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General Surgery

DOES FASCIAL CLOSURE MATTER? A PROSPECTIVE COMPARISON OF IPOM AND IPOM PLUS IN VENTRAL HERNIA REPAIR

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ABSTRACT **Background:** Laparoscopic Intraperitoneal Onlay Mesh (IPOM) repair without fascial closure is associated with high rates of hernia recurrence and mesh bulging. The modified IPOM Plus technique incorporates primary extracorporeal fascial defect closure prior to mesh reinforcement. This study compares the clinical outcomes of both techniques in a prospective controlled cohort.**Methods:** Thirty patients with symptomatic ventral hernias (fascial defect 2–6 cm; BMI ≤ 35 kg/m²) were equally allocated to Group I (IPOM, n=15) or Group II (IPOM Plus, n=15). Groups were matched for age, sex, and BMI. Primary outcome was hernia recurrence at six months; secondary outcomes included operative time, hospital stay, seroma, hematoma, wound infection, and mesh bulging. Statistical analysis was performed using SPSS v25.0, with $p < 0.05$ considered significant.**Results:** Both groups were comparable at baseline. Operative time was significantly longer in IPOM Plus (111.1 ± 28.1 vs 80.0 ± 28.0 min; $p < 0.001$). Six-month recurrence was significantly lower in IPOM Plus (6.7% vs 20.0%; $p = 0.029$), with an adjusted odds ratio (AOR) of 14.86 (95% CI: 2.51–87.85; $p = 0.003$). Mesh bulging was entirely absent in IPOM Plus (0% vs 13.3%; $p = 0.035$). Early complications were comparable between groups.**Conclusion:** IPOM Plus significantly reduces hernia recurrence and eliminates mesh bulging compared to standard IPOM, at the cost of modestly longer operative time. These findings support the routine adoption of IPOM Plus as the preferred laparoscopic technique for ventral hernia repair, consistent with current international guidelines.

KEYWORDS : Laparoscopic ventral hernia repair; IPOM; IPOM Plus; fascial defect closure; hernia recurrence; mesh bulging

INTRODUCTION

Ventral abdominal wall hernia repair is among the most frequently performed surgical procedures worldwide, with incisional hernias occurring in 11–20% of patients following abdominal surgery and primary ventral hernias in approximately 4–5% of the general population.[1,2] Recurrence rates after laparotomy approach 35–60% within five years, and nearly one in six patients requires reoperation within a decade.[3,4]

Since LeBlanc and Booth introduced laparoscopic ventral hernia repair (LVHR) in 1993, it has supplanted open repair owing to reduced wound complications, shorter hospital stay, and lower perioperative morbidity.[5,6] The standard Intraperitoneal Onlay Mesh (IPOM) technique involves bridging the fascial defect with a composite mesh fixed by a double-crown tacker technique and transfascial sutures, without primary defect closure. While technically straightforward, IPOM carries a recognised risk of mesh bulging, seroma, and recurrence — particularly in obese patients and those with larger defects.[7,8]

To address these shortcomings, the IPOM Plus modification was introduced, wherein the fascial defect is primarily closed with extracorporeal non-absorbable sutures before intraperitoneal mesh placement. This approach restores abdominal wall continuity, reduces dead space, and mitigates the mechanical failure mode of bridging repair. IPOM Plus is now endorsed as the preferred technique by the International Endohernia Society (IEHS), the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), and the European Association for Endoscopic Surgery (EAES).[9,10]

Published evidence supports the superiority of IPOM Plus. A meta-analysis by Tandon et al. (16 studies) reported a relative risk of 0.37 ($p < 0.001$) for seroma formation favouring IPOM Plus.[11] Basukala et al. reported six-month recurrence rates of 15.1% (IPOM) versus 3.5% (IPOM Plus) in a 130-patient cohort (AOR 14.86; 95% CI: 2.51–87.85).[12] Contrary findings by Banerjee et al. and Lambrecht et al. suggest that the benefit of primary closure may be size-dependent.[13,14] Given the ongoing debate and limited institutional data, the present study prospectively compares outcomes of IPOM and IPOM Plus in 30 matched patients, with six-month hernia recurrence as the primary endpoint.

MATERIALS AND METHODS

Study Design and Ethics

This prospective comparative cohort study was conducted at JK Hospital and LN Medical college, Bhopal between January 2025 to January 2026. All participants provided written informed consent in accordance with the Declaration of Helsinki.

Patient Selection

Thirty patients undergoing LVHR were allocated equally to Group I (IPOM, n=15) or Group II (IPOM Plus, n=15) based on surgeon preference and defect characteristics. Groups were matched for age, sex, and BMI. Inclusion and exclusion criteria are detailed in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Age ≥ 18 years	Age < 18 years
Symptomatic primary or incisional ventral hernia	Strangulated ventral hernia
Fascial defect size 2–6 cm	Defect size < 2 cm or > 6 cm
BMI ≤ 35 kg/m²	BMI > 35 kg/m²
Completed all follow-up visits up to 6 months	Patients requiring abdominal wall reconstruction
Fit for laparoscopic surgery under general anaesthesia	HIV / immunocompromised state

Surgical Technique

All procedures were performed under general anaesthesia via a standard three-port approach, with pneumoperitoneum at 12–14 mmHg. A 30° laparoscope was used throughout. In both groups, hernia contents were reduced, adhesions lysed, and defect margins clearly delineated.

In Group I (IPOM), the defect was bridged without closure. An appropriately sized composite mesh with ≥3 cm overlap was fixed using a double-crown tacker technique supplemented by transfascial sutures (Figure 1).

In Group II (IPOM Plus), the fascial defect was primarily closed using extracorporeal interrupted non-absorbable monofilament sutures (Prolene No. 1) placed at ~1 cm intervals using a suture passer, under laparoscopic guidance, before mesh placement. The mesh was then deployed and fixed identically to Group I (Figure 2).

Figure 1. Laparoscopic IPOM repair. Clockwise from top left: adhesiolysis and reduction of hernia contents to expose the fascial defect margins; the unclosed defect with the peritoneal edge visible; deployment of the composite mesh with double-crown tacker fixation;

close-up view of secured tacker fixation over the bridging mesh, without primary fascial closure.

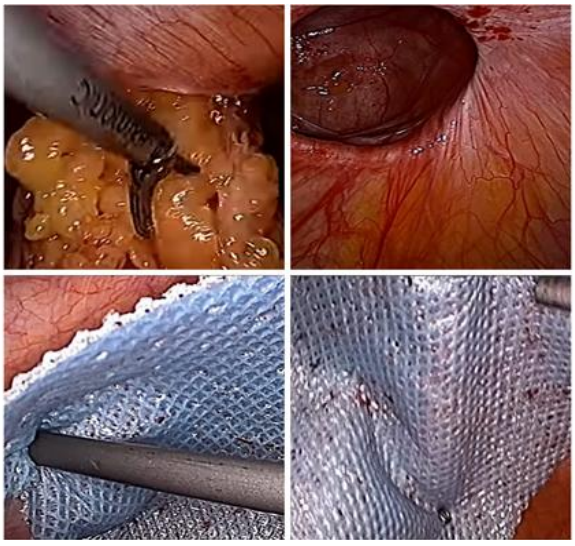

FIGURE 1.

Figure 2. Laparoscopic IPOM Plus repair. Top: primary closure of the fascial defect with an extracorporeal interrupted non-absorbable monofilament suture placed under laparoscopic guidance, restoring midline continuity before mesh placement. Bottom: the composite mesh secured over the closed defect with tacker fixation, seen as the characteristic double-crown pattern of fixation points.

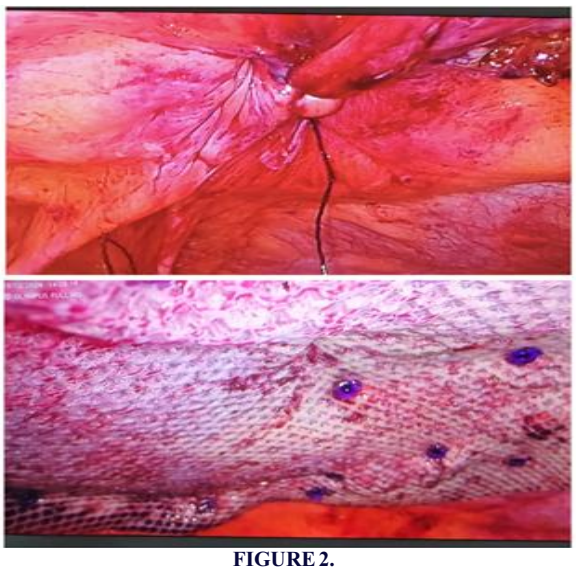

FIGURE 2.

Postoperative Care and Follow-up

Standardised postoperative protocols were applied to both groups: abdominal binders for 6–8 weeks, early ambulation, and restriction of heavy lifting for three months. Follow-up was conducted at days 7–10, six weeks, three months, and six months. At each visit, patients were assessed for recurrence (clinically and radiologically), mesh bulging, seroma, hematoma, and wound infection.

Statistical Analysis

Data were analysed using SPSS v25.0 (IBM Corp., Armonk, NY). Continuous variables are presented as mean ± SD and compared using the Mann-Whitney U test. Categorical variables are presented as frequencies and percentages and compared using Pearson's chi-square or Fisher's exact test. Multivariate logistic regression was performed to derive adjusted odds ratios (AOR) for six-month recurrence, controlling for defect size and mesh bulging. A two-tailed p-value < 0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

All 30 patients completed six-month follow-up. Both groups were well-matched at baseline with no significant intergroup differences in age, sex, BMI, hernia type, or ASA grade (Table 2). Female patients predominated in both groups (66.7%), consistent with the established epidemiological burden of incisional hernia in women.[15]

Table 2. Demographic and Baseline Characteristics

Variable	IPOM (n=15)	IPOM Plus (n=15)	p-value
Age (years) – Mean ± SD	52.3 ± 13.7	50.8 ± 13.5	0.637
Sex – Male, n (%)	5 (33.3)	5 (33.3)	1.000
BMI (kg/m²) – Mean ± SD	29.6 ± 2.8	29.4 ± 2.8	0.923
Incisional hernia, n (%)	14 (93.3)	12 (80.0)	0.589
Primary ventral hernia, n (%)	1 (6.7)	3 (20.0)	0.589
ASA Grade I, n (%)	8 (53.3)	10 (66.7)	0.456
ASA Grade II, n (%)	6 (40.0)	4 (26.7)	0.456
ASA Grade III, n (%)	1 (6.7)	1 (6.7)	1.000

Intraoperative Findings

A significant difference in defect size distribution was observed between groups ($p < 0.001$), with larger defects (4–6 cm) more prevalent in the IPOM Plus group (73.3% vs 20.0%), reflecting the clinical tendency to reserve primary closure for more challenging repairs. Mean operative time was significantly longer in IPOM Plus (111.1 ± 28.1 vs 80.0 ± 28.0 min; $p < 0.001$). One minor intraoperative bowel injury occurred in Group I, managed laparoscopically without conversion (Table 3).

Table 3. Intraoperative Parameters

Parameter	IPOM (n=15)	IPOM Plus (n=15)	p-value
Defect < 2 cm, n (%)	5 (33.3)	0 (0.0)	< 0.001
Defect 2–4 cm, n (%)	7 (46.7)	4 (26.7)	< 0.001
Defect 4–6 cm, n (%)	3 (20.0)	11 (73.3)	< 0.001
Operative time – Mean ± SD (min)	80.0 ± 28	111.1 ± 28.1	< 0.001
Bowel/bladder injury, n (%)	1 (6.7)	0 (0.0)	0.631

Early Postoperative Complications

Early complications within 30 days were comparable between groups (Table 4). Seroma and haematoma each occurred in one patient per group (6.7%; $p = 1.000$). One patient in Group II developed a superficial surgical site infection (SSI) that resolved with oral antibiotics ($p = 1.000$). No patient required reoperation. Mean hospital stay was marginally longer in IPOM Plus (1.72 ± 0.86 vs 1.51 ± 1.12 days; $p = 0.002$), likely reflecting postoperative pain from transfascial sutures.

Table 4. Early Postoperative Complications (within 30 days)

Complication	IPOM (n=15)	IPOM Plus (n=15)	p-value
Seroma, n (%)	1 (6.7)	1 (6.7)	1.000
Hematoma, n (%)	1 (6.7)	1 (6.7)	1.000
Wound infection (SSI), n (%)	0 (0.0)	1 (6.7)	1.000
Mean hospital stay ± SD (days)	1.51 ± 1.12	1.72 ± 0.86	0.002
Median hospital stay (IQR)	1 (1)	2 (1)	0.001

Six-Month Outcomes and Logistic Regression

Hernia recurrence at six months was significantly lower in IPOM Plus (6.7% vs 20.0%; $p = 0.029$). Mesh bulging was entirely absent in IPOM Plus (0% vs 13.3%; $p = 0.035$). On logistic regression adjusting for defect size and mesh bulging, the AOR for recurrence after IPOM repair was 14.86 (95% CI: 2.51–87.85; $p = 0.003$) compared to IPOM Plus (Table 5). Larger defect size (4–6 cm) and mesh bulging were independently associated with recurrence ($p = 0.009$ and $p = 0.013$, respectively).

Table 5. Six-Month Outcomes and Logistic Regression for Recurrence

Outcome	IPOM (n=15)	IPOM Plus (n=15)	p-value
Hernia recurrence at 6 months, n (%)	3 (20.0)	1 (6.7)	0.029
Mesh bulging, n (%)	2 (13.3)	0 (0.0)	0.035
OR (95% CI) – unadjusted	4.88 (1.04–22.98)	Reference	0.045
AOR (95% CI) – adjusted	14.86 (2.51–87.85)	Reference	0.003

DISCUSSION

Baseline Comparability and Demographics

The two groups were well-matched at baseline — a critical precondition for attributing outcome differences to surgical technique. The female predominance (66.7%) reflects published epidemiological data, with prior studies reporting that male sex is associated with lower odds of recurrence (OR 0.77; 95% CI: 0.61–0.97).[15] The high prevalence of overweight and obese patients in both groups (>90%) is consistent with the established association between elevated BMI and ventral hernia formation.[16]

Defect Size and Operative Time

The unequal distribution of defect sizes — with larger defects more common in the IPOM Plus group — reflects real-world surgical decision-making, wherein fascial closure is preferentially employed for medium-to-large defects. Despite this, IPOM Plus still achieved superior recurrence outcomes, arguably underestimating its true benefit since larger defects inherently carry greater recurrence risk. The additional operative time for IPOM Plus (~30 minutes) is consistent with previously published series,[12,17] and must be balanced against the substantially greater morbidity and cost of recurrence and reoperation.

Early Complications

No significant between-group differences were observed in seroma, haematoma, or SSI rates. The theoretical advantage of IPOM Plus in reducing seroma through dead-space obliteration — reported in a meta-analysis by Tandon et al. as a relative risk of 0.37 in favour of IPOM Plus[11] — was not replicated here, likely due to the small sample size and low baseline event frequency. The marginally longer hospital stay in IPOM Plus is attributable to pain from transfascial sutures, a well-documented phenomenon that may be mitigated by optimised perioperative analgesia.[18]

Hernia Recurrence

The six-month recurrence rate of 20.0% in IPOM versus 6.7% in IPOM Plus (p = 0.029; AOR 14.86) is the principal finding of this study. The mechanistic basis lies in the restoration of anterior abdominal wall integrity: primary fascial closure eliminates the bridging effect of standard IPOM, redistributes intra-abdominal pressure loading, and prevents central mesh migration and tacker pullout. These results closely parallel those of Basukala et al. (15.1% vs 3.5%; AOR 14.86)[12] and Chelala et al., who reported a recurrence rate of only 1.9% at 37.6 months using routine suturing equivalent to IPOM Plus.[19] Contrary findings by Banerjee et al. and Lambrecht et al.[13,14] likely reflect shorter follow-up intervals and smaller defect sizes, for which bridging repair may be comparably effective.

Mesh Bulging

Mesh bulging — a pseudo-recurrence driven by protrusion of the non-functioning abdominal wall into the residual hernia sac under intra-abdominal pressure, as described by Laplace's law[20] — was observed in 13.3% of IPOM patients and in none of the IPOM Plus patients (p = 0.035). This finding is mechanistically expected and corroborated by Clapp et al., who reported bulging rates of 69.4% after IPOM versus 8.3% after transcutaneous closure,[21] and by Suwa et al. in the context of large ventral hernias.[22]

LIMITATIONS

The principal limitations of this study include its small sample size (n=15 per group), which restricts statistical power for low-frequency outcomes and yields wide confidence intervals (AOR 95% CI: 2.51–87.85). The six-month follow-up may not capture late recurrences, given that up to 74% may develop beyond this window. Patient-reported outcome measures (pain scores, SF-36) were not collected. Additionally, the non-random allocation and significant difference in defect size distribution between groups represent potential sources of selection bias that logistic regression can only partially adjust for. Future adequately powered randomised controlled trials with defect-size stratification and minimum two-year follow-up are warranted.

CONCLUSION

This prospective comparative study demonstrates that IPOM Plus — through the addition of primary extracorporeal fascial closure before intraperitoneal mesh reinforcement — confers significantly superior outcomes over standard IPOM with respect to six-month hernia recurrence (6.7% vs 20.0%; p = 0.029; AOR 14.86; 95% CI: 2.51–87.85) and mesh bulging (0% vs 13.3%; p = 0.035). Early complications were comparable between techniques. The modest increase in operative time and hospital stay associated with IPOM Plus is a justified trade-off against a substantially reduced recurrence burden. In concordance with the current recommendations of the IEHS, SAGES, and EAES,[9,10] we recommend IPOM Plus as the standard of care for laparoscopic ventral hernia repair in patients with fascial defects ≥ 2 cm, BMI ≤ 35 kg/m², and no contraindications to laparoscopic surgery under general anaesthesia.

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