
IHOS (days)	8.3 ± 7.5 (5–65)	7.9 ± 8.0 (3–77)	.420
OR time (min)	152 ± 93	161 ± 87	.380
Wound infections	113 (10.8%)	51 (4.9%)	<.001

ICU, Duration of treatment on intensive care unit; *IHOS,* duration of stay in hospital; *OR time,* operation time from incision to wound closure. All data are presented as mean values ± SD.

hepatopancreatic, and vascular surgery. Analyzing our data retrospectively, we tried to exclude other risk factors influencing wound infections. Although other known factors for the development of wound infections were comparable in the 2 groups, it has to be pointed out that postoperative wound infections are difficult to standardize.

There are limitations to our study. The study was done in a single center in Germany over 2 different time periods and using 2 different types of suture material. There is no denying the superiority of a prospective, randomized study, but the large number of patients, the detailed prospective documentation, and the standardized surgical procedures of our study support the quality of our data. Nevertheless our results should be confirmed by large, multicenter, prospective, randomized, and blinded studies evaluating the clinical outcome of antibiotic-coated suture material.

In conclusion, our data show that the use of antibiotic-coated loop suture for abdominal wall closure can reduce the number of poorly healing wounds after abdominal surgery.

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