Hernia
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ORIGINAL ARTICLE

Open preperitoneal inguinal hernia repair has superior 1-year patient-reported outcomes compared to Shouldice non-mesh repair

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Abstract

Introduction The Shouldice method for inguinal hernia repair remains the gold standard for prosthesis-free repairs. Nonetheless, international guidelines have favored posterior mesh reinforcement as the standard of care for inguinal hernia repair due to lower risk of recurrence and chronic pain, avoidance of general anesthesia, and favorable biomechanical properties. Recent publications have shown the benefits of an open approach to posterior repairs. Herein, we use the Abdominal Core Health Quality Collaborative (ACHQC) registry to compare patient-reported outcomes after a Shouldice no-mesh repair versus open preperitoneal (OPP) mesh repair.

Methods We performed a propensity score matched analysis to compare patient-reported quality of life (QoL) and peri/postoperative outcomes after a Shouldice repair versus OPP. Data from 2012 to 2022 were obtained from the ACHQC, and 1:1 optimal matching was performed. EuraHS scores were used to estimate QoL, and further analysis on the EuraHS domains of pain, aesthetics, and activity restriction were performed between the two cohorts.

Results Matching resulted in 257 participants in each, Shouldice and OPP cohorts. OPP was associated with a better QoL score compared to Shouldice at 30 days after surgery (Median (IQR) 7.75 (2.0–17.0) vs 13.0 (4.0–26.1); OR 0.559 [0.37, 0.84]; $p=0.003$). This difference persisted at 6 months and 1 year postoperatively (OR 0.447 [0.26, 0.75] and 0.492 [0.26, 0.93], respectively). We did not observe any significant differences in hernia recurrence risk at 1-year, or rates of 30-day SSOs/SSIs, postoperative bleeding, peripheral nerve injury, DVTs, or UTIs.

Conclusion Our data suggest that OPP is associated with significantly better patient-reported QoL, in the first month after surgery and up to 1 year postoperatively, especially with respect to lesser pain, when compared to the Shouldice repair. In specialized inguinal hernia practices, open posterior mesh repairs may lead to better outcomes than non-mesh repairs. We encourage more training in both repairs to facilitate larger prospective studies and evaluation of the generalizability of these results to all surgeons performing IHR.

Keywords Shouldice · Inguinal hernia · TREPP/OPP · Quality of life · Preperitoneal repair

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Introduction

Over 100 techniques for inguinal hernia repair (IHR) have been described, including those that use prosthetic mesh as well as pure tissue-based repairs. Mesh-based techniques can be grouped into anterior approaches (e.g., Lichtenstein), posterior approaches (e.g., TEP, TAPP, and TREPP/OPP), and a combination of anterior and posterior (e.g., Plug and Patch, Prolene Hernia System). Modern tissue repairs, such as the Shouldice and Desarda, are typically performed through an anterior approach. The Shouldice repair, which is the gold standard for the prosthesis-free repair, has demonstrated recurrence rates as low as 1–2% over 25 year follow-up when performed at specialized centers [1–4].

However, mesh-based techniques might have an edge over the Shouldice approach in terms of lower recurrence risk and comparable patient-reported outcomes [5–8]. The 2023 international guidelines suggested that open posterior mesh placement and avoidance of general anesthesia result in better patient outcomes and reduced acute and postoperative pain, and can be an alternative to Lichtenstein [9, 10]. Both Shouldice and OPP can be performed under local anesthesia, thus yielding the benefits of avoiding general anesthesia [10, 11]. However, an OPP approach also satisfies the recommendation regarding posterior mesh placement while yielding excellent outcomes in specialized centers [12–18]. While mesh-reinforced IHRs reduce the risk of hernia recurrence, mesh use has also become the target of several lawsuits, including those with multi-district litigation [19]. Thus, there is a need for further discussion on the possible advantages of OPP relative to no-mesh repairs due to potential patient distrust in mesh-based approaches [20].

Here, we used data from the Abdominal Core Health Quality Collaborative (ACHQC), a US-based national registry that collects short- and long-term hernia-specific data at high-volume IHR centers [21], to compare the patient-reported outcomes after a Shouldice repair versus OPP. High-volume centers participating in the ACHQC centers eliminate the bias related to volume of surgeons and possible general anesthesia use, thus allowing one to compare two open IHR approaches with the primary difference being mesh usage. We hypothesize that, in the hands of experts, posterior mesh repairs under local anesthesia with sedation result in better outcomes compared to a no-mesh repair. Encouraged by recent data that demonstrate the advantages of posterior mesh placement, we conjectured that patients who undergo an open posterior IHR might have an overall improved QoL and lower long-term pain compared to patients who underwent a Shouldice repair.

Methods

Data collection

Between August 2012 and January 2022, data from 89,717 patients were collected by the ACHQC, which we used to compare OPP versus a no-mesh Shouldice repair of unilateral inguinal hernia (https://achqc.org/data). Patients who underwent bilateral inguinal hernia repair, minimally invasive (laparoscopic and robotic) approaches, transinguinal posterior approaches, combined inguinal and ventral hernia repair, or repair of multi recurrent (> 1 recurrence) inguinal hernias were excluded. Among the 4,163 patients who met the inclusion criteria, 914 patients underwent OPP and 434 underwent a Shouldice repair. We then matched 257 patients in the Shouldice IHR cohort with 257 patients in the TREPP group for our analysis using covariates summarized in Table 1. This study was approved by the Institutional Review Board at Prisma Health Upstate.

Characterization of open preperitoneal and Shouldice IHRs

In the ACHQC, open posterior mesh approaches that do not violate the anterior plane were grouped under OPP, including TREPP and Kugel. As previously described [12, 18, 22–26], these approaches involve a lower abdominal incision and opening of the external oblique aponeurosis superior to the inguinal canal. This dissection avoids the interparietal plane between the external and internal obliques where anterior repair is typically performed, thus minimizing scarring in the inguinal canal and allowing unobstructed anterior repair in the event of recurrence requiring future anterior repair. In medial defects, excess transversalis fascia is inverted and sutured to Cooper's ligament as well [27, 28]. Finally, a mesh is placed in the preperitoneal space, covering all possible groin hernias. A step-by-step guide on performing OPP has been previously described [17, 29] and is detailed in Appendix A, supplementary material.

The Shouldice technique is pure tissue-based repair that utilizes a four-layer running approach, allowing for decreased tension in each layer and increased mobility. A detailed overview of the Shouldice repair with an operative guide has been recently described [30, 31]; also outlined in Appendix B, supplementary material. Briefly, the first layer of the repair involves approximation of the rectus to the transversalis fascia and recreating the inguinal floor. Then, the internal ring is recreated by approximating the internal oblique muscle to the lateral edge of the external

Table 1 Standardized mean differences (SMDs) in baseline characteristics between the Shouldice and OPP IHR cohorts after propensity score matching

	TREPP	Shouldice	SMD
n	*257*	*257*	
Age capped at 90 [mean (SD)]	63.71 (14.63)	62.33 (15.14)	0.093
Gender = Male (%)	227 (88.3)	230 (89.5)	0.037
Race/ethnicity (%)			0.068
White, not of Hispanic origin	238 (92.6)	236 (91.8)	
Black, not of Hispanic origin	4 (1.6)	6 (2.3)	
Hispanic	3 (1.2)	4 (1.6)	
Other	12 (4.7)	11 (4.3)	
BMI capped 15–60 (mean (SD))	24.53 (3.38)	24.65 (3.51)	0.035
Insurance (%)			0.052
Private	104 (40.5)	107 (41.6)	
Medicare	126 (49.0)	120 (46.7)	
Other/unknown	27 (10.5)	30 (11.7)	
ASA class (%)			0.093
1	52 (20.3)	53 (20.6)	
2	175 (68.4)	172 (66.9)	
3	29 (11.3)	31 (12.1)	
4 +	0 (0.0)	1 (0.4)	
Hypertension = Yes (%)	75 (29.2)	74 (28.8)	0.009
Diabetes mellitus = Yes (%)	10 (3.9)	10 (3.9)	< 0.001
Chronic obstructive pulmonary disease = Yes (%)	2 (0.8)	5 (1.9)	0.101
Anti-platelet medications = Yes (%)	43 (16.7)	40 (15.6)	0.032
Anti-coagulation medications = Yes (%)	8 (3.1)	10 (3.9)	0.042
Smoker within 1 year = Yes (%)	10 (3.9)	15 (5.8)	0.091
Enlarging hernia = Yes (%)	15 (5.8)	21 (8.2)	0.092
Painful bulge = Yes (%)	248 (96.5)	244 (94.9)	0.077
Recurrent hernia = Yes (%)	20 (7.8)	18 (7.0)	0.03
Prior pelvic operation = Yes (%)	27 (10.5)	33 (12.8)	0.073
Prior mesh = Yes (%)	10 (3.9)	15 (5.8)	0.091
Medial type hernia size (%)			0.046
No Hernia	162 (63.3)	158 (61.7)	
I (< 1.5 cm or < 1 fingertip)	12 (4.7)	11 (4.3)	
II (1.5-3 cm or 1–2 fingertips)	52 (20.3)	54 (21.1)	
III (> 3 cm or > 2 fingertips)	30 (11.7)	33 (12.9)	
Lateral type hernia size (%)			0.053
No Hernia	64 (25.0)	68 (26.5)	
I (< 1.5 cm or < 1 fingertip)	20 (7.8)	22 (8.6)	
II (1.5-3 cm or 1–2 fingertips)	144 (56.2)	138 (53.7)	
III (> 3 cm or > 2 fingertips)	28 (10.9)	29 (11.3)	
Scrotal component = Yes (%)	13 (5.1)	13 (5.1)	< 0.001
Opioid/substance use history (CATA): other substance use = Yes (%)	115 (45.1)	106 (44.5)	0.011
Patient or surgeon reported opioid use in last 30 days at baseline = 1 or more opioids (%)	2 (0.8)	3 (1.2)	0.046
Any behavioral health hx = Yes (%)	19 (7.5)	16 (6.7)	0.028
EuraHS overall score at baseline [mean (SD)]	25.42 (18.01)	24.40 (17.17)	0.058

oblique and wrapping the cremasteric fibers around the cord. This is followed by the second layer of the repair, which involves suturing the internal oblique and the rectus muscle medially to the external oblique. Then, the third layer of the repair starts just medial to the internal ring. It is identical to the second layer, involving the approximation of the internal oblique and rectus to the external oblique. The fourth layer involves taking smaller bites of the internal oblique and rectus and 1 cm bites of the external oblique to wrap over the previous layer. Finally, the medial leaflet of the external oblique is approximated to the inferolateral external oblique edge in a running fashion to recreate the top of the canal [32].

Outcomes

We compared patient-reported QoL as well as longitudinal clinical outcomes between the OPP and the Shouldice IHR approaches using the ACHQC registry. Data collected include patient demographics and comorbidity, surgical details, clinical outcomes, and patient-reported outcomes (PRO) before, during, and after unilateral IHR procedures, as described previously [33]. The primary QoL outcome was reported by patients based on the EuraHS QoL measuring system at 30 days, 6 months, and 1 year after surgery. The EuraHS score assesses pain (range 0–30), restriction of activity (range 0–40), and cosmetic discomfort (range 0–20) with total scores ranging from 0 to 90 [34]. These domain-specific scores were available at the 30-day and 6-month timepoints. A lower score signifies an improved QoL.

Secondary outcomes include peri- and postoperative complications, and composite hernia recurrence. We also assessed patient-reported opioid use at 30-day follow-up. Surgical site infection (SSI) was defined in this study as a deep incisional, superficial incisional, or organ space infection, whereas surgical site occurrence (SSO) was defined as wound cellulitis, fascial disruption, wound drainage, seroma, hematoma, contaminated or infected mesh, enterocutaneous fistula formation, or skin or soft-tissue ischemia. Patient surveys were completed at 30 days, 6 months, and then once per year after surgery. Composite recurrence was documented by a physical exam or radiographic imaging at any point postoperatively or a patient-reported bulge at the site of the hernia at the 1-year time point or beyond after an IHR.

Statistical methods

Patient-level, hernia, and operative characteristics were compared between individuals who received TREPP and a Shouldice IHR. Pearson's chi-squared and Wilcoxon rank sum tests were used to conduct bivariate tests comparing categorical and continuous covariates, respectively. Pairwise analyses were performed to detect differences in OPP and the Shouldice IHR techniques. We accounted for differences in baseline covariates as previously described [17]. Briefly, we used 1:1 nearest-neighbor matching to create a propensity-score matched cohort that included the following variables: age, gender, race, BMI, insurance status, ASA class, comorbidities, indication for surgery (enlarging hernia, painful bulge, and recurrent hernia), prior pelvic operation, prior mesh, hernia size, scrotal component, history of substance use, history of opioid use, behavioral health history, and EuraHS quality-of-life score measured at baseline. Odds ratios (OR) and their 95% confidence intervals (CI) were estimated using logistic, proportional odds, or Cox proportional hazards models for binary, patient-reported, and time-to-event outcomes, respectively. To assess the difference in EuraHS quality-of-life scores between surgical approaches for populations with the same baseline score, we adjust for baseline scores in a proportional odds regression model.

Results

Baseline patient characteristics

Between August 2012 and January 2022, 4,163 patients underwent an IHR and met the inclusion criteria (see Methods; Fig. 1). The OPP approach was used in 914 patients, whereas a Shouldice no-mesh repair was performed in 434 individuals. To account for confounding covariates, we used 1:1 propensity score matching (PSM) using the nearest-neighbor matching algorithm, which resulted in balanced cohorts with 257 participants in each group. Balance was assessed by examining the standardized mean differences (SMD) of baseline covariates. We observed no significant differences between the adjusted groups based on age, gender, race/ethnicity, ASA class, or medical comorbidities (Table 1). Since both OPP and Shouldice are nationally performed by a relatively small group of surgeons, 9 surgeons across 10 surgical centers contributed data for OPP repairs, compared to 16 surgeons across 19 centers who contributed data for Shouldice repairs.

Assessment of patient-reported QoL measures

The primary outcomes we examined were postoperative patient-reported EuraHS QoL scores. Propensity-score matched analysis, after accounting for baseline scores, demonstrated a significantly lower overall EuraHS QoL score in OPP compared to Shouldice (Table 2) at 30 days after surgery (Median(IQR) 7.75 (2.0–17.0) vs 13.0 (4.0–26.1); OR 0.559 [0.37, 0.84]; $p = 0.003$). This difference persisted at 6 months and 1 year postoperatively (OR 0.447 [0.26, 0.75] and 0.492 [0.26, 0.93], respectively). Examining specific EuraHS domains post hoc further suggested that the overall

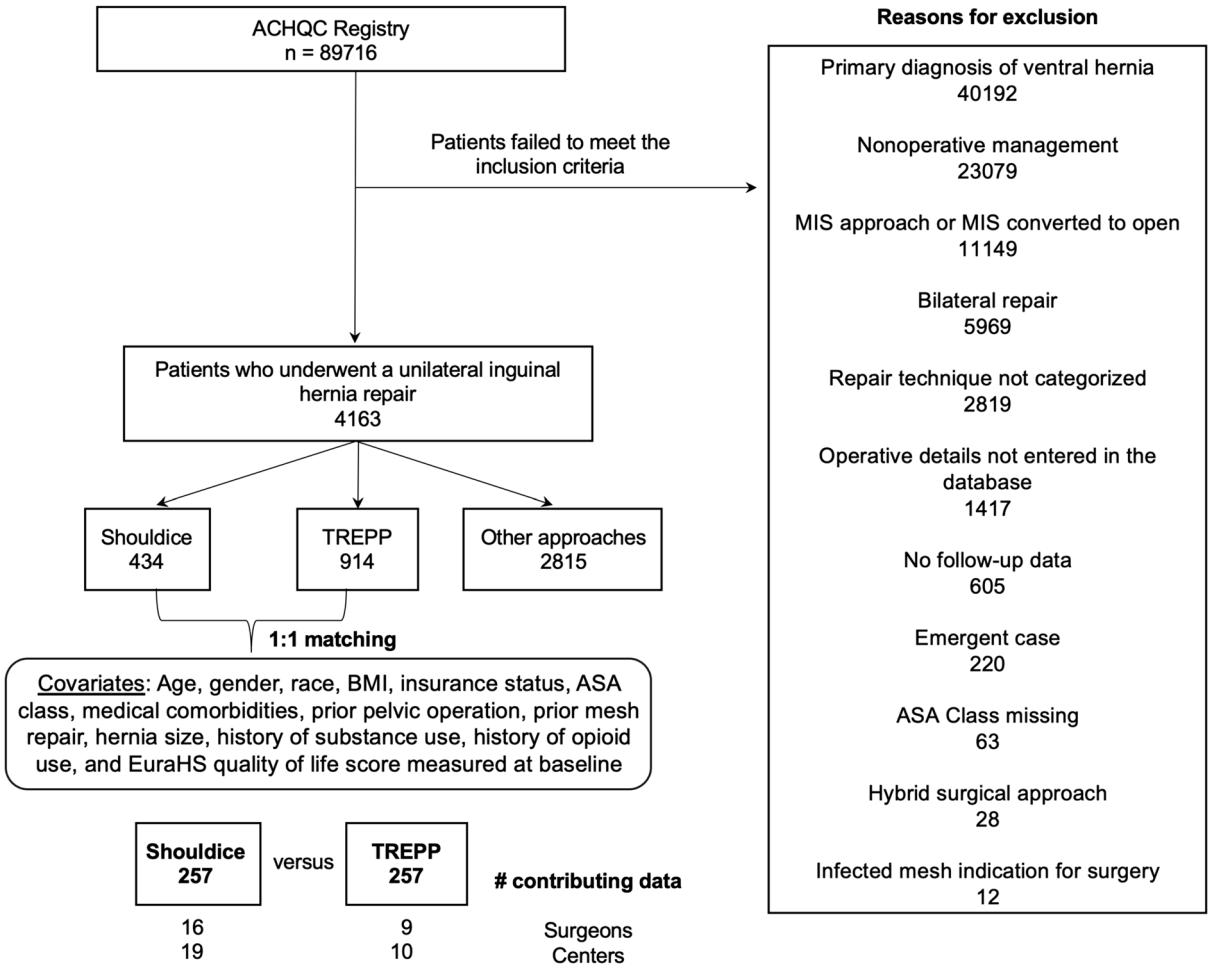

Fig. 1 CONSORT flow diagram with inclusion and exclusion criteria of participants whose clinical data were used in this study

QoL score differences appeared to likely be driven by lower pain domain scores. Patients who underwent OPP reported lower QoL pain domain scores compared to those who underwent a Shouldice repair at both 30 days and 6 months after surgery (OR 0.557 [0.33, 0.95] and 0.361 [0.15, 0.85], respectively). No QoL differences were evident between the two cohorts in the restriction and esthetic domain scores (Table 2).

Comparative secondary outcomes

We did not observe any differences in the clinical composite hernia recurrence between the OPP and Shouldice cohorts (OPP:Shouldice hazard ratio 0.776, 95% CI (0.327, 1.844); $p = 0.56$). We further evaluated perioperative and postoperative complications after IHR, and found no differences in the 30-day frequency of SSIs and SSOs between the OPP and Shouldice cohorts (Table 3). There were no statistically significant differences in the proportion of NSQIP complications between the two groups, including rates of urinary retention, ileus or bowel obstructions, pulmonary emboli, DVT, or respiratory failure.

Additionally, we did not observe any statistically significant differences in patient-reported opioid use at 30-day follow-up between the two cohorts. Matched analysis demonstrated that among those undergoing OPP repair, 82.8% of patients did not require opioids postoperatively, compared to 73.7% of those who underwent a Shouldice repair.

Discussion

Hernia repair, in the absence of incarceration and strangulation, can be primarily regarded as a surgery that helps patients regain and improve their QoL. Consequently, it can be argued that patient-reported QoL is one of the most important measures of the efficacy and success of an IHR [35, 36]. Herein, we compared two open IHR techniques—Shouldice and OPP—and found that after accounting for confounding variables, in specialized, high-volume

Table 2 Overall and domain-specific EuraHS patient-reported outcomes

Outcome	Total *N*	Shouldice (*N* = 257)	TREPP (*N* = 257)	*P* value	OR	95% CI
EuraHS QoL score from 30-day survey (score 0–90)	286			0.005	0.559	(0.372, 0.839)
N		142	144			
Median (interquartile range)		13.00 (4.00–26.08)	7.75 (2.00–17.00)			
Range		0.00–61.50	0.00–63.00			
Mean ± SD		17.35 ± 15.85	12.51 ± 13.72			
EuraHS QoL score from 6-month survey (score 0–90)	191			0.002	0.447	(0.264, 0.75)
N		100	91			
Median (interquartile range)		2.50 (0.00–6.58)	0.00 (0.00–4.83)			
Range		0.00–63.00	0.00–58.00			
Mean ± SD		5.60 ± 9.39	3.96 ± 9.68			
EuraHS QoL score from 1-year survey (score 0–90)	134			0.03	0.492	(0.256, 0.933)
N		69	65			
Median (interquartile range)		2.00 (0.00–6.33)	0.00 (0.00–3.00)			
Range		0.00–47.00	0.00–50.00			
Mean ± SD		5.46 ± 9.49	3.67 ± 8.26			
Domain-specific scores						
EuraHS QoL pain domain score from 30-day survey (score 0–30)	286			0.031	0.557	(0.325, 0.948)
N		142	144			
Median (interquartile range)		3.00 (1.00–6.00)	2.00 (0.00–4.58)			
Range		0.00–27.00	0.00–25.00			
Mean ± SD		4.22 ± 4.81	3.06 ± 3.98			
EuraHS QoL pain domain score from 6-month survey (score 0–30)	191			0.018	0.361	(0.146, 0.845)
N		100	91			
Median (interquartile range)		0.00 (0.00–2.00)	0.00 (0.00–0.00)			
Range		0.00–27.00	0.00–17.00			
Mean ± SD		1.97 ± 3.99	1.30 ± 3.32			
EuraHS QoL restriction domain score from 30-day survey (score 0–40)	278			0.235	0.717	(0.413, 1.242)
N		138	140			
Median (interquartile range)		4.50 (0.00–14.00)	2.00 (0.00–7.50)			
Range		0.00–36.00	0.00–35.00			
Mean ± SD		8.98 ± 10.19	6.08 ± 8.68			
EuraHS QoL restriction domain score from 6-month survey (score 0–40)	191			0.106	0.463	(0.171, 1.176)
N		100	91			
Median (interquartile range)		0.00 (0.00–1.19)	0.00 (0.00–0.00)			
Range		0.00–35.00	0.00–40.00			
Mean ± SD		1.70 ± 4.75	1.27 ± 5.34			
EuraHS QoL esthetical domain score from 30-day survey (score 0–20)	286			0.591	0.864	(0.506, 1.473)
N		142	144			
Median (interquartile range)		2.00 (1.00–7.00)	2.00 (0.00–5.00)			
Range		0.00–18.00	0.00–16.00			
Mean ± SD		4.28 ± 4.40	3.43 ± 4.02			
EuraHS QoL esthetical domain score from 6-month survey (score 0–20)	191			0.071	0.49	(0.221, 1.061)
N		100	91			
Median (interquartile range)		0.50 (0.00–2.58)	0.00 (0.00–1.00)			
Range		0.00–16.00	0.00–17.00			
Mean ± SD		1.93 ± 3.10	1.38 ± 2.78			

N is the number of participants with non-missing data

P value, Odds Ratio (OR), and 95% confidence interval (CI) calculated using proportional odds regression model

OR reported as TREPP:Shouldice

Table 3 30-day clinical outcomes between the Shouldice and OPP IHR cohorts after propensity score matching

Outcome	N	Shouldice ($N=257$)	TREPP ($N=257$)	*P* value	OR	95% CI
30-day surgical site infection (SSI): Yes	472	0/236 (0.00)	1/236 (0.42)	0.996	–	–
Deep incisional: Yes	1		1/1 (100.00)			
Organ space: Yes	1		0/1 (0.00)			
Superficial: Yes	1		0/1 (0.00)			
30-day surgical site occurrence (SSO): Yes	472	5/236 (2.12)	2/236 (0.85)	0.27	0.395	(0.056, 1.852)
Wound cellulitis: Yes	7	0/5 (0.00)	0/2 (0.00)			
Non-healing incisional wound: Yes	7	0/5 (0.00)	0/2 (0.00)			
Fascial disruption: Yes	7	0/5 (0.00)	0/2 (0.00)			
Skin or soft-tissue ischemia: Yes	7	0/5 (0.00)	0/2 (0.00)			
Skin or soft-tissue necrosis: Yes	7	0/5 (0.00)	0/2 (0.00)			
Wound serous drainage: Yes	7	1/5 (20.00)	0/2 (0.00)			
Wound purulent drainage: Yes	7	0/5 (0.00)	0/2 (0.00)			
Chronic sinus drainage: Yes	7	0/5 (0.00)	0/2 (0.00)			
Localized stab wound infection: Yes	7	0/5 (0.00)	0/2 (0.00)			
Stitch abscess: Yes	7	0/5 (0.00)	0/2 (0.00)			
Seroma: Yes	7	4/5 (80.00)	1/2 (50.00)			
Infected seroma: Yes	7	0/5 (0.00)	0/2 (0.00)			
Hematoma: Yes	7	0/5 (0.00)	1/2 (50.00)			
Infected hematoma: Yes	7	0/5 (0.00)	0/2 (0.00)			
Exposed biologic mesh: Yes	7	0/5 (0.00)	0/2 (0.00)			
Exposed synthetic mesh: Yes	7	0/5 (0.00)	0/2 (0.00)			
Contaminated biologic mesh: Yes	7	0/5 (0.00)	0/2 (0.00)			
Contaminated synthetic mesh: Yes	7	0/5 (0.00)	0/2 (0.00)			
Infected biologic mesh: Yes	7	0/5 (0.00)	0/2 (0.00)			
Infected synthetic mesh: Yes	7	0/5 (0.00)	0/2 (0.00)			
Mucocutaneous anastomosis disruption: Yes	7	0/5 (0.00)	0/2 (0.00)			
Enterocutaneous fistula: Yes	7	0/5 (0.00)	0/2 (0.00)			
Unspecified: Yes	7	0/5 (0.00)	0/2 (0.00)			
30-day SSO or SSI requiring procedural intervention (SSOPI): Yes	472	2/236 (0.85)	1/236 (0.42)	0.57	0.498	(0.023, 5.232)
Wound opening: Yes	3	0/2 (0.00)	0/1 (0.00)			
Wound debridement: Yes	3	0/2 (0.00)	0/1 (0.00)			
Suture excision: Yes	3	0/2 (0.00)	0/1 (0.00)			
Percutaneous drainage: Yes	3	0/2 (0.00)	0/1 (0.00)			
Partial mesh removal: Yes	3	0/2 (0.00)	0/1 (0.00)			
Complete mesh removal: Yes	3	0/2 (0.00)	0/1 (0.00)			
30-day NSQIP complications: Yes	472	1/236 (0.42)	3/236 (1.27)	0.339	3.026	(0.384, 61.411)
Ileus: Yes	472	0/236 (0.00)	0/236 (0.00)			
Bowel obstruction: Yes	472	0/236 (0.00)	0/236 (0.00)			
Pain: Yes	472	0/236 (0.00)	0/236 (0.00)			
PE: Yes	472	0/236 (0.00)	1/236 (0.42)			
Stroke: Yes	472	0/236 (0.00)	0/236 (0.00)			
DVT: Yes	472	0/236 (0.00)	0/236 (0.00)			
Sepsis: Yes	472	0/236 (0.00)	0/236 (0.00)			
Septic shock: Yes	472	0/236 (0.00)	0/236 (0.00)			
MI: Yes	472	0/236 (0.00)	0/236 (0.00)			
Cardiac arrest: Yes	472	0/236 (0.00)	0/236 (0.00)			
UTI: Yes	472	0/236 (0.00)	0/236 (0.00)			
Renal insufficiency: Yes	472	0/236 (0.00)	0/236 (0.00)			

Table 3 (continued)

Outcome	N	Shouldice ($N=257$)	TREPP ($N=257$)	*P* value	OR	95% CI
Renal failure: Yes	472	0/236 (0.00)	0/236 (0.00)			
Pneumonia: Yes	472	0/236 (0.00)	0/236 (0.00)			
Postoperative respiratory failure requiring endotracheal intubation: Yes	472	0/236 (0.00)	0/236 (0.00)			
Ventilator > 48 h: Yes	472	0/236 (0.00)	0/236 (0.00)			
Coma > 24 h: Yes	472	0/236 (0.00)	0/236 (0.00)			
Peripheral nerve injury: Yes	472	0/236 (0.00)	0/236 (0.00)			
Post-op bleeding transfusion: Yes	472	0/236 (0.00)	0/236 (0.00)			
Graft/prosthesis/flap failure: Yes	472	0/236 (0.00)	0/236 (0.00)			
Urinary retention requiring catheter placement: Yes	472	1/236 (0.42)	2/236 (0.85)			
Death (< 45 days post-sx): No	514	257/257 (100.00)	257/257 (100.00)			

N is the number of non-missing value

P value, Odds Ratio (OR), and 95% confidence interval (CI) calculated using proportional odds regression model

OR reported as TREPP:Lichtenstein

centers, where multiple surgical approaches are offered, short-term and long-term QoL is better in patients who underwent a posterior mesh IHR (OPP) as opposed to the gold standard non-mesh repair (Shouldice). Patients who request non-mesh repairs commonly are motivated by concerns over mesh-related complications, but, contrary to this belief, the mesh group as a whole fared better postoperatively.

Existing work has demonstrated substantial advantages of IHRs done under local anesthesia in contrast to those that require general anesthesia, including fewer postoperative complications, reduced costs, early discharge, reduced pain, and patient satisfaction [11, 37, 38]. OPP offers all the benefits of minimally invasive (laparoscopic/robotic) IHR techniques, while avoiding general anesthesia, and does not violate both anterior and posterior planes. Our findings are in accordance with existing literature which supports the faster recovery, relatively low recurrence risk, and reduced rates of chronic pain associated with a posterior mesh repair [9]. At 30 days, 6 months, and 1 year postoperatively, the OPP cohort reported significantly lower EuraHS QoL scores (Table 2) with a 2–5 point mean difference in scores. Although this is lower than the minimal clinically important difference (MCID) for the overall EuraHS QoL scores, which has been suggested to be 10 [39], it is plausible that in the appropriately selected patients, this small score difference might still amount to a clinical benefit. The pain domain-specific differences between the two cohorts were < 2 points, lower than the suggested MCID of 3; however, our findings shed light on the factors that surgeons can consider when offering various IHR approaches to patients, while taking their prior medical history and pain tolerance into account. Future studies can assess how MCIDs might vary based on patient-specific factors to determine clinically significant QoL differences.

In addition, our current analysis found no significant differences in the hernia recurrence risk between the two techniques using time-to-event analysis for up to 5 years after an IHR. There were no significant differences in rates of postoperative complications between the two groups in rates of SSOs (~ 2.1% in Shouldice versus 0.9% in OPP), urinary retention (~ 0.4% in Shouldice versus 0.8% in OPP) or overall 30-day NSQIP complications (~ 0.4% in Shouldice versus 1.3% in OPP). In terms of absolute numbers, five cases of seroma formation were observed in the Shouldice cohort compared to 2 in the OPP cohort. One patient in the OPP group developed an incisional SSI, which was managed with antibiotics.

Our analysis further supports the destigmatization of mesh with respect to IHRs. The Shouldice repair is regarded as the optimal no-mesh repair currently, and our analysis suggests that patients undergoing OPP have an improved QoL comparatively. Both approaches result in excellent patient outcomes, with very low risk of hernia recurrence and other complications, while restoring patients to their prehernia quality of life. With expertise in both of these approaches, surgeons can select the repair tailored to individual patient needs. Discussions then ought to focus on improving education for both surgeons and patients, principally on hernia anatomy and IHR teaching methods rather than on the implants and new technologies.

Importantly, of the surgeons participating in the ACHQC, mostly high-volume inguinal hernia specialists perform OPP and Shouldice repairs. Therefore, this comparison eliminates the bias that might result from heterogeneity in surgical volume and training, and allows for a more realistic

comparison of the two IHR techniques when used by experienced surgeons. Our observations highlight that despite the public skepticism around prosthesis-based repairs, there is mounting evidence that mesh-based repairs performed by high-volume surgeons have significantly better clinical and patient-reported QoL outcomes than those undergoing a primary no-mesh repair.

Limitations of our study include its retrospective nature. Additional prospective studies with more comprehensive longitudinal follow-up will be warranted. Nonetheless, our data add to the literature on the clinical utility of an open posterior mesh repair in the appropriate patient population, and argues for its education among the wider surgical community. With clear anatomical knowledge and meticulous surgical technique, excellent outcomes including low recurrence rates can be replicated for both Shouldice and OPP repairs [2–4, 17]. A Shouldice repair can be offered to patients whose primary goal is to avoid mesh, while an OPP should be offered to those whose primary goal is better QoL at 1 year. At high-volume centers, both could be good options for IHRs based on the surgeon's experience and patient preference.

Conclusion

Our data suggest that in high-volume inguinal hernia practices, an open, pure posterior mesh repair is associated with better patient-reported QoL in the first postoperative year than the gold standard non-mesh IHR. The magnitude of the impact of such differences is an area for further research. In the hands of experienced surgeons, both repairs are excellent tools for the care of patients with inguinal hernia. We encourage more training in both repairs to facilitate larger prospective studies and evaluation of the generalizability of these results to all surgeons performing IHR.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10029-023-02936-3.

Data availability The data used to conduct this analysis and support the results of this paper are directly available from the ACHQC. Data requests can be made directly to the organization at: https://achqc.org/data

Declarations

Conflict of interest The authors have no conflicts of interest to declare.

Ethical approval This study was approved by the Institutional Review Board at Prisma Health Upstate.

Human and animal rights This article does not contain any studies directly involving human participants, as it is a retrospective analysis of data already collected in a hernia database.

Informed consent Participants were notified of their deidentified data being used for research, and provided informed consent.

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