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Wound Infection in Abdominal Surgery by Using Double Ring Wall Autoretractor

Juan J Arenal[1,3], John H. Herrera[1], Agustín Martínez[2], Claudia Tinoco[3], César Benito[3], Miguel A Citores[3], Alejandro Acosta[1] and José M Eiros[4]*

[1]Department of Surgery, Hospital Recoletas Campo Grande, Spain

[2]Department of Anaesthesia, Hospital Recoletas Campo Grande, Spain

[3]Department of Surgery, University Hospital Río Hortega, Spain

[4]Department of Microbiology, University Hospital Río Hortega, Spain

Abstract

Background: Surgical Site Infection (SSI) remains an important problem in abdominal surgery. The aim of this study is to determine if the use of a wound protection system can be effective in reducing the incidence of wound infection after abdominal surgery.

Methods: Prospective observational study over 409 consecutive patients underwent laparotomy by two surgeons during an eight-year period (2010-2018). A laparotomy auto-retractor was used in all cases (Alexis Wound Retractor; Applied Medical, Rancho Santa Margarita, CA). Ther were151 colorectal resections, 144 appendicectomies, 80 cholecystectomies, 14 gastrectomies and other operations in 20 cases. Preoperative antibiotic prophylaxis was given to all patients. To perform the laparotomy, the skin, subcutaneous tissue, fascia and peritoneum were cut with diathermy. On closing the laparotomy, gloves were changed and no previously used needle holders, forceps, and separators were used. No antibacterial-coated sutures were used for laparotomy closure. The principal variable of the study was wound infection at 30 days, both deep and superficial.

Results: Median age of the series was 58 years (range 14-92). The median Body Mass Index was 24 (range 18-39.5). One hundred and eighty patientes (44%) were operated on an emergency basis. Two hundred and ninety six patients were classified ASA I-II (72%). There were oly four cases of wound infection (1%). The median postoperative stay was four days (range 1-34).

Conclusion: Our results suggest that Alexis wound retractor, is an effective wound edge protector, which contributes to significantly reduce the wound infection rate in abdominal surgery.

Keywords: Wound infection; Wound edge protector; Double ring retractor; Wound isolation

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Correspondence:

Juan J Arenal, Department of Surgery, Hospital Recoletas Campo Grande, Plaza de Poniente 2, 3º 47003, Valladolid, Spain, Tel: +34 606387995; E-mail: jujoarve@yahoo.com

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Introduction

Surgical Site Infection (SSI) remains a common complication after abdominal surgery. Since the introduction of antibiotic prophylaxis in the 1970s, very little improvement has been achieved in wound infection outcomes, especially after gastrointestinal and biliary surgery [1,2]. During the last decades, most of the preventive efforts have been directed toward the destruction of the bacterial inoculum in the surgical wounds and to detection of patient-associated risk factors as an alternative method for managing wound infections; forty years later, these methods are being proposed as the direction of future research [3]. Nonetheless, the only inarguable fact is that production of a surgical wound infection requires that pathogenic microorganisms come into contact with the wound. Introduction of autoretractors in abdominal surgical procedures, which also act as barrier protectors, has resulted in a dramatic decrease in the rates of surgical wound infections in colorectal surgery [2,4-8]. However, those reports only had a small number of cases. In this prospective study, we anlyzed the clinical value of a double ring retractor to prevent the ocurrence of wound infections in 409 patients who underwent abdominal surgery.

Methods

A prospective observational study was done between January 2010 and July 2018 with over 409 consecutive patients who had undergone any type of laparotomy by one of two surgeons. Thirty-eight patients underwent surgery in a 600 bed tertiary university hospital and 371 in a private 70 bed hospital. A laparotomy auto-retractor was used in all cases (Alexis Wound Retractor; Applied

Table 1: Description of the series.

	Colorectal resection	Appendicectomy	Cholecystectomy	Gastrectomy	Other	Total
	N=151	N=144	N=80	N=14	N=20	N=409
Age (median)	68	34	62	61.5	70	58
Sex						
Male	83 (55%)	77 (53%)	38 (48%)	8 (57%)	4 (20%)	210 (51%)
Female	68 (45%)	67(47%)	42 (52%)	6 (43%)	16 (80%)	199 (49%)
Surgery						
Elective	137 (91%)	3 (2%)	63 (79%)	14 (100%)	12 (60%)	229 (56%)
Emergency	14 (9%)	141 (98%)	17 (21%)	---	8 (40%)	180 (44%)
ASA grade						
I-II	90 (60%)	135 (94%)	51 (64%)	9 (64%)	11 (55%)	296 (72%)
III-IV	61 (40%)	9 (6%)	29 (36%)	5 (36%)	9 (45%)	113 (28%)
BMI (median)(kg/m²)	24.8	24.2	26	23.7	24	24
Antibiotic prophylaxis						
Amoxicillin-clavulanic	21 (14%)	111 (77%)	70 (88%)	14 (100%)	14 (70%)	230 (56%)
Cefotaxime+metronidazole	128 (85%)	31 (22%)	9 (11%)	----	5 (25%)	173 (42%)
Ciprofloxacin+metronidazole	2 (1%)	2 (1%)	----	----	1 (5%)	5 (1%)
Imipenem+metronidazole	----	----	1 (1%)	----	----	1 (0.2%)
Type of incision						
Minilaparotomy	69 (50%)	138 (98%)	60 (75%)	----	5 (25%)	272 (67%)
Formal laparotomy	82 (50%)	6 (2%)	20 (25%)	14 (100%)	15 (75%)	137 (33%)
Location of incision						
Medium	61 (40%)	6 (4%)	1 (1%)	10 (71%)	14 (70%)	92 (23%)
Transverse	90 (60%)	2 (1%)	1 (1%)	----	1 (5%)	94 (23%)
Subcostal	----	----	78 (98%)	4 (29%)	4 (20%)	86 (21%)
Mc Burney	----	136 (95%)	----	----	1 (5%)	137 (33%)
Emergency Pathology						
No complicated appendicitis	----	110 (76%)	----	----	----	110 (27%)
No complicated cholecystitys	----	----	12 (15%)	----	----	12 (3%)
Bowel obstruction	9 (2%)	----	----	----	8 (40%)	17 (4%)
Local Peritonits	2 (0.5%)	27 (19%)	5 (6%)	----	----	34 (8%)
General peritonitis	2 (0.5%)	7 (5%)	----	----	----	9 (2%)
Gangrene	----	34 (24%)	5 (6%)	----	----	39 (10%)
	1 (0.3%)	----	----	----	----	1 (0.2%)
Postoperative stay (median)	7	2	2	8	4	4

Table 2: Results by type of surgery.

	Colorectal resection N=151	Appendicectomy N=144	Cholecystectomy N=80	Gastrectomy N=14	Other N=20
Wound infection	1 (0.7%)	----	2 (2.5 %)	----	1 (5%)
Anastomotic dehiscence	5 (3.3%)	----	----	1 (7%)	----
Anastomotic fistula	2 (1.3%)	----	----	1 (7%)	----
Intra-abdominal abscess	4 (2.6%)	1 (1%)	1 (1.3%)	----	----
Intestinal obstruction	4 (2.6%)	2 (2%)	----	----	----
Pancreatic fistula	2 (1.3%)	----	----	----	----
Deep venous thrombosis	2 (1.3%)	----	----	----	----
Respiratory fin sufficiency	2 (1.3%)	1 (1%)	1 (1.3%)	----	----
Pneumothorax	1 (0.7%)	----	----	----	----
Bleeding	3 (2.0%)	----	----	----	----
Myocardial infarction	2 (1.3%)	----	----	----	----
Pseudomembranous colitis	----	1 (1%)	----	----	----
Fistula of cystic duct stump	----	----	3 (3.8%)	----	----
Percutaneous drainage	2 (1.3%)	1 (1%)	2 (2.5%)	----	----
Reoperation	6 (4.0%)	1 (1%)	1 (1.3%)	1 (7%)	----

Medical, Rancho Santa Margarita, CA). Alexis wound retractors provide 360° of atraumatic, circumferential retraction and reduce the need for hand-held retractors. The Alexis O-Ring consists of two stiff rings with a polyurethane cylinder in-between the two rings. The inner ring is positioned within the peritoneal cavity. The outer ring is rolled up until it is circumferentially taut around the wound. Six sizes are available for different lengths of surgical incision, which range from XX-small (for 1 cm to 3 cm incisions) to XX-large (for 17 cm to 25 cm incisions). The size that best matches the length of the laparotomy was used in each operation. Preoperative antibiotic prophylaxis was given to all patients. Patients received standard care during surgery (no normothermia). In order to perform the laparotomy, the skin, subcutaneous tissue, fascia and peritoneum were cut with diathermy. No antibacterial-coated sutures were used for laparotomy closure.

Table 3: Rates of wound infection reported in the last years for abdominal surgery.

Author	Type of surgery	Rate of wound infection
De Werra C et al. [27]	Colon operation Appendicectomy Cholecystectomy Small bowel Laparotomy	12.5% 4.3% 3.1% 16.3% 7.4%
Xiao Y et al. [28]	Appendicectomy	6.7%
Degrate et al. [29]	Colorectal surgery	11.2%
Isik O et al. [30]	Hepatobiliary Colorectal Upper GI	7.2% 10.4% 8.8%
Rafiq MS et al. [31]	no complicated appendicitis	8.5%
Yamamoto et al. [32]	Colorectal perforation Control Bundle SSI	 43% 20%
Ozmen et al. [33]	Gastric cancer surgery	19%
Jeong SJ et al. [34]	Gastric surgery	3.3%
Park SJ et al. [35]	Gastrectomy Colectomy Cholecystectomy Appendectomy	3.4% 6.6% 0.9% 3.3%
Karthik S et al. [36]	Laparoscopic cholecystectomy	1.8%
Mir MA et al. [37]	Laparoscopic cholecystectomy	6.7%
Yanni F et al. [38]	Laparoscopic cholecystectomy	4%
Siribumrungwong B et al. [39]	Complicated appendicitis Primary wound closure Delayed wound closure	 7,3% 10%
Xiao et al. [40]	Open appendicectomy Laparoscopic appendicectomy	4.2% 1.9%
Gandaglia G et al. [41]	Appendicectomy Colectomy	5.4% 12.1%
Aranda JM et al. [42]	Appendicectomy	11%
Garcell GH et al. [43]	Appendicectomy	3.8%
Bou H et al. [44]	Gastric cancer surgery	13.9%

In colorectal surgery, a section of the colon and anastomosis for laparoscopic right colectomies or a section of left colon and insertion of the anvil of CEEA for laparoscopic left colectomies were made extracorporeally. The Alexis retractor was placed immediately after the the peritoneal opening. Upon closing the laparotomy, gloves were changed, and no previously used needle holders, forceps, and separators were re-used. In all cases of re-operation, an Alexis wound retractor was used again. The surgical wound was washed with 500 mL of normal saline after peritoneal closure. In all patients, wound was closed primarily and the skin was closed by stapling. Incisions were inspected daily until the day of discharge by a nurse and the responsible surgeon. Decisions of whether there was an SSI or not were made by the surgeon and a nurse with no knowledge of the study. Those patients who were discharged early were revised in the outpatient clinic the seventh postoperative day by the responsible surgeon and a nurse with no knowledge of the study. All patients were revised on the 30th postoperative day by the responsible surgeon and a nurse with no knowledge of the study. Analyzed factors included age, sex, Body Mass Index (BMI), American Society of Anesthesiologists grade (ASA), types of surgery and incision, complications, and postoperative hospital stay. The principal study variable was deep/superficial wound infection. Definitions of wound infection occurrence were defined according to the criteria of the Centers for Disease Control and Prevention (CDC) Hospital Infection [9].

Results

Table 1 shows the description of the series. The total number of analyzed patients was 409 and included 151 colorectal resections, 144 appendicectomies, 80 cholecystectomies, 14 gastrectomies, and 20 other operations. The median age of the series was 58 years (range (14-92)). The median BMI was 25 kg/m^2 (range 18-39.5). One hundred and ninety-nine patients (49%) were female. One hundred and eighty patients (44%) underwent surgery on an emergency basis. Two-hundred ninety-six patients (72%) were classified as ASA I-II grade, and 113 were classified as grade ASA III-IV grade (28%). A minilaparotmy was used in 272 patients (67%), and a formal laparotomy in 137 (33%). Results are shown in Table 2. There were only four cases of wound infection (1%) consisting of three superficial and one deep one. There were ten re-operations that included six for anastomotic dehiscence, one for postoperative intra-abdominal bleeding, one for peri-ileostomy cellulitis, one for intra-abdominal abscess, and another one for postoperative small bowel obstruction. One patient died (0.2%). Three patients (0.7%) were re-admitted after hospital discharge due to late anastomotic dehiscence, wound infection, and small bowel obstruction. The median postoperative stay of the series was five days (range 1–34).

Discussion

With the introduction of antibiotic prophylaxis in the 1970s and 1980s, there was a significant decrease in the rates of wound infections after gastrointestinal surgery [10-26]. Although much has changed in terms of peri-operative and operative practices in forty years, no further improvements has been made related to wound infections [1,2]. In spite of the medical advances in the last decades, the ratess of wound infections after gastrointestinal surgery remain surprisingly high as described in Table 3 [27-43]. The evolution of wound infections after colorectal surgery in the last 50 years has been extensively described recently [2]. As can be seen, there are no appreciable differences between the results in the 21st century and those in the 1970 and 1980s. It is as if since the introduction of antibiotic prophylaxis in this field has been frozen in time.

Surgical wound infection in any surgery is a consequence of intraoperative contamination of the abdominal wall tissues. Regardless of any risk factor such as age, sex, co-morbidity, mass index, diabetes, area of the open digestive tract, type of operation, or type of wound closure, the only constant factor for the development of an infection of the operative wound in gastrointestinal surgery is the inoculation of bacterias in the open abdominal wall. There is a recent study documenting the microbiota discordance between the microenvironment of the surface in contact with the abdominal cavity and the surface in contact with the margin of the incision [7]. Surprisingly, no patient had positive cultures of the incisional margin of the self-retractor. Dual ring wound-edge protectors create a physical hermetic closed barrier that reduces or avoids the accumulation of bacteria in the wound tissues [7]. On other hand, wound retractors reduce tissue damage due to the need for handheld retraction. Previous contributions from our group have allowed us to confirm studies of very low rates or no documentation of wound infection (Table 4) [2,4-8,44-47]. The use of single ring protectors has failed to reduce the incidence of surgical wound infection as was shown in the ROSSINI trial [48]. These results are consistent with previously published results describing the use of a single ring. Single ring devices provide weak protection for the subcutaneous tissues for obvious reasons. The isolation that single-ring devices provide to the

Table 4: Rate of wound infection by using wound protector.

Autor	Type of surgery	Device	Wound protector	Control group
Luo Y et al. [8]	Colorectal	dual-ring	1.8%	13.5%
Nakamura H et al. [45]	Appendicectomy	dual-ring	0%	14.3%
Silva A et al. [46]	Appendicectomy	dual-ring	7.2%	17%
Horiuchi et al. [4]	Colorectal	dual-ring	0%	13%
Reid K. et al. [6]	Colorectal	dual-ring	4.7%	22.7%
Horiuchi et al. [7]	Colorectal Gastric	dual-ring	2.5% 0%	---- ----
Cheng K et al. [5]	Colorectal	dual-ring	0%	20%
Pinkney TD et al. [47]	Abdominal	single-ring	24.7%	25.4%
Mihaljevic AL et al. [48]	Abdominal	single-ring	9.9%	19.1%
Arenal J et al. [2]	Colorectal	dual-ring	1%	----

Table 5: Systematic reviews and meta-analysis of the clinical effectiveness of wound edge protectors.

Author	Focus	Conclusion
Mihaljevic AL et al. [49]	Open abdominal surgery	Wound edge protectors significantly reduce the rate of surgical site infections in open abdominal surgery.
Chen Q et al. [50]	Gastrointestinal surgery	Double-ring wound-edge protection devices, but not single-ring design, reduces wound infection rate significantly in gastrointestinal surgery.
Ahmed K et al. [51]	Appendectomy	Our review suggests some benefit in using ring retractors to reduce SSI post appendectomy; however the small number and variable quality of the studies suggest the need for more randomized controlled trials to confirm these results.
Zhang MX et al. [52]	Laparotomy	Our exploratory meta-analysis suggests that wound edge protectors reduces the incidence of SSI in patients receiving laparotomies, especially in the circumstance of dual-ring wound edge protectors and in contaminated incisions.
Edwards JP et al. [53]	Abdominal surgery	Our results suggest that wound protectors reduce rates of SSI after gastrointestinal and biliary surgery.
Gheorghe A et al. [54]	Abdominal surgery	Evidence to date suggests that WEPDs may be efficient in reducing SSI rates in patients undergoing open abdominal surgery. However, the poor quality of the existing studies and their small sample sizes raise the need for a large, good quality randomized controlled trial to validate this indication.
Zhang MX et al. [55]	Lower gastrointestinal surgery	Wound protector use is associated with decreased odds of developing SSI in patients undergoing lower gastrointestinal surgery. There was a subgroup effect when comparing dual-ring to single-ring devices.

wound is not hermetic, and it allows contact of wound tissues with intraabdominal bacteria.

Our report in conjunction with other recent systematic review studies and meta-analyses report that barrier protectors, especially double-ring protectors, significantly reduce infection rates of the operative wound in abdominal surgery (Table 5) [48-54]. The rate of surgical wound infection in our series, especially in colorectal and appendiceal surgery, is surprisingly low when compared with recent studies [27-31,39,40]. Our results are in agreement with the results from reports using the Alexis retractor [2,4-7]. The rational explanation of these results is that this dual-ring retractor contributes to diminishing or avoiding the bacterial inoculum in the surgical wound tissues. In two of the four cases of wound infection reported in our series, we were able to intraoperatively check gallbladder and plastic self-retractor cylinder perforations.

Independent of the presence or absence of risk factors, avoiding bacterial contact with wound tissues is, for the time being, the only way to progress in the improvement of infection rates of the operative wound in abdominal surgery. We believe that the future investigations must be directed to procedures that avoid the intraoperative contamination of the wound tissues as herein described.

Our results suggest that the Alexis wound retractor in conjunction with an autoretractor provides an effective wound edge protector, which contributes to significantly reduction of the wound infection rate in abdominal surgery. We agree with the World Health Organization's published guidelines suggesting routine use of the Alexis retractor for bowel surgery devices in clean-contaminated, contaminated, and dirty abdominal surgical procedures for the purpose of reducing the rate of SSI [55]. In our opinion, a clear commitment should be made to the implementation of this device in healthcare practice due to its advantages in terms of economic evaluation (reduction of complications, days of hospital stay, and feelings of failure because of the infection). The main strength of our study is the significant number of analyze patients. No previous study using double ring protectors used one-hundred patients. One of the potential limitations of our findings was the absence of a control group. However, we decided not to do a control group for the following reasons: 1) Poor results reported in the literature, already described in the control groups; 2) absence of surgical wound infections in our previous experience with the use of double-ring device; 3) our historical figures for wound infection in patients who underwent colorectal and emergency abdominal surgery [56,57] following the actual standard methods are quite high (17%) and have not changed in the last twenty years; and 4) we agree with other authors that the presence of a control group is not always justified, especially for ethical reasons [58].

There is not a financial relationship with the organization that sponsored the research before the reference list in our manuscript. We have full control of all primary data and we agree to allow the journal to review the data if requested.

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