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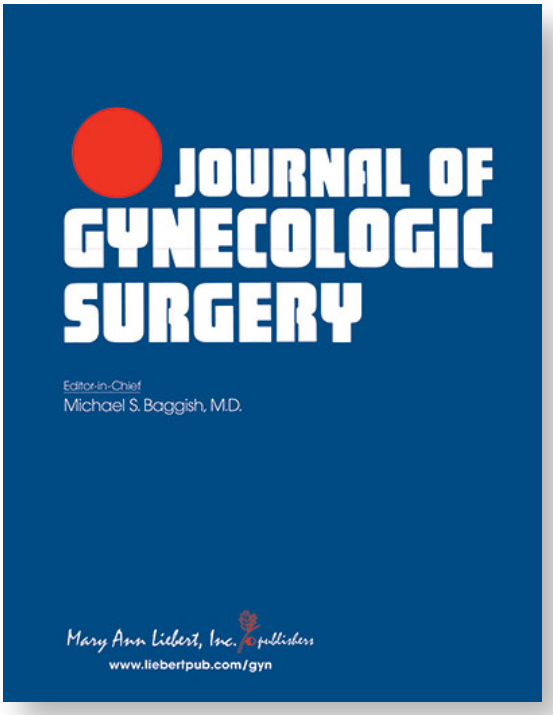

Key Findings

“The current study was the largest prospective randomized trial of antislip surfaces for surgery…”

“Post-operative erythema was significantly less common in The Pink Pad® group…”

“The Pink Pad was associated with less postoperative pain…”

“There was significantly less movement on The Pink Pad® at all anatomical landmarks…”

“(Total additional operative time for) The Pink Pad® was found to be 37.1% … and 45.5% … faster than the gel pad and the beanbag, respectively."

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A Prospective Randomized Trial of Antislip Surfaces During Minimally Invasive Gynecologic Surgery

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Abstract

Objective: The aim of this research was to assess the effectiveness of antislip surfaces for reducing intraoperative patient displacement while in the Trendelenburg position.

Materials and Methods: A prospective randomized trial was conducted on intraoperative displacement in patients undergoing major laparoscopic or vaginal gynecologic surgery from June 2018 to December 2019. Patients were randomly assigned to 1 of 3 antislip surfaces: pink pad (The Pink Pad XL®; Xodus Medical Inc., New Kensington, PA), gel pad (Action® O.R. Overlay; Action Products Inc., Hagerstown, MD), or beanbag (Olympic Vac-Pac®; Natus Medical Inc., Pleasanton, CA). A total of 161 patients were enrolled, with 148 eligible for analysis. The primary outcome was intraoperative displacement related to the Trendelenburg position. This was assessed by measuring movement at the perineum, anterior superior iliac spine (ASIS), umbilicus, acromion, and head. Secondary measures also assessed included positioning time, postoperative pain, and erythema. A sample size of 50 patients per arm could achieve a >90% power.

Results: There was significantly less movement on the pink pad at all anatomical landmarks, compared to the gel pad ($p \leq 0.001$). The beanbag was equivalent to the pink pad, except at the ASIS ($p = 0.008$) and perineum ($p = 0.022$), where it had greater displacement. The most-consistent predictors of movement included: height; weight; and body mass distribution. Obese patients' displacement was 32%–55% greater than the nonobese patients' displacement. The pink pad was 19.2% ($p = 0.042$) and 30.8% ($p < 0.001$) faster to position than the gel pad and beanbag, respectively. Postoperative back pain was less on the pink pad, compared to the gel pad ($p = 0.036$). Postoperative erythema was significantly less common on the pink pad versus the beanbag (6.2% versus 30%, respectively; $p = 0.005$). There were no differences in complications among the antislip surfaces.

Conclusions: Patients on the pink pad had significantly less displacement with Trendelenburg and faster positioning, compared to the gel pad. Obesity is a major predictor of movement. The pink pad was associated with less postoperative pain than the gel pad and less postoperative erythema than the beanbag. (J GYNECOL SURG 20XX:000)

Keywords: intraoperative displacement, minimally invasive surgery, surgical positioning, patient safety, Trendelenburg

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Introduction

LAPAROSCOPIC SURGERY has become increasingly important in the drive to reduce patient morbidity. A key requirement of any minimally invasive gynecologic procedure is adequate visualization of the pelvis. Steep Trendelenburg positioning in the range of 30°–40° has historically been referenced as necessary for adequate visualization, but modern studies have found 16°–28° to be adequate.[1,2] There is significant potential morbidity associated with patient movement on the operating room (OR) table. A prior study with a mannequin-based model showed that patient position and weight in addition to the bed surface influenced a tendency to slip.[3] Complications from intraoperative movement include unexpected endotracheal-tube displacement, cervical spine hyperextension, and neurologic injury.[4,5]

Previous studies of intraoperative movement were limited by small numbers, inconsistent testing protocols, evaluation of a single anatomic site, and a lack of controls for important confounding variables.[3,6–10] Most existing studies only measured displacement after reversal of Trendelenburg positioning, which has limited clinical relevance as the studies failed to reflect intraoperative conditions.[7–9] Farag et al. compared the a beanbag product (Olympic Vac-Pac®; Natus Medical Inc., Pleasanton, CA) to a pink pad product (The Pink Pad XL®; Xodus Medical Inc., New Kensington, PA) and showed a 2.73-cm difference in displacement, favoring the beanbag. This trial was limited by a small sample size ($N=43$) and the use of shoulder braces only in the beanbag group.[7]

The literature lacks a prospective trial that evaluates the breadth of laparoscopic gynecologic surgery. The current study's primary outcome was to determine the best antislip surface as measured by patient displacement when placed in a Trendelenburg position. Variables that influence the propensity for movement, and these variables' clinical relevance to the surgery, were also evaluated. The secondary objectives were to assess differences in complication rates, costs, pain, erythema, and times required to use each of the antislip surfaces.

Materials and Methods

Approval from the institutional review board of the University Hospitals Cleveland Medical Center (Cleveland OH) was obtained to perform this prospective, randomized trial (ClinicalTrials.gov identifier: NCT03573557). Patients older than age 18 undergoing laparoscopic or vaginal surgery by participating gynecologic surgeons at the University Hospitals were approached to participate. Only patients undergoing major procedures (e.g., hysterectomy) or surgery anticipated to last longer than 2 hours were included to ensure sufficient opportunity for intraoperative movement. Simple randomization (1:1:1) with replacement was used to assign patients to 1 of three antislip surfaces. Group assignments were made ahead of time by the study coordinator and sealed in opaque envelopes. The investigators and patients were blinded to group assignment until after the patients consented (in the preoperative holding area) to participate. The 3 evaluated surfaces were a pink pad, a gel pad (Action® O.R. Overlay; Action Products Inc., Hagerstown, MD), or a beanbag.

Positioning

Patient positioning was standardized by in-servicing all personnel and posting instructions in the OR. Each surface was set up per manufacturer instructions. The bottom edge or perineal cutout of the antislip surface was positioned to match the edge of the OR table and the legs were positioned in Allen stirrups. Draw sheets were prepositioned on top of the antislip surface to align with the patient's hips/lower back. All patients were positioned with the perineum at the edge of the bed to ensure a consistent starting point. For the patients on the pink pad, the arms were tucked with One-Step Trendelenburg Arm Protectors (Xodus Medical Inc.) and the torso was secured using the provided chest strap. For the gel pad and beanbag, egg-crate foam (Foam Ulnar Nerve Protector; Medichoice, Mechanicsville, VA) was used to pad the arms, and surgical towels and surgical tape were used to secure the torso.

Measurements and patient variables

Intraoperative displacement was assessed at multiple anatomical landmarks (perineum, anterior superior iliac spine (ASIS), umbilicus, acromion, and the top of the head) at 3 times during the procedure: initial positioning, after initial placement in a Trendelenburg position, and prior to leveling at the conclusion of the surgery. The initial location of the ASIS, umbilicus, and acromion were marked on the OR table at the time of positioning. The initial positions of the perineum and the head were recorded as the distance from the bottom or top of the OR table, respectively. All measurements of displacement were in relation to these starting points. The protocol set the initial perineum measurement at 0. Head displacement was defined as the distance the top of the head moved from the maximum Trendelenburg position until just prior to being leveled. Displacement ''1'' equaled movement from initial positioning to that recorded at the maximum Trendelenburg position. Displacement ''2'' equaled the movement between the maximum Trendelenburg position and prior to leveling. Total displacement was the sum of these 2 values.

Positioning time was the time required to position the patient on the OR table, tuck the arms, and place the chest restraint on the patient. Total time added to the procedure was the sum of the time added to the procedure due to either impaired uterine manipulation or visualization related to the bed surfaces as assessed by the attending physician in minutes. Back pain was assessed on a 1–10 Likert scale, and back erythema was assessed as a binary value—present or absent. Back pain was assessed in preoperative holding by the preoperative nurse and again as the first pain score after surgery by the postanesthesia care unit nurse. Erythema was assessed in preoperative holding and immediately after the operation by a member of the surgical team.

Additional surgical variables were recorded at the time of the surgery including: type of OR table; degrees of maximum Trendelenburg positioning; surgical length; intraoperative complications; height; weight; hip circumference; and waist circumference. Three brands of OR tables were used: Steris AMSCO BL58728 (Steris, Mentor, OH); Skytron 6701 Hercules (Skytron, Grand Rapids, MI); and Trumpf TruSystem® 7000 U (dV; Trumpf Medical, Saalfeld, Germany). Other variables included: postoperative complications;

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uterine weight; procedure type; race; and age. These data were obtained by assessing the medical record at a minimum of 6 weeks after surgery.

Analysis of predictors of intraoperative displacement was prespecified in the protocol. Predictors analyzed included: age; uterine weight; surgery type; race; body mass index (BMI), height; weight; waist circumference; waist-to-hip ratio; OR bed model; surgery length; and degrees of maximum Trendelenburg positioning. Surgery types were segregated into the following categories:

(1) Laparoscopic hysterectomy (total laparoscopic hysterectomy [TLH] ± removal of adnexa/staging and total robotically assisted [TRH] laparoscopic hysterectomy ± removal of adnexa/staging)
(2) Laparoscopic adnexectomy
(3) Other laparoscopy, such as laparoscopic and robotic removal of lymph nodes, trachelectomy, and removal of large masses
(4) Other types of procedures, including laparoscopically assisted vaginal hysterectomy (LAVH), total vaginal hysterectomy (TVH), and miscellaneous.

Hip circumference was not included among the predictors, given its strong correlation with waist circumference.

Complications were assessed as either intraoperative or postoperative (up to 6 weeks after surgery). Major complications were defined as those requiring readmission or potentially life-threatening. Minor complications were all other issues that did not meet major criteria but required intervention or evaluation.

Statistical analysis

The primary outcome of this study was patient displacement. At the time this study was designed, the only information available that addressed the displacement on the pink pad was in abstract form and evaluated movement at the ASIS on the beanbag and pink pad.[7] Therefore, the power calculation was based on the ASIS and the other anatomical landmarks were extrapolated to be similar. The intended sample of 150 subjects (50 in each group) could achieve a power >90% to detect differences among the means versus the alternative of equal means using an F test with a 0.05 significance level.

Per protocol and intention-to-treat (ITT) analyses were conducted for the primary outcome (intraoperative displacement) to allow transparency in reporting of the primary outcome and to address any concerns about measurement bias related to follow-up losses or protocol deviations. Patients were not included in the per protocol analysis if there were significant missing data or protocol deviations ($n = 13$). For the ITT analysis, displacement data were used as recorded when available with the remainder being imputed using the R package MICE. Five imputed observations with variations were used to create a random effect. For both analyses, in cases of likely transcription errors (e.g., inverted negative signs or an anatomical point moving against gravity ≥1 cm opposite other measured points), these individual measurements were removed from the analysis to avoid potentially inaccurate data.

Analysis of variance, linear regressions, or Poisson regression models were used to compare displacement, pain, and demographic information. When multiple comparisons were required, Tukey's multiple comparisons method was also used to limit the risk of false-positives. Multivariable linear regressions were used to assess the influence of patient factors on displacement. Erythema differences among the surfaces were evaluated with a 2-sample proportions test. Multivariable logistic regression was used to assess potential risk factors of erythema. The effect of obesity on displacement was evaluated with a t-test. A Type I error level of 0.05 was adopted. All statistical analyses were performed using R (version 3.6.2).

Results

A total of 161 patients were enrolled from June 2018 through December 2019, of whom, 148 were be eligible for the per protocol analysis (Fig. 1). Procedures were performed by 7 different surgeons. Patients' demographics and surgical characteristics are summarized in Table 1. The groups were overall comparable in their demographic and surgical characteristics.

Intraoperative movement

The total displacements for each of the antislip surfaces are summarized in Figure 2. The amount of displacement varied by the anatomical locations (Table 2). For all surfaces combined, the perineum and the head moved a mean distance of 4.68 cm (range: 3.12–5.87 cm) and 3.55 cm (range:1.89–5.08 cm), respectively. The torso measurements (ASIS, umbilicus, and acromion) were larger and moved in tandem with each other. The ASIS (mean: 9.39 cm; range: 6.60–9.29 cm) and acromion (mean: 9.03 cm; range: 7.00–11.86 cm) did not move as much as the umbilicus (mean: 13.71 cm; range: 11.17–17.01 cm).

The effect of the antislip surfaces on total displacements were evaluated using Tukey's multiple comparisons. As shown in Table 2, the pink pad had less displacement than the beanbag at the ASIS ($p = 0.008$) and perineum ($p = 0.022$). The pink pad had significantly less movement ($p \leq 0.001$) in all measures versus the gel pad. The beanbag showed significantly less movement ($p < 0.004$) than the gel pad in the torso but was not different in the head or perineum. An intention to treat (ITT) analysis was performed to assess the movement of all patients who had originally enrolled (including those who were not included in the other analyses). The mean differences in total displacement for each anatomical area are shown in Table 3. All significant differences among the antislip surfaces were confirmed by the ITT analysis.

Multiple factors were hypothesized to influence the propensity for intraoperative movement. In the combined analysis, age, surgery type, OR bed model, surgical length, and maximum Trendelenburg position did not influence total displacements. Taller stature led to less total movement at the umbilicus ($p = 0.004$), acromion ($p = 0.009$), and head ($p = 0.029$). Greater weight increased total displacement at the ASIS ($p = 0.047$), umbilicus ($p = 0.026$), and acromion ($p = 0.003$). Waist circumference was positively correlated with total displacement at the umbilicus ($p = 0.003$) and perineum ($p = 0.005$). Similarly, the only other factor that influenced perineal movement was a smaller waist-to-hip ratio that was associated with more total movement ($p = 0.039$).

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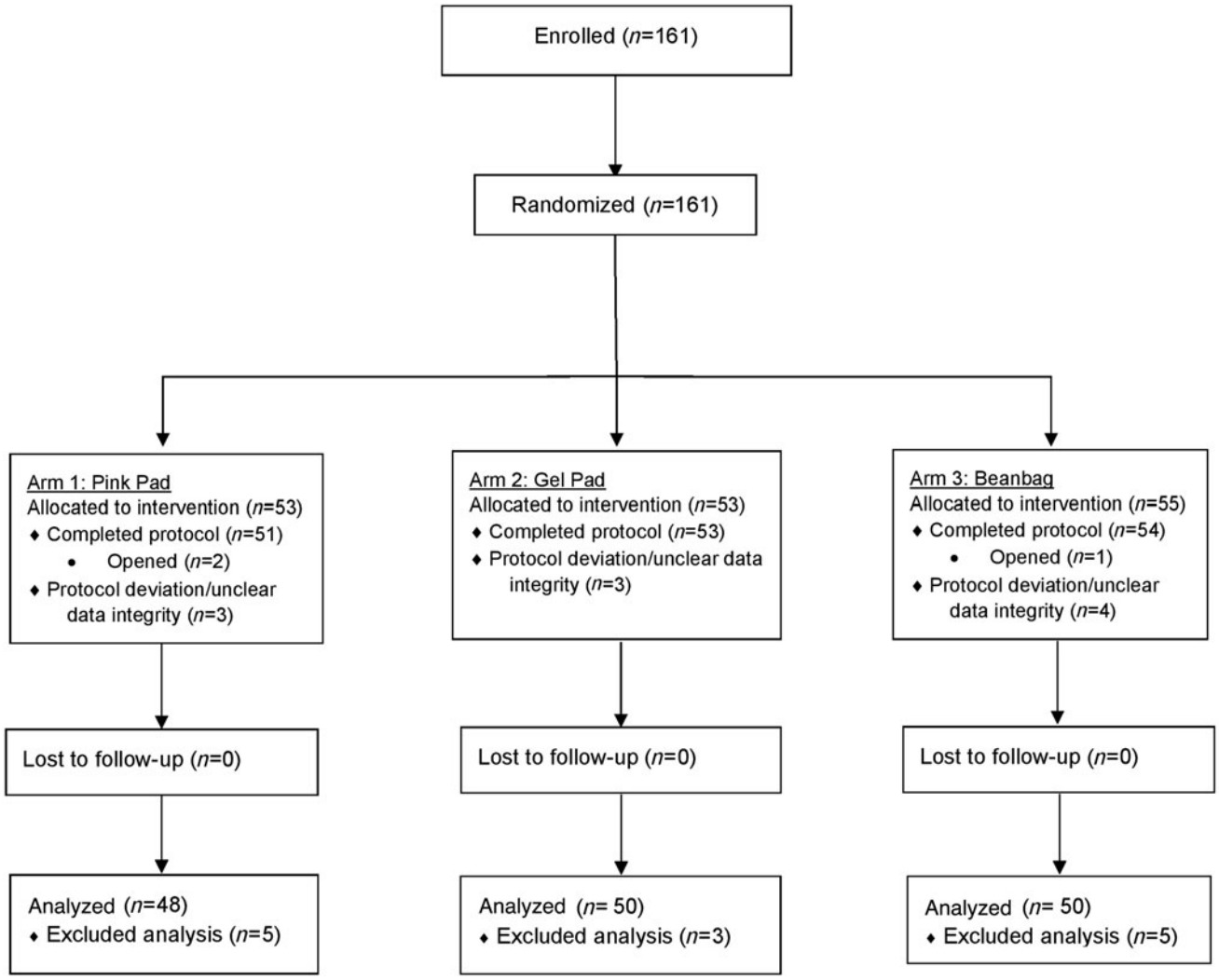

FIG. 1. Enrollment, randomization and interventions.

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The effect of obesity was assessed further by comparing the displacement of obese (BMI ≥30) to nonobese (BMI <30) patients. The groups were well-matched in terms of mean BMI (Table 1; $p=0.127$) and obesity class ($p=0.654$). The total displacement for the combined surfaces was significantly increased by 32%–55% in obese patients for all measured locations except the head (Appendix A; $p=0.221$). The amounts of displacement associated with the individual antislip surfaces were then compared in the obese population (Table 4). The gel pad and the beanbag performed similarly except at the acromion, where the beanbag was superior ($p=0.042$). The pink pad and beanbag performed equally well except at the ASIS, where the pink pad has less displacement ($p=0.046$). Obese patients had less movement at all anatomical markers on the pink pad, compared to the gel pad (all p-values <0.05).

Positioning and procedure timing

Positioning times among the antislip surfaces differed significantly ($p<0.001$). The pink pad positioning (4.75 minutes) was 19.2% faster than the gel pad (5.87 minutes; $p=0.042$) and 30.8% quicker than the beanbag (6.86 minutes; $p<0.001$). There were no differences in intraoperative visualization among the surfaces, but the pink pad had less uterine manipulation delay than the beanbag (0.38 versus 2.22 minutes; $p<0.023$). When the total additional operative times attributable to each surface were compared, the pink pad was found to be 37.1% (3.10 minutes; $p=0.004$) and 45.5% (4.41 minutes; $p<0.001$) faster than the gel pad and the beanbag, respectively.

Back pain and erythema

Preoperative pain scores were similar among the patients in the different surface groups with all reporting pain scores <1 of 10 (Fig. 3A). Postoperative back pain was 2.5 times greater in the gel pad group versus the pink pad group (2.40 versus 0.96 points; $p=0.036$). The remainder of the comparisons showed no significant differences among the patients on the surfaces (Appendix B). An exploratory analysis showed that surgical length did not affect back pain ($p=0.803$). Increased weight was associated with less postoperative back pain ($p=0.008$), while increased waist-to-hip ratio led to more pain ($p=0.014$).

Table 1. Patients' Demographics and Surgical Characteristics

Patients' characteristics	*Beanbag*[a] (n = *50*) *mean*	*Gel pad*[b] (n = *50*) *mean*	*Pink pad*[c] (n = *48*) *mean*	p-*Value*
Age, yrs (SD)	58.9 (12.8)	59.7 (12.8)	55.7 (12.0)	0.252
Uterine weight, g (SD)	147.1 (107.1)	178.7 (234.9)	181.0 (209.1)	0.702
Surgery (%)				0.039
TLH/TRH	35 (70.0)	47 (94.0)	41 (85.4)	
Laparoscopic adnexectomy with adhesiolysis	7 (14.0)	2 (4.0)	3 (6.2)	—
Other laparoscopy	5 (10.0)	0 (0.0)	4 (8.3)	—
LAVH/TVH/other	3 (6.0)	1 (2.0)	0 (0.0)	
Race (%)				0.541
White	33 (67.3)	34 (69.4)	38 (79.2)	—
Asian	1 (2.0)	0 (0.0)	0 (0.0)	—
Black	14 (28.6)	15 (30.6)	9 (18.8)	—
Other	1 (2.0)	0 (0.0)	1 (2.1)	—
Height, cm (SD)	162.0 (7.5)	159.9 (10.8)	163.4 (7.4)	0.137
Weight, kg (SD)	85.3 (24.3)	94.4 (29.2)	91.8 (30.6)	0.255
BMI (SD)	32.6 (9.5)	38.3 (20.3)	34.1 (10.2)	0.127
Waist circumference, cm (SD)	100.4 (24.0)	109.2 (30.4)	106.1 (34.5)	0.337
Waist-to-hip ratio (SD)	0.9 (0.1)	0.9 (0.01)	0.9 (0.1)	0.102
Bed model (%)				0.795
Skytron[d]	15 (30.0)	11 (22.0)	14 (29.2)	
Steris[e]	23 (46.0)	22 (44.0)	20 (41.7)	
Trumpf[f]	12 (24.0)	17 (34.0)	14 (29.2)	
Surgery length, min (SD)	189.1 (63.1)	216.8 (87.2)	202.3 (64.4)	0.165
Max Trendelenburg, degrees (SD)	26.0 (3.6)	26.1 (4.6)	26.5 (4.4)	0.793

[a]Olympic Vac-Pac® (Natus Medical Inc., Pleasanton, CA).
[b]Action® O.R. Overlay (Action Products Inc., Hagerstown, MD).
[c]The Pink Pad XL,® (Xodus Medical Inc., New Kensington, PA).
[d]Skytron 6701 Hercules (Skytron, Grand Rapids, MI).
[e]Steris AMSCO BL58728 (Steris, Mentor, OH).
[f]Trumpf TruSystem® 7000 U (dV; Trumpf Medical, Saalfeld, Germany).
yrs, years; SD, standard deviation; TLH, total laparoscopic hysterectomy; TRH, total robotic-assisted hysterectomy; LAVH, laparoscopically assisted vaginal hysterectomy; TVH, total vaginal hysterectomy; BMI, body mass index; min, minutes; max, maximum.

Preoperative back erythema did not differ (Fig. 3B; $p = 0.732$) among the beanbag (8.0%), gel pad (4.0%), and pink pad (4.2%). Postoperative erythema differed significantly among the patients on the different antislip surfaces ($p = 0.005$). The beanbag group had the highest postoperative erythema rate at 30%. This was significantly higher than the pink pad group (6.2%; $p = 0.017$). While the gel pad group's erythema rate of 12% was lower than the beanbag group and higher than the pink pad group, neither comparison was significantly different ($p = 0.099$ and 0.525, respectively). Postoperative erythema was not affected by surgery length ($p = 0.697$), weight ($p = 0.449$), or waist-to-hip ratio ($p = 0.200$).

Complications

Complications were rare with no intraoperative complications observed. There were no differences in postoperative complication rates by surface types (beanbag: $n = 7$ [14%]; gel pad: $n = 9$ [18%]; and pink pad: $n = 4$ [8%]; $p = 0.356$). The distribution of minor complications (8%, 10%, and 6%, respectively) and major complications (6%, 8%, and 2%, respectively) were nonsignificantly divided among the beanbag, gel pad, and pink pad groups (Appendix C). There were no postoperative neuropathies.

Discussion

The current study was the largest prospective randomized trial of antislip surfaces for surgery. The pink pad had less displacement, compared to the gel pad at all 5 anatomical areas and the beanbag at the ASIS and perineum. These results were confirmed on the ITT analysis, which lowered the risk that these results were caused by bias due to patients' exclusions or from the protocol itself. This differs from the prior literature, which showed less movement at the ASIS for the beanbag.[7] However, that trial only used shoulder braces in the beanbag group and not for the pink pad group, resulting in an uneven comparison. Shoulder braces were excluded from this study due to concern for potential brachial-plexus injuries.

Obese patients had 32%–55% more displacement than nonobese patients except at the head, which was likely less affected given its relative lack of adipose tissue. Additionally, how a patient's weight is distributed can also affect movement. A larger waist increased movement at the perineum and umbilicus. This may be secondary to increased adipose tissue allowing for more skin shifting when a patient is placed in a Trendelenburg position. While the current authors believe that all laparoscopic procedures using a Trendelenburg position would benefit from using an antislip surface, these findings underscore the importance of antislip surfaces in obese patients.

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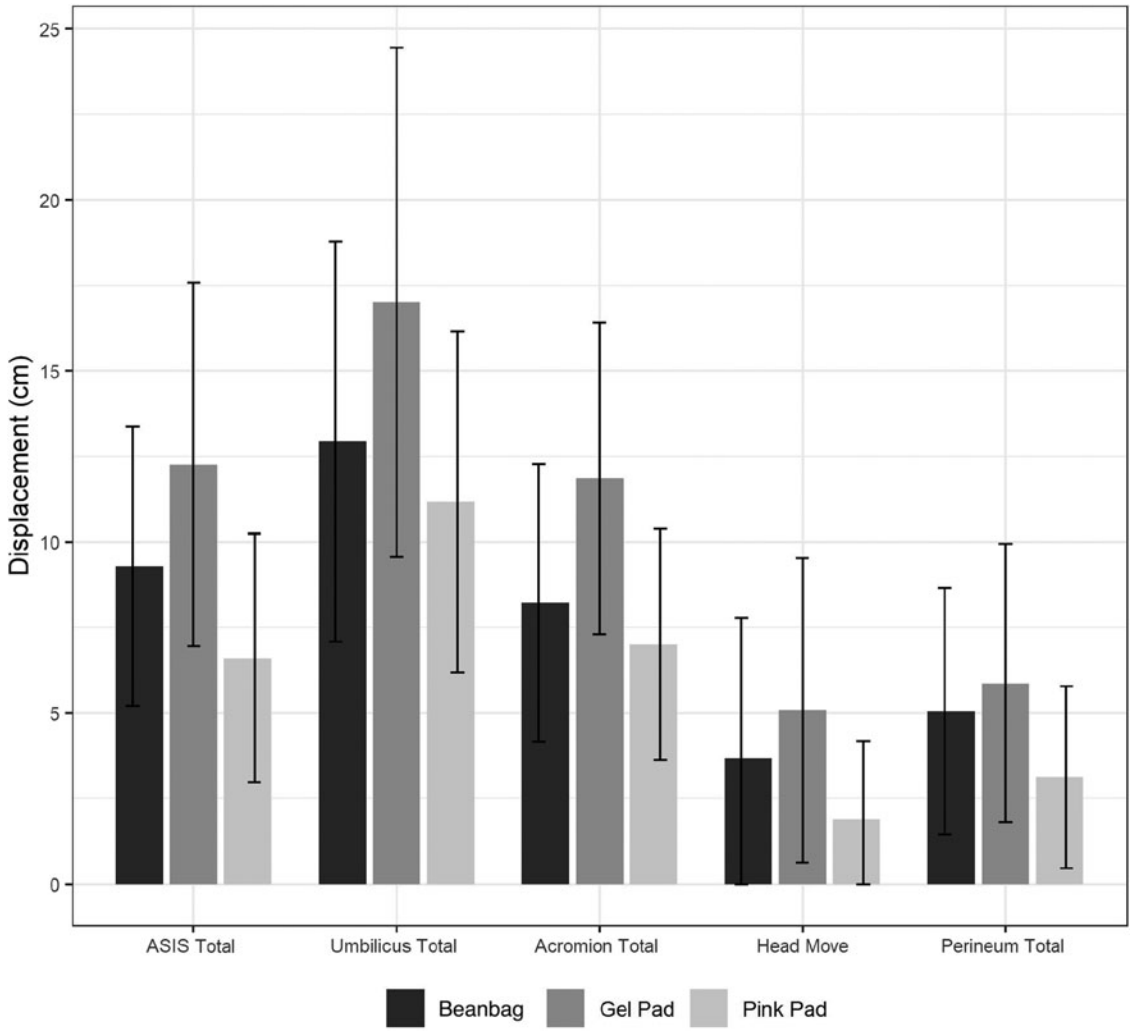

FIG. 2. Total displacement stratified by antislip surfaces per protocol. Surfaces were a beanbag (Olympic Vac-Pac®; Natus Medical Inc., Pleasanton, CA), a gel pad (Action® O.R. Overlay; Action Products Inc., Hagerstown, MD), or a pink pad (The Pink Pad XL®; Xodus Medical Inc., New Kensington, PA). ASIS, anterior superior iliac spine.

TABLE 2. COMPARISON OF DISPLACEMENT BETWEEN ANTISLIP SURFACES (PER PROTOCOL)

	Displacement by antislip surface			p-*Value for mean displacement difference between surfaces*[a]		
Anatomical position	*Beanbag*[b] (n = *50*) *mean (SD)*	*Gel pad*[c] (n = *50*) *mean (SD)*	*Pink pad*[d] (*n* = *48*) *mean (SD)*	*Gel pad vs. beanbag*	*Pink pad vs. beanbag*	*Pink pad vs. gel pad*
ASIS total cm	9.29 (4.07)	12.27 (5.30)	6.60 (3.63)	0.003	0.008	<0.001
Umbilicus total cm	12.94 (5.85)	17.01 (7.45)	11.17 (4.99)	0.004	0.334	<0.001
Acromion total cm	8.22 (4.06)	11.86 (4.55)	7.00 (3.38)	<0.001	0.302	<0.001
Head cm	3.67 (4.11)	5.08 (4.46)	1.89 (2.28)	0.172	0.056	<0.001
Perineum total cm	5.05 (3.60)	5.87 (4.08)	3.12 (2.66)	0.483	0.022	0.001

[a]Tukey's multiple comparison used in this analysis.
[b]Olympic Vac-Pac® (Natus Medical Inc., Pleasanton, CA).
[c]Action® O.R. Overlay (Action Products Inc., Hagerstown, MD).
[d]The Pink Pad XL,® (Xodus Medical Inc., New Kensington, PA).
SD, standard deviation; ASIS, anterior superior iliac spine.

Table 3. Comparison of Displacement Between Antislip Surfaces (Intention to Treat)

	Displacement by antislip surface			p-*Value for mean displacement difference between surfaces*[a]		
Anatomical position	*Beanbag*[b] (n=*55*) *mean (SD)*	*Gel pad*[c] (n=*53*) *mean (SD)*	*Pink pad*[d] (n=*53*) *mean (SD)*	*Gel pad vs. beanbag*	*Pink pad vs. beanbag*	*Pink pad vs. gel pad*
ASIS total cm	9.47 (4.06)	12.12 (5.22)	7.12 (4.26)	0.007	0.020	<0.001
Umbilicus total cm	13.13 (5.82)	16.60 (7.38)	11.70 (5.78)	0.013	0.470	<0.001
Acromion total cm	8.45 (4.38)	11.78 (4.57)	8.00 (5.01)	<0.001	0.863	<0.001
Head cm	3.56 (4.08)	5.16 (4.43)	2.30 (2.79)	0.062	0.176	<0.001
Perineum total cm	4.88 (3.53)	5.78 (3.99)	3.06 (2.63)	0.354	0.017	<0.001

[a]Tukey's multiple comparison used in this analysis.
[b]Olympic Vac-Pac® (Natus Medical Inc., Pleasanton, CA).
[c]Action® O.R. Overlay (Action Products Inc., Hagerstown, MD).
[d]The Pink Pad XL,® (Xodus Medical Inc., New Kensington, PA).
SD, standard deviation; ASIS, ASIS, anterior superior iliac spine.

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Cost is also an important consideration in surface selection. The beanbag and gel pad are reusable surfaces while the pink pad is a single-use product costing less than $150 as tested. However, surface setup time should be factored into the total cost. Every minute in the OR, not including the base OR charge, anesthesia costs, and additional fees, is $86–$142, depending on the complexity of the case.[11] The pink pad saved 4.4 and 3.1 minutes during setup, compared to the beanbag and gel pad, respectively, resulting in a conservatively estimated savings of $378–$625 or $267–$440 per case.

This trial also evaluated patient-centered outcomes such as postoperative erythema and pain, which had not been addressed in the literature. While there were no differences in complications among the antislip surfaces, there were differences in pain and erythema. There was more postoperative pain on the gel pad ($p=0.036$) and postoperative erythema on the beanbag ($p=0.017$), compared to the pink pad. Consistent with prior trials and common practice, patients were placed directly on the antislip surface with only a draw sheet in between.[7,9] The current authors hypothesize that the cushioning effect and breathability of the open-cell foam found in the pink pad helped to minimize postoperative pain and erythema. Further testing with pressure- and moisture-sensors is needed to confirm these findings.

This study was the largest prospectively randomized trial of antislip surfaces, with 20–30 more patients per arm, compared to prior studies. This was also the only trial to evaluate a wide variety of potential risk factors systematically for intraoperative displacement as well as patient-centered outcomes, such as postoperative pain and erythema. Finally, this trial introduced the idea that displacement should be measured prior to the reversal of the Trendelenburg position as a more clinically meaningful endpoint.

Limitations of the trial included the inability to blind the surgical team to the antislip surfaces and the need to identify multiple anatomical landmarks, which can be challenging, especially in obese individuals. Selection bias was limited

Table 4. Comparison of Displacement Between Antislip Surfaces in Obese Patients in Trendelenburg Position

	Mean displacement difference			p-*Value*[a]		
Anatomical position	*Gel pad*[b] *vs. beanbag*[c]	*Pink pad*[d] *vs. beanbag*	*Pink pad vs. gel pad*	*Gel pad vs. beanbag*	*Pink pad vs. beanbag*	*Pink pad vs. gel pad*
ASIS total cm	2.03	–3.19	–5.22	0.251	0.046	<0.001
Umbilicus total cm	2.95	–2.10	–5.05	0.213	0.477	0.009
Acromion total cm	2.92	–1.31	–4.23	0.042	0.525	0.001
Head cm	0.63	–2.50	–3.13	0.847	0.092	0.018
Perineum total cm	0.51	–2.53	–3.04	0.885	0.072	0.013

[a]Tukey's multiple comparison used in this analysis.
[b]The Pink Pad XL,® (Xodus Medical Inc., New Kensington, PA).
[c]Action® O.R. Overlay (Action Products Inc., Hagerstown, MD).
[d]Olympic Vac-Pac® (Natus Medical Inc., Pleasanton, CA).
ASIS, anterior superior iliac spine.

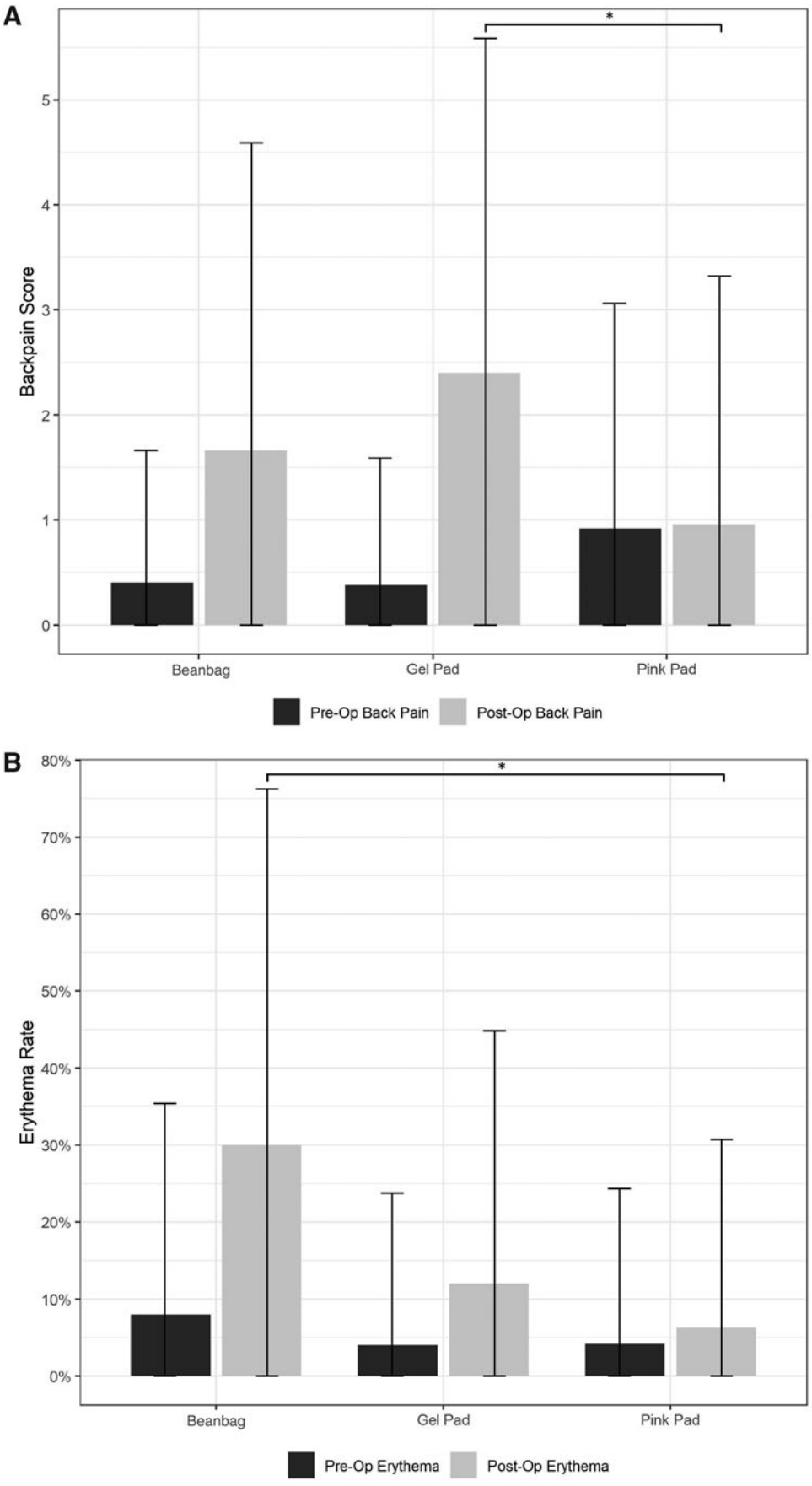

FIG. 3. **(A)** Patient-reported pain before and after surgery. **(B)** Back erythema before and after surgery. Surfaces used were a beanbag (Olympic Vac-Pac®; Natus Medical Inc., Pleasanton, CA), a gel pad (Action® O.R. Overlay; Action Products Inc., Hagerstown, MD), or a pink pad (The Pink Pad XL®; Xodus Medical Inc., New Kensington, PA). op, operative. $*p < 0.05$.

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by randomizing after patients were enrolled in preoperative holding to limit the risk of changes to the surgical plans based on group assignments. Measurement variations were limited by having a set protocol that was immediately available in the OR for which all study personnel were familiarized. Measurement of erythema and pain were limited due to the subjective nature of these measurements. These sources of potential error were minimized by standardizing measurement timing and making erythema a present or absent variable.

Conclusions

The pink pad resulted in significantly less total displacement than the gel pad. Antislip surface selection should be based on the need to minimize movement especially in obese patients. While further study is needed, the pink pad was associated with less postoperative pain than the gel pad and less postoperative erythema than the beanbag.

Authors' Contributions

All of the authors were involved with analysis and writing the article. Drs. Nakayama and Waggoner were also involved in designing the study and collecting data with Drs. Ashby and Dominck.

Author Disclosure Statement

Dr. Nakayama is a consultant for AstraZeneca and Clovis Oncology. The other authors have no financial conflicts of interest.

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