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Assessing the clinical utility of a modified surgical drape in robotic radical prostatectomy: a retrospective study

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Additional Declarations: Competing interest reported. The modified surgical drape has been granted a utility model patent by the China National Intellectual Property Administration (Patent No. 202520608607.1), with Weifang People's Hospital as the patentee.

Abstract

Robot assisted radical prostatectomy (RARP) has gained widespread adoption, yet the reusable cloth drapes conventionally used in these procedures pose drawbacks including infection risk, excessive weight, and high reprocessing costs. To address these limitations, we developed a modified disposable surgical drape composed of a trilayer composite material (hydrophilic polypropylene, polyethylene film, and water-repellent polyester). This retrospective study compared the modified drape (MD, n = 71) with the conventional reusable cloth drape (CD, n = 57) in RARP procedures, evaluating weight and per-unit cost. The MD was significantly lighter than the CD (1.91 ± 0.01 kg vs. 10.04 ± 0.03 kg, P < 0.001). The unit cost of the MD was 126 CNY, representing a 49% reduction compared with 248 CNY for the CD. Microbiological assessment using peri-wound area swabs after drape removal showed no bacterial colonies adjacent to the surgical incision in the MD group, whereas the CD group yielded bacterial CFUs of 1.4 ± 0.24 (p = 0.0046) on the right side and 1.6 ± 0.24 (p = 0.0028) on the left side. The modified disposable drape thus offers substantial advantages in weight reduction, cost savings, and perioperative contamination control. These findings support its potential to enhance the cost-effectiveness and safety of robotic pelvic surgery, pending confirmation in larger prospective trials.

Introduction

Robotic radical prostatectomy (RARP) have become increasingly adopted worldwide, driven by improved perioperative outcomes compared with open and laparoscopic radical prostatectomy, including lower complication rates, and shorter hospital stays[1,2]. The advantages of robotic platforms are generally attributed to enhanced visualization and instrument control during dissection[3]. Technical innovations regarding operation procedure achieve excellent oncological outcomes – with 5-year survival rates reaching 100% for localized disease[4].

A bunch of innovations in robotic-assisted surgical techniques such as Haptic feedback, Teleoperation and remote surgery, and artificial intelligence in surgical decision-making increase the advantages in the future[5]. Even though robotic surgerys allow minimal invasiveness into the body of the patient aiding in faster recovery followed by reduced costs per patient. The substantial cost of robotic systems, their maintenance and higher surgical expenses are still the primary limitation of its usage in China. A more cost-effective manner in every aspect of surgical procedures is urgenly needed.

In current RARP surgery, reusable cloth drapes with standard configurations are commonly employed. However, these conventional drapes present several notable limitations[6,7]. First, concerning infection risk, repeated use of cloth drapes carries the potential for surgical site infection if sterilization is inadequate, along with a risk of secondary contamination arising from improper handling or suboptimal storage[8]. Second, the heavy and thick nature of cloth drapes may impose an additional burden on the patient and hinder surgical maneuvers. Third, the requirement for repeated reprocessing leads to material degradation and attrition during laundering, and the associated consumption of water and transportation resources further contributes to a relatively high overall cost of use[7].

This study aims to report a modified surgical drape in RARP and investigate its cost and safety compared to conventional reusable cloth drape.

Methods

Subjects

The study was approved by the Ethics Committee of Weifang People's Hospital (no. KYLL202305264). As this was a retrospective study, the requirement for informed consent was waived. This modified surgical drape has been granted a utility model patent by the China National Intellectual Property Administration (Patent No. 202520608607.1), with Weifang People's Hospital as the patentee.

Sample size and statistical power

Given the retrospective design, not a priori sample size or power calculation was performed; instead, all eligible consecutive cases within the study period were included. The present study retrospectively analyzed the clinical data of 128 patients who underwent RARP for prostate cancer at the First Affiliated Hospital of Shandong Second Medical University (Weifang People's Hospital) between January 2025 and May 2026. Patients were categorized into conventional drape (CD, n = 57) and modified drape (MD, n = 71). All RARP surgeries were performed using the *da Vinci Xi Surgical System* (Intuitive Surgical, Sunnyvale, CA, USA).

Modified surgical drape

The main body of the modified sterile surgical drape is constructed from a three-layer composite material. The first layer is a polypropylene (PP) hydrophilic spunbond nonwoven fabric capable of absorbing liquid up to seven times its own weight. The second layer is a polyethylene (PE) cast film, and the third layer is a polyethylene terephthalate (PET) water-repellent spunbond nonwoven fabric, which together provide a potent liquid barrier. This trilayer design ensures that even when large volumes of body fluid or blood are generated intraoperatively, they are rapidly absorbed while being completely prevented from penetrating the surgical drape and gown. Figure 1 shows the diagram of the MD.

Statistical analysis

GraphPad Prism 7 Software was used for statistical analysis. Quantitative data were expressed as mean ±standard deviation (SD), and 2 independent samples t-test was used to compare the weights, costs and colony forming units (CFUs) between MD and CD. All reported P values are determined by Unpaired t test with Welch's correction and the difference was considered statistically significant at $P < 0.05$.

Results

The modified drape is lighter and less costly than the conventional reusable cloth drape

First, we compared the weight of the two drapes. We measured the weight of them on an electric balance (Hengxin, #HCS-200-RT) with readability of 0.01 kg. The mean ± standard deviation (SD) weight of the MD group was 1.91 ± 0.01 kg, whereas that of CD group was 10.04 ± 0.03 kg. As shown in Fig. 2A, the weight of CD was significantly greater than that of MD ($P < 0.001$). This reduction in weight may improve patient tolerance, especially during prolonged surgery. Next, we compared the costs of the two drapes. The expenses included the material cost, laundry fee, depreciation cost, packing fee, consumables cost, Radio Frequency Identification (RFID) chip fee, and delivery/shipping fee. As shown in Supplementary Table 1, the per-unit cost of MD was 126 CNY, whereas that of CD was 248 CNY. Therefore, MD is less expensive than CD, which could contribute to cost savings for the healthcare system.

The modified drape prevents contamination around the surgical area

Samples were collected using sterile swab sticks from three areas around the wound that were covered by the drapes. We randomly selected five surgeries from each group for sample collection. As shown in Fig. 3A, after the surgery was completed and the drapes were removed, the samples were taken from the areas indicated by the orange rectangle. The collected samples were spread onto nutrient agar (NA) plates, sealed, and incubated at 37°C for 72 hours. Both MD and CD effectively prevented contamination in the distal area. In the CD group, the mean ± standard error of the mean (SEM) of bacterial colony-forming units (CFUs) was 1.4 ± 0.24 from the right periwound area and 1.6 ± 0.24 from the left periwound area; in contrast, no bacterial colonies were detected in the corresponding areas of the MD group (Fig. 3B-D). Interestingly, both the bacterial CFUs and the colony diameters were greater on the left side than on the right side. In our center, the bedside assistant stands on the left side of the patient during RARP. Therefore, we speculate that the movement of the bedside assistant might increase the incidence of contamination.

Discussion

With advances in basic and clinical research, the treatment outcomes of urological malignancies have improved substantially[9,10]. In particular, surgical innovations exemplified by robot-assisted radical prostatectomy have enhanced oncological outcomes in localized prostate cancer[11]. The present study evaluated a modified disposable surgical drape for RARP, comparing it with a conventional reusable cloth drape in terms of weight, cost, and perioperative contamination. Our findings demonstrate that the modified drape is significantly lighter, less expensive, and provides superior protection against wound-area contamination, supporting its clinical value as a cost-effective alternative in robotic pelvic surgery.

The marked reduction in drape weight (1.91 kg vs. 10.04 kg) has direct clinical implications. During prolonged robotic procedures, the heavy cloth drape can exert sustained pressure on the patient's thorax and abdomen, potentially compromising respiratory compliance and increasing the risk of pressure-related injuries. The lighter MD alleviates this burden and may improve patient tolerance, which is particularly relevant for RARP cases that may extend over several hours.

The economic analysis represents another advantage for adopting the MD. With a unit cost of 126 CNY compared with 248 CNY for the CD, the MD achieved a cost reduction of approximately 49%. We explain the differences as the disposable drape eliminates the hidden expenses inherent to reusable cloth drapes, including repeated laundering, sterilization, transportation, and inevitable material attrition. In the context of the high acquisition and maintenance costs of robotic platforms that continue to limit broader adoption in China, such savings in consumables—however modest on a per-case basis—can accumulate into meaningful budget relief for healthcare institutions.

Our microbiological assessment provides biological evidence supporting the barrier function of the MD. While both drapes effectively prevented contamination in the distal area sampled, only the modified drape consistently yielded no bacterial colonies in the periwound areas (left and right sides). In contrast, the CD showed bacterial CFUs in these immediate peri-incisional zones. This observation suggests that, despite sterilization, reusable cloth drapes may permit minimal intraoperative microbial penetration, whereas the trilayer composite material of the MD effectively prevents such penetration. The superior fluid-handling properties of the MD's PP hydrophilic layer (capable of absorbing 7 times its weight in liquid) paired with a PE impermeable film and a PET water-repellent outer layer likely underpin this enhanced resistance. Furthermore, we observed a higher bacterial burden on the left side of the wound in the CD group, which we attribute to the positioning of the bedside assistant on the patient's left side in our standard RARP surgery. Frequent instrument exchanges and assistant movement may generate airborne particulate or cause contact contamination that the heavier, less stable cloth drape fails to fully contain.

There are some limitations of this study. First, it is a retrospective, single-center study with a relatively small sample size, which may limit the generalizability of our findings. Second, while we evaluated bacterial colonization as a surrogate marker, we did not perform biochemical techniques to identify bacterial species. Therefore, we could not determine whether the observed colonies resulted from intraoperative contamination or inadequate sterilization of the surgery area. Third, we measured total drape weight but did not quantify the mechanical pressure distribution on the patient, which could further illuminate the clinical advantage of weight reduction. Finally, our cost analysis relied on institutional procurement and reprocessing data, which may vary across different healthcare settings.

In conclusion, the modified disposable surgical drape described in this study is lighter, less costly, and provides more effective perioperative contamination control than conventional reusable cloth drapes in RARP. Prospective randomized trials with larger sample sizes and clinical endpoints such as surgical site infection rates are warranted to confirm these preliminary observations.

Declarations

The authors declare that the research was conducted in the absence of any financial or nonfinancial relationships that could be construed as a potential conflict of interest.

Author contributions

L.C., Y.S. and M.Z. were involved in study conception and design. L.C. collected the data. L.C., Q.Z. and N.C. analysed the data. Y.S. wrote the manuscript. L.Q. and M.Z. supervised the study process. All authors reviewed and approved the final version of the manuscript.

Ethics declarations

The study was approved by the Ethics Committee of Weifang People's Hospital (no.KYLL202305264). As this was a retrospective study, the requirement for informed consent was waived.

Declaration of competing interest

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Figures

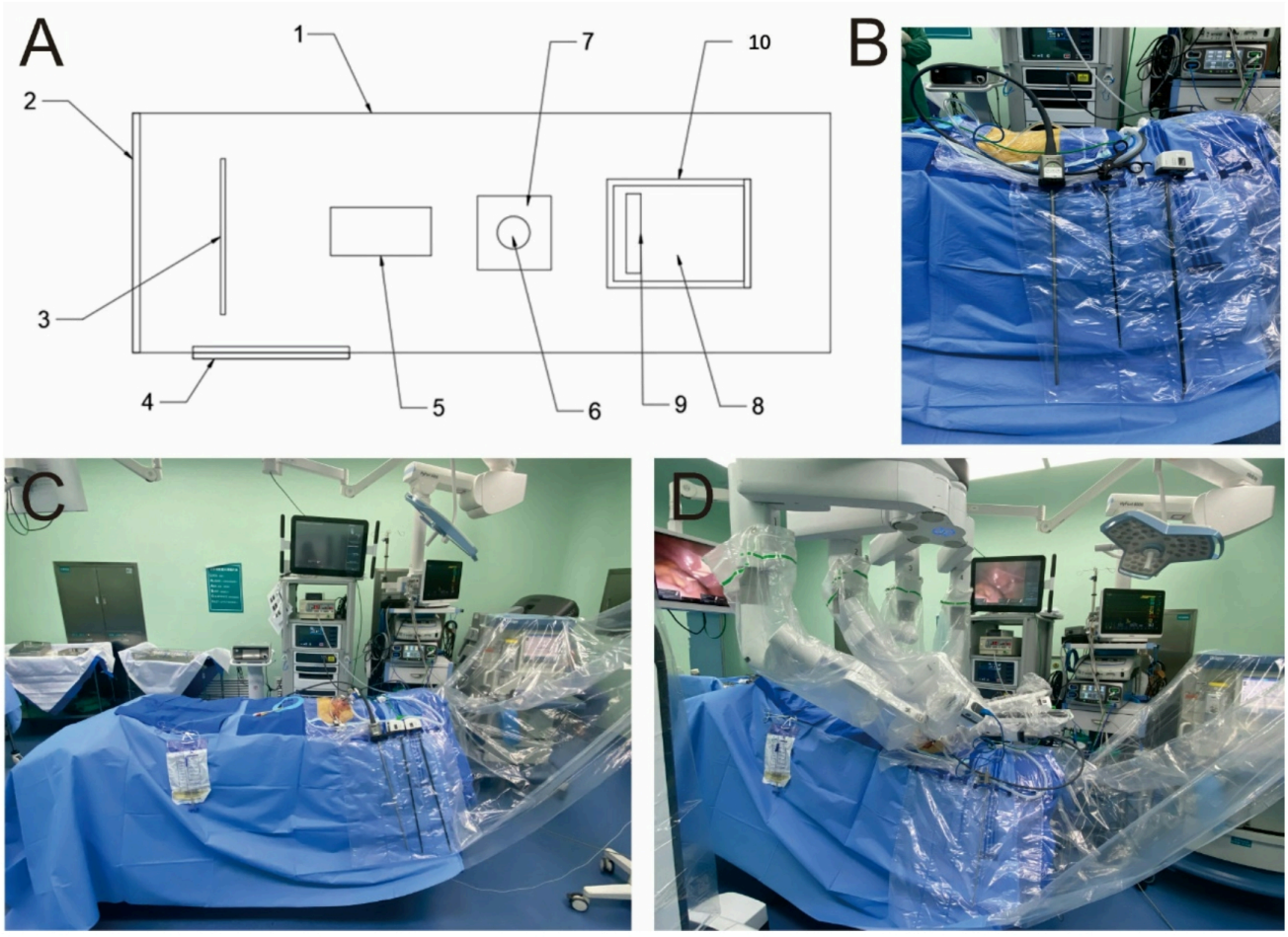


Figure 1

Modified surgical drape. **(A)** the diagram of the MD. (1). The main body of the MD; (2). The connecting portion. It is used for connecting the drape body (1) to surrounding surgical equipment to achieve

fixation; (3). The head shaping portion. After being shaped, it is capable of forming an accommodation space at the position of the patient's head; (4) The instrument bag. It is used for storing surgical instruments; (5) The surgical operation area; (6) The perineal operation are; (7) The soft elastic portion. It is to facilitate manipulation at the perineal site; (8) The instrument placement area; (9) The raised portion. It allows the instruments to be placed in an inclined manner for easy retrieval; (10) The double-fold pressing line structure. It prevents instruments from sliding off. **(B)** The instrument bag. **(C)** The drape before the robotic system docking. **(D)** The drape after the robotic system docking.

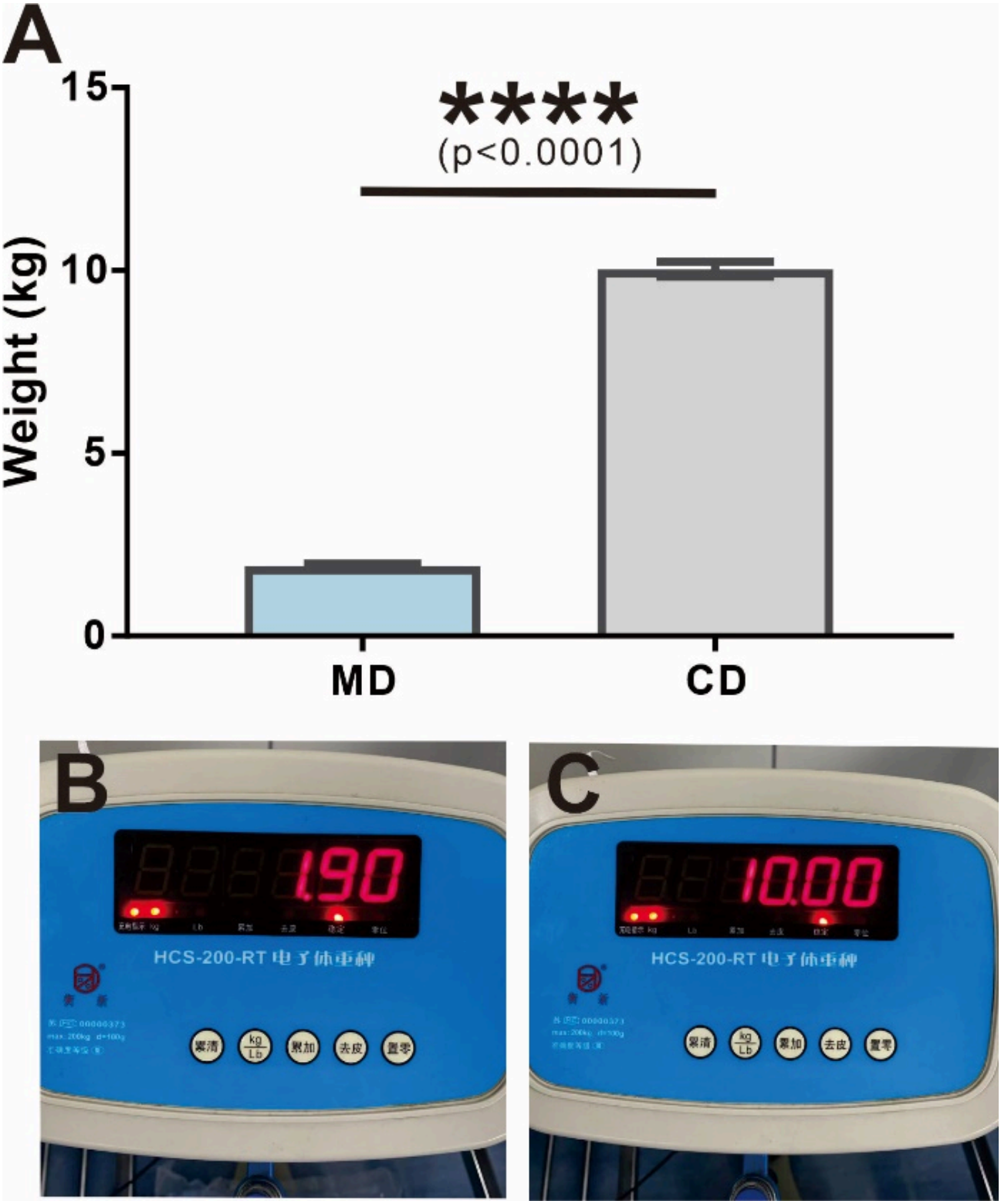


Figure 2

The modified drape is lighter than the conventional drape. **(A)** MD is lighter CD. Results are shown as means ± SD. P values were determined by Unpaired t test with Welch's correction. ****p<0.0001. **(B)** One representative weight of MD. **(C)** One representative weight of CD.

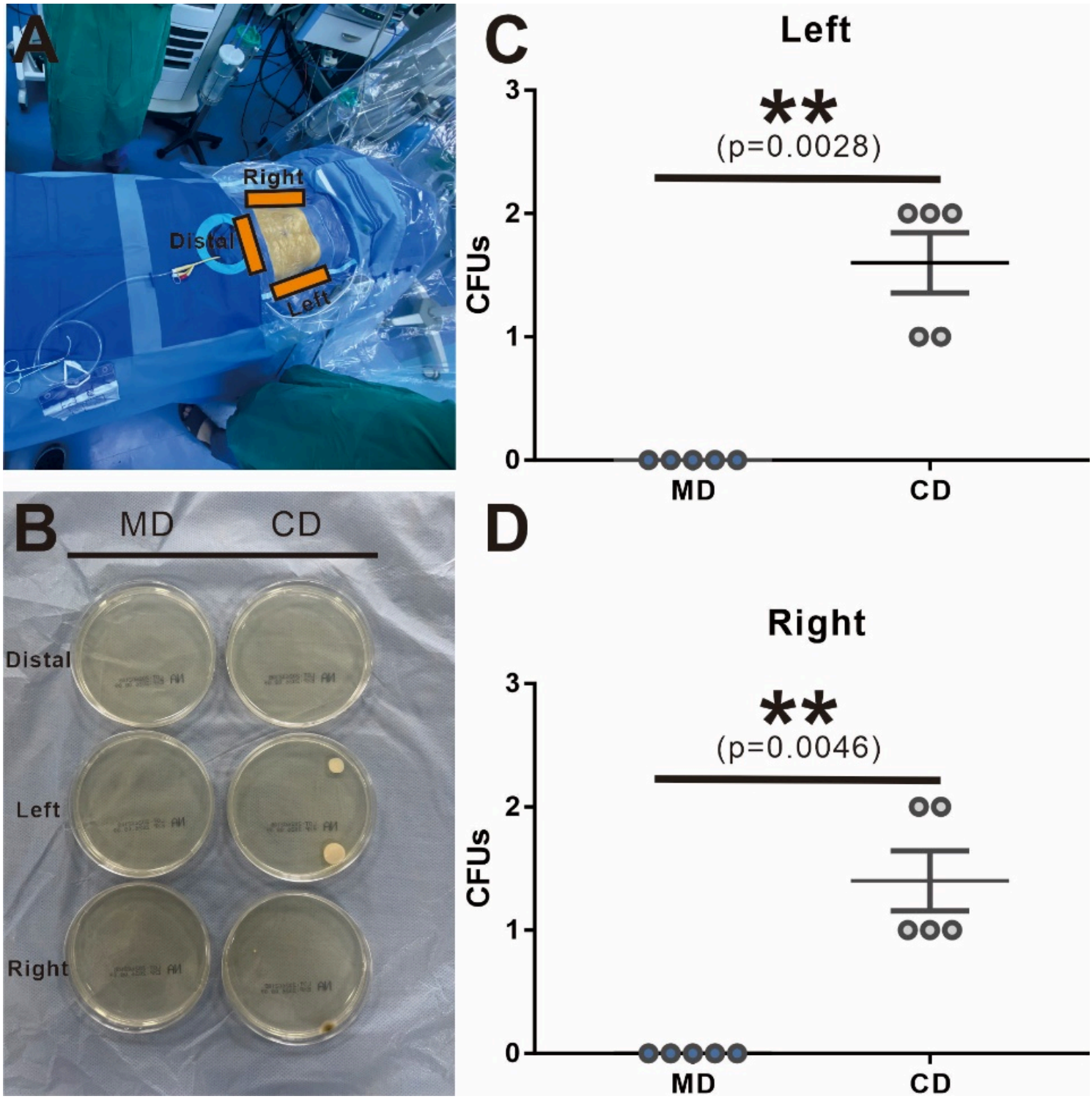


Figure 3

The modified drape prevents contamination around the surgical area. **(A)** Samples were collected from indicated areas. **(B)** NA plates were incubated at 37 °C for 72 hours. One representative image is shown. **(C)** The quantifications of bacterial CFUs from left area. Results are shown as means ± SEM. P values were determined by Unpaired t test with Welch's correction. $^{**}p<0.01$. **(D)** The quantifications of bacterial CFUs from right area. Results are shown as means ± SEM. P values were determined by Unpaired t test with Welch's correction. $^{**}p<0.01$.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTable1Costofthedrapes.xlsx