Int Surg 2013;**98:**129–132
DOI: 10.9738/CC179

A Study of the Efficacy of Antibacterial Sutures for Surgical Site Infection: A Retrospective Controlled Trial

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To reduce bacterial adherence to surgical sutures, triclosan-coated polyglactin 910 suture materials with antiseptic activity were developed. The aim of this study was to evaluate whether the incidence of surgical site infections can be reduced when triclosan-coated sutures are used. Until December 2009, we used conventional polyglactin 910 sutures (VICRYL, Ethicon) for the closure of the fascia in digestive tract surgery. Therefore, for the control group we retrospectively collected surveillance data for 1.5 years. In the control group, 611 patients underwent digestive tract surgery with VICRYL sutures. Beginning in July 2010, we used triclosan-coated polyglactin 910 sutures (VICRYL Plus, Ethicon, Tokyo, Japan) for the closure of the fascia in all digestive surgeries. So, we collected data for the study group from July 2010 until June 2011. In the study group, 467 patients underwent digestive tract surgery with triclosan-coated VICRYL Plus sutures. In the control group, 75 patients (12.2%) developed wound infections. In the study group, 31 patients (6.6%) developed wound infections, which was significantly lower. Emergency cases; laparoscopic cases, including some cholecystectomy and colectomy cases; American Society of Anesthesiologists classification; the use of immunosuppressive therapy; colostomy cases; wound classification; and suture material were identified as the risk factors for wound infections. In both groups, as the wound classification worsened, the wound infection rate increased. Triclosan-coated polyglactin 910 antimicrobial sutures lead to a significant decrease in the incidence of surgical site infections, especially in clean/contaminated cases.

Key words: Triclosan-coated polyglactin 910 – Surgical site infection – Antimicrobial suture – Wound classification

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Surgical site infections (SSIs) continue to be one of the most common complications in conventional surgery. Various risk factors for the development of poor wound healing have been identified.[1–3] Although patient-related factors, such as sex, age, body mass index (BMI), complications, prior surgical procedures, and lifestyle-related factors, are difficult to control, meticulous surgical technique, skin antisepsis, appropriate antimicrobial prophylaxis, and the identification of strategies for decreasing wound contamination are the most important surgery-related factors that can help decrease the risk of SSIs. In addition, the presence of suture material in wounds increases the susceptibility of the tissue to infection.[4,5] To prevent microbial colonization of suture materials, triclosan-coated polyglactin 910 (VICRYL Plus, Ethicon) sutures were developed. Although several studies have shown the superiority of VICRYL Plus in *in vitro* and *in vivo* studies, no evaluation was done according to the wound classification.[6–11]

The most widely recognized definition of infection, which is used throughout the United States and Europe, is that devised and adopted by the Centers for Disease Control and Prevention.[12] An SSI is defined as an infection occurring within 30 days of surgery that meets the following criteria: (1) the diagnosis consists of the infection of an anatomic plane by one of the following manifestations: collection, inflammatory signs (pain, edema, tenderness, redness), dehiscence, or positive culture; and (2) classification according to the anatomic plane as follows[13]: superficial incisional SSI, infection of the skin and subcutaneous tissue; deep incisional SSI, infection of the deep soft tissue (fascia and muscles); and organ/space SSI, infection of the organ/space. In this study, SSIs were categorized by the above classifications.

A system of classification for surgical wounds that is based on the degree of microbial contamination was developed by the US National Research Council group in 1964.[14] Four wound classes with an increasing risk of SSI were described: clean, clean-contaminated, contaminated, and dirty. In this study, SSIs were researched based on each of the wound classes.

The aim of this study was to evaluate whether the incidence of SSIs can be reduced when triclosan-coated sutures are used for the closure of the fascia, and to evaluate the incidence of SSIs according to each wound classification.

Patients and Methods

Until December 2009, we used conventional polyglactin 910 sutures (VICRYL) for the closure of the fascia in digestive tract surgery. Therefore, for the control group we retrospectively collected surveillance data for 1.5 years, including the patient age, sex, BMI, diagnosis, complication data, preoperative compete blood count, American Society of Anesthesiologists (ASA) physical status score as determined by an anesthesiologist, procedures performed, data regarding the operation, duration of the operation, quantity of blood lost, quantity of blood transfused, and surgical wound classification. Beginning in July 2010, we used triclosan-coated polyglactin 910 sutures (VICRYL Plus) for the closure of the fascia in all digestive surgeries. So, we collected data for the study group from July 2010 until June 2011.

Signs of SSIs according to the Centers for Disease Control and Prevention criteria were monitored over a period of 30 days. After discharge, patients were requested to return to the outpatient clinic about 30 days after surgery.

The analysis was performed using the SAS statistical software package (SAS Inc, Cary, North Carolina). The variables were compared using the χ^2 test and Student *t* test for categoric and continuous variables. The univariate analysis and multivariate logistic regression analyses were used to determine predictors for the risk of SSIs.

Results

In the control group, 611 patients underwent digestive tract surgery with Vicryl sutures. Of these patients, 15 were excluded because of complicated organ/space SSIs. In the study group, 467 patients underwent digestive tract surgery with triclosan-coated VICRYL Plus sutures. Twelve patients were excluded from the study group because of organ/space SSIs.

There were no significant differences between the groups regarding the age, sex, and other risk factors for SSI, such as diabetes, smoking, use of immunosuppressive therapy, or BMI. The preoperative white blood cell count and lymphocyte count were not differentiated, but the C-reactive protein level was higher in the study group. The patient characteristics in both groups, as well as the SSI risk factors, are shown in Table 1. Furthermore, both groups were comparable with regard to the procedures performed, length of the operation, blood loss, and blood transfusion. The site of the operation, the use of a

Table 1 Characteristics

	Control group	Study group	*P*
Age, y	64.04	64.02	0.982
Male:female	360:255	274:178	0.983
DM, +:−	81:511	61:391	0.93
Smoking, +:−	104:488	61:390	0.076
Steroid, No. (%)	12 (2)	6 (1.33)	0.385
BMI	21.2	21.9	0.280
WBC count	6098	6473	0.051
Lymphocyte %	25.5	24.4	0.661
CRP level	1.042	1.793	0.002

CRP, C-reactive protein; DM, diabetes mellitus; WBC, white blood cell.

laparoscope, and the rate of colostomy were also not significantly different (Table 2), nor were the surgical sites (Table 3).

Wound infections

In the control group, 72 of 596 patients (12.2%) developed wound infections. In the study group, 30 of 455 patients (6.6%) developed wound infections. These rates were significantly different by the χ^2 test. In the univariate logistic regression analysis, emergency cases, laparoscopic cases, those with an ASA classification, those on immunosuppressive therapy, colostomy cases, a higher wound classification, and the suture material were the risk factors for the development of a wound infection. In the multivariate logistic regression analysis, laparoscopic cases, ASA classification, and wound classification were the risk factors for a wound infection (Table 4). In both cases, as the wound classification worsened, the wound infection rate increased. However, the difference was only significant for clean/contaminated cases ($P = 0.0001$; Fig. 1).

Discussion

The surgical materials are the easily changed risk factor. Triclosan, a widely used antibacterial agent, possesses potent activity against the most common bacteria responsible for SSIs. Because triclosan is an antibacterial agent, and not an antibiotic, the risk of resistance is very low.[15] Triclosan is a broad-spectrum antibacterial agent that has been used for more than 30 years in various products, such as soap and toothpaste. Its mode of action is thought to be through the nonspecific disruption of the bacterial cell membrane.[16] Galal and El-Hindawy[17] reported a prospective, randomized, double-blind study that showed that triclosan-coated polyglactin 910 reduced the incidence of SSIs from 15% to 7%. In another study of 2088 patients, the rate of SSIs was decreased from 10.8% in a polyglactin closed group to 4.9% in a triclosan-coated polyglactin 910 antimicrobial suture (VICRYL Plus) group.

In a sternal wound closure study, the rate of SSI after the use of VICRYL Plus was found to be 0 of 103 (0%) versus 24 of 376 (6%) after the use of conventional VICRYL.[18] In another study in cerebrospinal fluid shunt surgery, the shunt infection rate when triclosan-coated polyglactin 910 antimicrobial sutures were used was 4.3% versus 21% in a conventional polyglactin 910 suture group.[19]

In a recent study, many kinds of digestive tract surgery were examined. SSIs occurred in 30 of 455 patients (6.6%) in the study group versus 72 of 596 (12.2%) in the control group. In each wound classification, the incidence of SSIs was lower in the

Table 2 Characteristics

	Control group	Study group	*P*
OR time, min	219.4	216.4	0.777
Blood loss, mL	288.5	282.3	0.887
Transfusion, mL	42.8	49.8	0.622
Laparoscopic, No. (%)	164 (27.5)	136 (30.1)	0.606
Stoma, No. (%)	33 (5.5)	23 (5.1)	0.726
SSIs, %	12.2	6.6	0.002

OR time, operation time.

Table 3 Category of surgery

	Control group	Study group	*P*
Esophagus	14	11	
Stomach	103	79	
Small intestine	32	37	
Colorectal	197	141	
Liver	37	29	
Cholecystis	118	109	
Other	88	49	0.201

Table 4 Univariate and multivariate logistic regression analyses for wound infection

	Univariate	Multivariate
Sex	0.4778	
Emergency	0.0086	0.2761
Laparoscope	<0.0001	0.0007
ASA score	<0.0001	0.02
DM	0.7815	
Smoking	0.7935	
Wound class	<0.0001	<0.0001
Stoma	<0.0001	0.088
VICRYL Plus	0.0036	0.7067

DM, diabetes mellitus.

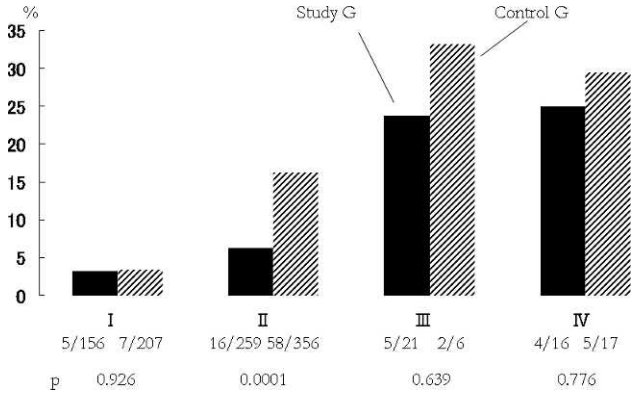

Fig. 1 SSI rate by wound classification.

study group. However, in the present study there was only a significant difference in the clean/contaminated cases (4 of 16 versus 5 of 17; $P = 0.776$). These results suggest that it was difficult to prevent SSIs with the triclosan-coated polyglactin 910 antimicrobial suture in dirty cases. Triclosan may therefore be most effective in clean and clean/contaminated cases. To the best of our knowledge, this is the first time that the effect of antibacterial-coated sutures has been evaluated for each wound classification. More studies are needed to reduce the incidence of SSIs in contaminated and dirty wound cases.

The study was done in a single center in Japan during two different time periods and used two different types of suture material. There is no denying the superiority of a prospective, randomized study, but the large number of patients will support the quality of our data.

The use of triclosan-coated polyglactin 910 antimicrobial sutures leads to a significant decrease in the incidence of SSIs, especially in clean/contaminated cases.

References

1. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for Prevention of Surgical Site Infection, 1999. Centers for Disease Control and Prevention (CDC) Hospital Infection Control Practice Advisory Committee. *Am J Infect Control* 1999;**27**(2):97–132
2. National Nosocomial Infections Surveillance System. National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 through June 2004, issued October 2004. *Am J Infect Control* 2004;**32**(8):470–485
3. Engemann JJ, Carmeli Y, Cosgrove SE, Fowler VG, Bronstein MZ, Trivette SL *et al*. Adverse and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection. *Clin Infect Dis* 2003;**36**(5):592–598
4. Katz S, Izhar M, Mirelman D. Bacterial adherence to surgical sutures: a possible factor in suture induced infection. *Ann Surg* 1981;**194**(1):35–41
5. Edlich RF, Panek PH, Rodeheaver GT, Turenbull VG, Kurtz LD, Edgerton MT. Physical and chemical configuration of sutures in the development of surgical infection. *Ann Surg* 1973;**177**(6):679–688
6. Fleck T, Moidl R, Blacky A, Fleck M, Wolner E, Grabenwoger M *et al*. Triclosan-coated sutures for the reduction of sternal wound infections: economic considerations. *Ann Thorac Surg* 2007;**84**(6):232–236
7. Justinger C, Moussavian MR, Schlueter C, Kopp B, Kollmar O, Schilling MK. Antibacterial coating of abdominal closure sutures and wound infection. *Surgery* 2009;**145**(3):330–334
8. Justinger C, Schuld J, Sperling J, Kollmer O, Richter S, Schilling MK. Triclosan-coated sutures reduce wound infections after hepatobiliary surgery-a prospective non-randomized clinical pathway driven study. *Langenbecks Arch Surg* 2011;**396**(6):845–850
9. Rasic Z, Schwarz D, Adam VN, Sever M, Lojo N, Rasic D *et al*. Efficacy of antimicrobial triclosan-coated polyglactin 910 (Vicryl* Plus) suture for closure of the abdominal wall after colorectal surgery. *Coll Antropol* 2011;**35**(2):439–443
10. Rothenburger S, Spangler D, Bhende S, Burkley D. In vitro antimicrobial evaluation of coated VICRYL plus antibacterial suture (coated polyglactin 910 with triclosan) using zone of inhibition assays. *Surg Infect (Larchmt)* 2004;**3**(suppl 1):S79–S87
11. Storch ML, Rothenburger S, Jacinto G. Experimental efficacy of coated VICRYL plus antibacterial suture in guinea pigs challenged with staphylococcus aureus. *Surg Infect (Larchmt)* 2004;**5**(3):281–288
12. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. Definitions of nosocomial surgical site infections; 1992: a modification of CDC definitions of surgical wound infections. *Infect Control Hosp Epidemiol* 1992;**13**(10):606–608
13. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. *Am J Infect Control* 1999;**27**(2):97–134
14. Berard F, Gandon J. Postoperative wound infections: the influence of ultraviolet irradiation of the operating room and of various other factors. *Ann Surg* 1964;**160**(suppl 2):1–192
15. Slater-Radosti C, Van Aller G, Greenwood R, Nicholas R, Keller PM, DeWolf WE Jr *et al*. Biochemical and genetic characterization of the action of triclosan on *Staphylococcus aureus*. *J Antimicrob Chemother* 2001;**48**(1):1–6
16. Escalada MG, Harwood JL, Maillard JY, Ochs D. Triclosan inhibition of fatty acid synthesis and its effect on growth of *Escherichia coli* and *Pseudomonas aeruginosa*. *J Antimicrob Chemother* 2005;**55**(6):879–882
17. Galal I, El-Hindawy K. Impact of using triclosan-antibacterial sutures on incidence of surgical site infection. *Am J Surg* 2011; **202**(2):133–138
18. Fleck T, Moidl R, Blacky A, Fleck M, Wolner E, Grabenwoger M *et al*. Triclosan-coated sutures for the reduction of sternal wound infections: economic considerations. *Ann Thorac Surg* 2007;**84**(1):232–236
19. Rozzelle CJ, Leonardo J, Li V. Antimicrobial suture wound closure for cerebrospinal fluid surgery: a prospective, double-blinded, randomized controlled trial. *J Neurosurg Pediatr* 2008; **2**(2):111–117