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Plastic wound retractors as bacteriological barriers in gastrointestinal surgery: a prospective multi-institutional trial

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SUMMARY

Background: Surgical site infection remains a significant problem, and peri-operative strategies to reduce wound exposure to bacteria are needed urgently. Plastic ring wound retractors, used to gain access to the abdominal cavity, may shield the incision site from bacteria.
Aim: To evaluate exposure of the surgical incision site to bacteria using a plastic ring wound retractor in gastrointestinal surgery.
Methods: Prospective, observational, multi-centre study. Patients undergoing clean-contaminated gastrointestinal surgery with standard antibiotic prophylaxis were included ($N = 250$ patients, 500 samples). A plastic wound retractor was used to facilitate access to the abdominal cavity. Samples were taken for bacterial culture from the inside (luminal) and outside (wound) surfaces of the retractor at the end of the operation.
Findings: Bacteria were found on 56% (140/250) of samples from the inside surface of the retractor compared with 34% (85/250) of samples from the outside surface of the retractor ($P < 0.0001$). There was no significant difference in skin-derived organisms from the inside [34/245 (14%)] and outside [27/250 (11%)] surfaces of the retractor ($P = 0.108$). However, enteric organisms were cultured twice as often from the inside surface of the retractor compared with the outside surface of the retractor (49% vs 26%, respectively; $P < 0.0001$).
Conclusion: Plastic wound retractors reduce wound exposure to enteric bacteria in gastrointestinal surgery.

Introduction

Gastrointestinal surgery is high risk for surgical site infection (SSI), with as many as 25% of patients undergoing colorectal surgery developing SSI.[1–4] Subsequent prolonged inpatient admission, antibiotic use and slower recovery times are

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detrimental to patients and costly.[5,6] Intra-operative technique and peri-operative procedures are important for the prevention of SSIs.[7] This study examined the use of a simple plastic wound retractor as a peri-operative barrier to enteric bacterial contamination of the incision site.

The Alexis plastic ring wound retractor (Applied Medical, Rancho Santa Margarita, CA, USA) facilitates access to the abdominal cavity, particularly during minimally invasive surgery (Figure 1). Other reported uses include gradual closure of gastroschisis in paediatric patients, intravaginal use in vaginal hysterectomy, and stoma creation in obese patients.[8–10] Enteric bacteria (e.g. *Escherichia coli*) commonly cause SSIs after visceral surgery.[11] Minimizing contact between the surgical incision site and enteric bacteria should reduce SSIs as intra-operative bacterial exposure is associated with postoperative infection.[12,13] While not its primary function, the Alexis retractor might provide a barrier to bacterial contamination. However, studies of similar interventions have yielded surprising results; a Cochrane review suggested that non-iodophore impregnated adhesive plastic wound drapes may increase the rate of wound infection.[14] There is limited literature on whether plastic retractors protect the wound edge from exposure to gastrointestinal bacteria.[15] Several randomized controlled trials have suggested that ring wound retractors prevent SSIs, although Kercher *et al*. found that they did not.[16–21] A recent randomized controlled trial compared a 'bundle of care' with conventional management, including use of a plastic ring wound protector. Paradoxically, those in the bundle group had a higher rate of wound infection.[22]

The aim of this study was to evaluate whether a plastic wound retractor protects the wound from exposure to enteric bacteria during gastrointestinal surgery, by detecting growth of enteric bacteria from either side of the retractor. If the retractor protects the incision, fewer enteric bacteria would be expected on the outside of the retractor at the end of an operation compared with the inside of the retractor. The primary endpoint of the study was the difference in microbial flora inside and outside the retractor.

Methods

Study design

This multi-centre, prospective observational study was conducted over 36 months between November 2007 and June 2010 at St. Vincent's University Hospital, St. Vincent's Private Hospital and the Mater Miseracordiae Hospital, all of which are affiliated to University College Dublin. Ethical approval for the study was granted from the trial centre (St. Vincent's University Hospital); the study was registered with www.clinicaltrials.gov (Reference: NCT01007487).

Figure 1. Alexis plastic ring wound retractor.

Inclusion criteria

Patients undergoing elective or emergency abdominal gastrointestinal surgery were included in the study.

Data collection

Standard pre-operative patient preparation in the operating room prior to the surgical incision included routine antibiotic prophylaxis (cefuroxime or ciprofloxacin with metronidazole, or co-amoxiclav) and hair removal if necessary. The abdomen was prepared with povidone-iodine, and impermeable disposable drapes were used. Oral mechanical bowel preparation was not used. An Alexis plastic ring wound retractor was used to facilitate retraction. Samples were collected by drawing a culture swab (Probact transport swab, Technical Service Consultants Limited, Heywood, Lancashire, UK) around the full 360° circumference of the retractor (internal and external surfaces) immediately prior to its removal (Figure 2). 'Inside' the wound was defined as the part of the wound retractor in contact with the intra-abdominal organs, and 'outside' was defined as the part in contact with the skin and subcutaneous tissues.

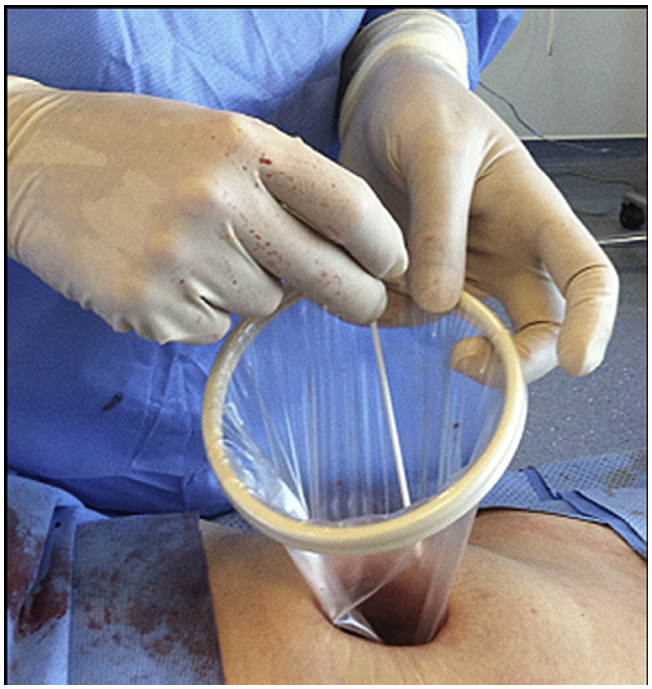

Figure 2. Sample collection from the inside surface of the retractor prior to removal of the plastic wound retractor from the abdominal cavity.

Table I
(a) Overall analysis of samples from the inside and outside surfaces of the retractor. Five samples could not be classified as skin organisms or not, and three samples could not be classified as enteric organisms or not. These non-classifiable samples were excluded from the overall analysis. (b) Enteric bacteria cultured from samples from the inside and outside surfaces of the retractor ($P < 0.05$). Note these do not equal the overall number of culture-positive samples for enteric bacteria as several different enteric organisms were isolated from some samples

	Inside surface of retractor Positive samples (*N*)	Outside surface of retractor Positive samples (*N*)
(a) Overall analysis		
Skin organisms	34/245	27/250
Enteric organisms	122/247	66/250
(b) Enteric bacteria		
Enterobacteriaceae	99	56
Anaerobic organisms	45	22
Enterococcus (including vancomycin-resistant enterococci)	35	18

Culture

The swabs were inoculated on to Columbia Blood Agar (Oxoid Ltd, Cambridge UK) and UriSelect chromogenic agar (BioRad Laboratories Ltd, Hemel Hempstead, Hertfordshire, UK), and incubated in ambient air at 37 °C. They were also inoculated on to Neomycin Blood Agar (Oxoid), and incubated anaerobically at 37 °C. Plates were examined at 24 and 48 h. Any isolates were identified by standard methods.

Classification of culture results

Two blinded assessors independently categorized the bacteria cultured from samples into two categories: skin or enteric organisms. Coagulase-negative staphylococci, *Staphylococcus aureus*, *Streptococcus* spp. (other than *Streptococcus bovis* and *Streptococcus anginosus group*) and *Corynebacterium* spp. were considered to be skin-derived organisms, and enterococci, enterobacteriaceae, *Pseudomonas aeruginosa* and anaerobes were considered to be enteric-derived organisms. Non-classifiable cultures and fungi were excluded. Discordant results were reviewed by the assessors, and any discrepancies were resolved by discussion (Table I).

Statistical analysis

GraphPad Prism 5 software (Graph Pad Software Inc., San Diego, CA, USA) was used for statistical analysis. The Wilcoxon pairs signed rank test was used to test for statistical significance as the data were non-parametric.

Results

Study population

Five hundred samples were obtained from 250 operations. The median patient age was 64 years (range 19–93 years), with 137 (55%) males and 113 females (45%). Most operations were colorectal [$N = 223$ (89%)]. Overall, 54% ($N = 134$) of operations were open and 46% ($N = 116$) were laparoscopic.

Discordant and excluded samples

Five and 11 results were initially discordant between the assessors for the enteric-derived organisms and the skin-derived organisms, respectively. Bacteria on five inside samples were deemed to be non-classifiable for skin-derived bacteria, and were excluded from the analysis, as were three inside samples for non-classifiable enteric-derived bacteria.

Wound retractor colonization

Overall, bacteria were cultured from more samples collected from the inside surface of the retractor (140/250, 56%) than the outside surface (85/250, 34%) ($P < 0.0001$). Enteric organisms were isolated from 49% (122/247) of samples from the inside surface compared with 26% (66/250) of samples from the outside surface ($P < 0.0001$) (Table I). Enteric organisms isolated are shown in Table I and included *E. coli*, *Klebsiella* spp., *Enterobacter* spp., *Serratia* spp., *Citrobacter* spp., *Morganella* spp., *Kluyvera* spp. and *Proteus* spp.

There was no significant difference in the rate of culture of skin-derived organisms from the inside (34/245, 14%) and outside (27/250, 11%) surface of the retractor ($P = 0.108$)

Table II
Number of samples culture-positive for enteric organisms by operation type

Operation type	*N*	Number of positive samples from inside the retractor	Number of positive samples from outside the retractor
Anterior resection/abdominoperineal resection	83	25	13
Partial gastrectomy	3	1	0
Laparotomy/other	18	5	2
Completion proctectomy +/− pouch	13	6	3
Laparotomy with end stoma creation or reversal	12	8	5
Colectomy	115	72	39
Small bowel resection	6	5	4

(Table I). There was a lower rate of enteric bacteria on the outside surface for laparoscopic cases than open cases: 25/116 (21%) vs 41/134 (31%), respectively ($P = 0.098$). The enteric organisms isolated by type of operation are given in Table II.

Discussion

Unlike previous wound edge protectors which did not aid surgical access to the abdominal cavity but were mainly used to reduce bacterial contamination, the plastic ring wound retractor is used primarily to retract the wound edge and facilitate access to the abdominal cavity. The authors believe that this retractor may have a dual role: as a barrier to contamination of the incision site by enteric bacteria during surgery, and as a retractor.

Many strategies have been reported to reduce enteric bacterial contamination of the surgical incision site, with varying degrees of success.[14,23–34] Minimizing contact between the wound edge and the abdominal cavity by a plastic wound retractor would be expected to reduce exposure of the incision site to bacteria.

If passage of bacteria through the retractor had occurred, equal numbers of enteric bacteria would have been expected on either side of the barrier. However, a clear difference was found in the rates of enteric colonization between the inside and outside surfaces of the retractor, suggesting that its use reduces contamination of the surgical incision site by organisms from the abdominal cavity. There was no significant difference in the rate of isolation of skin organisms from either side of the retractor, although there was a trend towards more on the inside surface of the retractor. While skin organisms are already in contact with the outside surface of the wound retractor at the start of the operation, the finding of equal numbers of skin organisms on the inside surface implies contamination from the skin during the operation, either by the operator's hands or surgical instruments. The outside surface of the retractor, and therefore the surgical incision site, appear to be protected from enteric colonization.

Reduction in bacterial colony counts correlates with reduced SSI rates.[35] Additionally, results from intra-operative culture samples taken at the end of operations have been shown to predict postoperative SSI.[36,37] Reducing exposure of the incision site to enteric bacteria intra-operatively may translate into reduced SSI. Indeed, the results of previous randomized trials that focused on SSI as the primary endpoint suggest that the ring wound retractor reduces SSI.[16–19]

The only other study of intra-operative bacteriology using the plastic ring wound retractor found a much lower rate of bacterial isolation.[15] This may reflect the heterogeneous nature of the study population, which included a significant number of gastrectomy patients, compared with the more homogenous cohort of colorectal cases in the present study. Furthermore, these authors sampled the inside surface of the retractor and the wound site on the outside, whereas the samples in the present study were taken from the inside and outside surfaces of the retractor, allowing a more direct comparison.

In summary, use of a plastic wound retractor may result in reduced enteric bacterial colonization of the surgical incision site during gastrointestinal surgery. Reduced colonization of the surgical incision site by enteric bacteria due to the use of a plastic wound retractor should result in a reduction in SSI following gastrointestinal surgery.

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Conflict of interest statement
None declared.

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