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Examining the Role Of 3d Mesh and Polypropylene Mesh in Laparoscopic Inguinal Hernia Repairs: A Retrospective Study in Adults

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ABSTRACT:

Introduction: Inguinal hernia is the most common type of hernia, occurring most commonly among men. Laparoscopic hernia surgery is the only way of treatment modality for hernia surgery. Polypropylene mesh is the most commonly used prosthetic material in hernia surgery, however, use of three-dimensional (3D) mesh has been increased in recent times, because of its anatomical design and ease of placement. Given the higher cost of 3D mesh, evidence comparing its clinical outcomes with conventional polypropylene mesh is required. **Objective:** To assess and compare the clinical outcomes of 3D mesh versus polypropylene mesh in adults undergoing laparoscopic inguinal hernia repair. **Methods:** A retrospective cross-sectional study was conducted at a tertiary care teaching medical college and hospital in Chennai. Retrospectively, medical records of 100 adult patients who underwent laparoscopic inguinal hernia repair either with 3D mesh or polypropylene mesh between January 2023 and December 2025 were included and their data were reviewed. Data on demographic variables, operative time, mesh fixation time, postoperative pain, duration of hospital stay, complications, and recurrence were collected. Statistical analysis was performed using SPSS version 26, applying Welch's t-test and Chi-square or Fisher's exact test was used. **Results**: Patients in the 3D mesh group demonstrated significantly shorter operative time (48.96 ± 4.30 vs. 69.46 ± 8.85 minutes), reduced mesh fixation time (10.90 ± 3.79 vs. 14.60 ± 4.66 minutes), lower immediate postoperative pain scores, and shorter hospital stay (3.16 ± 0.61 vs. 4.24 ± 0.51 days) compared to the polypropylene mesh group ($p < 0.001$). Seroma formation was significantly higher in the polypropylene mesh group, while recurrence rates were low and comparable between both groups. No significant differences were observed in chronic pain, hematoma, or sensory impairment. **Conclusion**: Laparoscopic inguinal hernia

repair using 3D mesh is associated with improved perioperative efficiency, reduced postoperative morbidity, and shorter hospitalization compared to polypropylene mesh. Despite higher cost, 3D mesh appears to be a favorable alternative, offering better early clinical outcomes with comparable recurrence rates.

INTRODUCTION:

It has been estimated that over 20 million repairs of inguinal hernia are carried out each year globally, the specific operation rates varying between countries from around 100 to 300/100,000 population/year. [(1)] In India, the estimated annual incidence of inguinal hernias is 1,957,850. [(1)] "A hernia occurs when part of your insides bulges through an opening or weakness in the muscle or tissue that contains it. Most hernias involve one of your abdominal organs pushing through one of the walls of your abdominal cavity". [(2)] . Based on their location and etiology hernia are classified into eight types, where Inguinal hernias are the most common type, accounting for nearly 75% of all hernias, commonly affecting men. [(3)] Where the prevalence of inguinal hernia is high with a lifetime risk of 275 to 435 in men and it is just 35 to 6% in women [(4)]. Femoral hernias, are less common, occur through the femoral canal beneath the inguinal canal, which often involves fatty tissue. Hiatal hernias develop when widening of the diaphragmatic hiatus allows a part of the stomach to herniate into the thoracic cavity. Congenital diaphragmatic hernias are birth defects resulting from incomplete closure of the diaphragm during fetal development. Incisional hernias arise through weakened areas of the abdominal wall. Umbilical hernias involve protrusion of intestinal contents through the umbilical region which is congenital. Ventral hernias occur through the anterior abdominal wall, including umbilical and incisional hernias, while perineal hernias are rare and result from herniation through defects in the pelvic floor. People who are involved in lifting heavy weights, chronic coughing, chronic constipation, history of abdominal or pelvic surgery, multiple pregnancies, and chronic obesity with a BMI more than 30 are at risk of developing hernia.[(5)] Symptoms vary by type and might be absent in some individuals, but most common symptoms are visible or palpable bulge, local pressure, discomfort, dull aching, or intermittent sharp pain in the groin region.[(3)] Hernia complications most commonly occur when the herniated tissue becomes incarcerated, preventing its reduction, leading to increasing pain and severity. Incarceration involving the bowel may result in intestinal obstruction and strangulation which leads to tissue ischemia, necrosis, or gangrene. Complications of diaphragmatic hernias are very less common, hiatal hernias rarely cause serious complications aside from chronic gastroesophageal reflux. Most hernias can be diagnosed through a physical examination. In some cases, imaging such as CT scan is required to confirm the diagnosis.[(2)] The main stay of treatment for hernia is through surgery, Hernia repair involves reducing the herniated tissue and reinforcing the defect with sutures or mesh, commonly using minimally invasive techniques such as laparoscopic or robotic surgery, which allow faster recovery and less postoperative pain, open surgery is reserved for selected cases. An ideal mesh should retain its properties in tissue fluids, be chemically inert and hypoallergenic, and not cause inflammation, foreign body reaction, hypersensitivity, or carcinogenic effects. It should be mechanically strong, easily shaped without fraying, sterilizable, pliable, and biocompatible [(6)]. Polypropylene mesh (PPM) remains the most commonly used prosthetic material in hernia surgery [(7)]. Most common complication faced with polypropylene mesh is adhesion formation and post-operative pain [(8)]. Recent technological advancements have led to the increasing use of three-dimensional (3D) mesh in laparoscopic inguinal hernia repair. Given its higher cost and post-operative complication compared with standard polypropylene mesh, an evaluation of its effectiveness is essential [(9)]. Therefore, a retrospective comparative study was done to assess the clinical outcomes of polypropylene mesh and 3D mesh in laparoscopic inguinal hernia repair and to evaluate the quality of life, cost-effectiveness, and long-term recurrence outcomes in both groups

Objectives:

- To assess the clinical outcomes of 3D mesh versus polypropylene mesh in adult laparoscopic inguinal hernia repair.

Methodology:

Study Design

A retrospective cross-sectional study was done to assess and compare the clinical outcomes of 3D mesh and polypropylene mesh in adults undergoing laparoscopic inguinal hernia repair. Medical records of eligible patients were reviewed over the following study period Jan 2023 to Dec 2025

Study Setting

The study was conducted at the Department of General Surgery of a tertiary care teaching medical college and

hospital in Chennai.

Study period

Surgical data collected and stored during the period January 2023 – January 2026 were used for this research

Study Population

Data recorded and maintained from patients who underwent treatment in a tertiary care teaching medical college and hospital in Chennai, over the past couple of years (2023 - 2025).

Inclusion Criteria

- Adult patients aged 18 years and above diagnosed with unilateral or bilateral inguinal hernia who underwent laparoscopic inguinal hernia repair using either 3D mesh or polypropylene mesh

Exclusion Criteria

- Patients with missing or incomplete data relevant to the study variables (e.g., missing operative notes, incomplete follow-up records);
- Complicated hernias (strangulated or obstructed)
- Patients with previous lower abdominal surgery
- Patients converted to open surgery

Sampling Method

Hospital records of patients who fulfilled the inclusion criteria and exclusion criteria were included in the study and their records were retrospectively assessed for a period of one year . Patient data were obtained retrospectively from hospital records and surgical registers, with procedures identified using ICD-10 codes. Demographic data and relevant clinical variables were reviewed and recorded. Patients were categorized into two groups based on the type of mesh used during surgery: polypropylene mesh or three-dimensional mesh. The postoperative outcomes of each groups were compared and appropriate statistics were applied

Study Groups

Patients undergoing laparoscopic inguinal hernia repair was separated into two groups, in Group A, 3D mesh was used, and in Group B polypropylene mesh was used.

Surgical procedure

With a single video monitor at the foot end of the patient, pneumoperitoneum was created by closed technique via 10 mm infraumbilical port. Two additional 5mm ports were made on either side of the rectus muscle. The defect is visualized from within the peritoneal cavity. After bilateral inguinal inspection, the median and medial umbilical ligaments, and the lateral umbilical folds were identified. The parietal layer of peritoneum is incised superior to the hernia defect and reflected inferiorly. The cord structures are dissected free of peritoneal attachments and sac is reduced back to peritoneal cavity. A polypropylene or a 3D mesh is placed between the peritoneum and transversalis fascia. The mesh is stapled or tacked. The incised peritoneal flap is anchored over the mesh using tacks. Pneumoperitoneum is released gradually. The infraumbilical trocar site is closed with a 1-0 Vicryl. Postoperatively, patients were monitored in the ward. For postoperative pain, analgesics were given. Early mobilisation of the patient was encouraged, and patient were started on oral, on the same day of operation or the next morning. Patients was be discharged from the hospital as soon as the patients become ambulatory and are called for follow-up at 1week, 2 weeks, 4 weeks, 3 months, 6 months, and 12 months.

Data Collection

Data were collected retrospectively from hospital medical records, operative notes, and follow-up records using a structured data extraction proforma. Information recorded included patient demographic details such as age and sex, type of hernia (unilateral or bilateral), type of mesh used, operative time, and intraoperative complications. Postoperative variables assessed included pain scores where available, duration of hospital stay, early postoperative complications such as seroma, hematoma, and surgical site infection, incidence of chronic groin pain, and hernia recurrence during the follow-up period. Outcome Measures

Statistical Analysis

The data were arranged in excel sheet (MS365) and coded for analysis, which was carried out using SPSS software v.26. The descriptive results of the participants were tabulated in tables shown in frequency and percentages or means and standard deviation whichever relevant. The data when checked for normality between the groups using Shapiro wilk test showed significant p-value indicating non-normal distribution between the study groups. So further analysis for comparison between the groups were done using Welch's T Test and Chi-Square Test.

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Volume 20 Issue 3, Year of Publication 2026, Page 600-606 | DoI-10.564220/1674-0815.2026.83

Ethical Considerations
Ethical approval was obtained from the Institutional Human Ethics Committee. Patient confidentiality was strictly maintained, and data were anonymized during analysis.

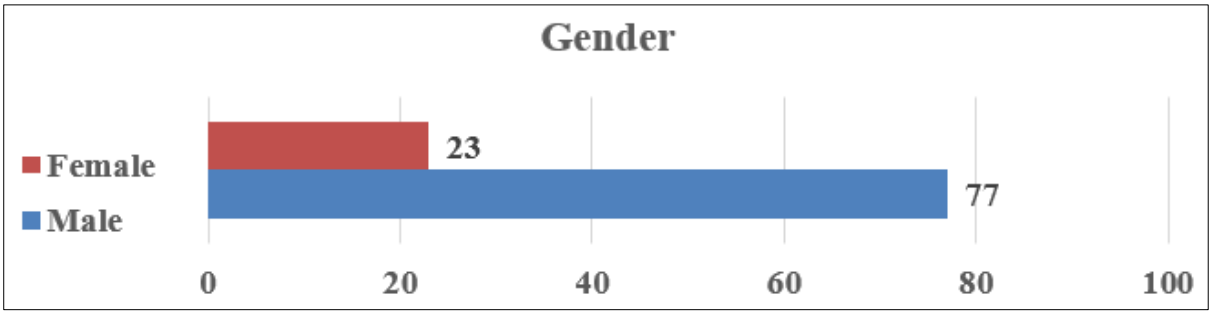
Results:

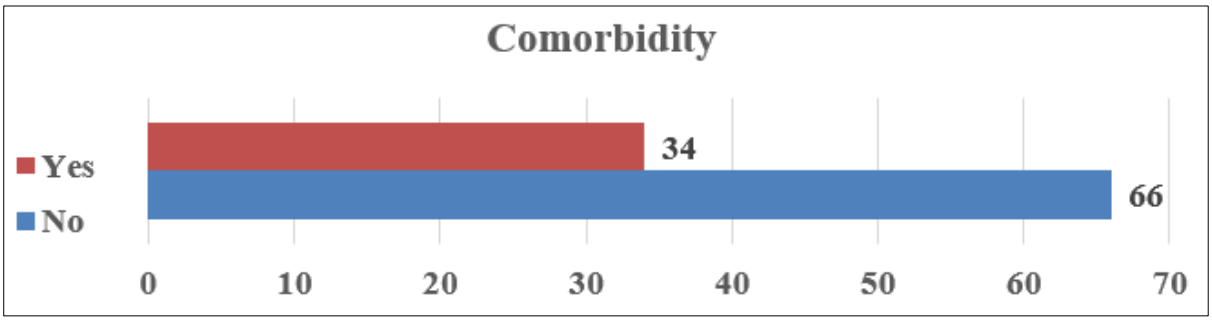
Table 1: The distribution of the participants based on their recorded values (n = 100)

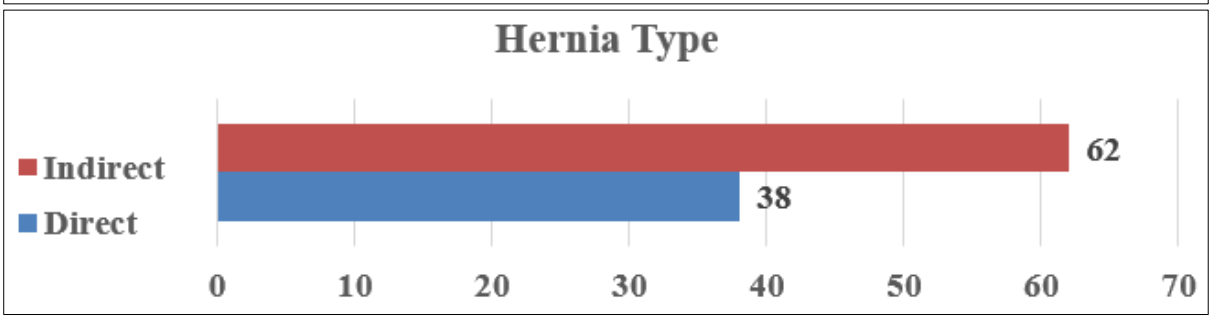
Groups	Mean	Standard Deviation (SD)
Age (years)	53.15	±11.82
BMI	27.09	±4.37
Operative Time (minutes)	59.21	±12.41
Mesh Fixation Time (minutes)	12.75	±4.61
Pain Score (on emergence)	3.69	±1.96
Duration of Hospital Stay (days)	3.70	±0.78

Table 2: Distribution of participants based on their post-op history (n = 100)

Post-op Complaints	Outcomes	Frequency	Percentage
Seroma	No	95	95.0 %
	Yes	5	5.0 %
Hematoma	No	99	99.0 %
	Yes	1	1.0 %
Conversion to Open	No	100	100.0 %
	Yes	0	0.0 %
H/O recurrence after this surgery	No	97	97.0 %
	Yes	3	3.0 %
Chronic Pain	No	89	89.0 %
	Yes	11	11.0 %
Sensory Impairment	No	93	93.0 %
	Yes	7	7.0 %







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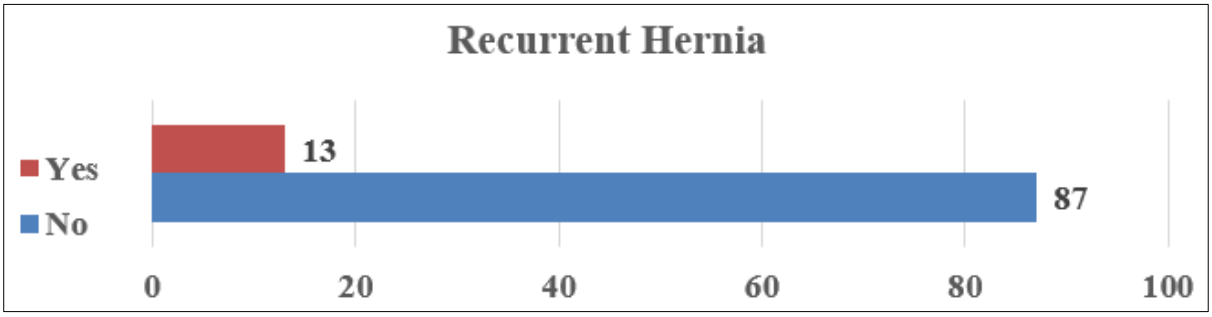

Figure 1: Distribution of the participants based on their gender, comorbidity, type of hernia and H/O recurrence

From table 1 and table 2 shows the distribution of participants based in their age, BMI, operative time, mesh fixation time, hospital stay and post-operative complication. The Above figure shows the distribution based on their gender, type of hernia, comorbidity and recurrence (Figure 1)

Table 3: Association between the type of mesh used and post-op complications among the participants (n = 100)

Post-Op Complications			Group			p-value
			3D Mesh	Polypropylene Mesh	Total	
Seroma	No	n	50	45	95	**.028**
		%	52.6%	47.4%	100.0%	
	Yes	n	0	5	5	
		%	0.0%	100.0%	100.0%	
Hematoma	No	n	49	50	99	1
		%	49.5%	50.5%	100.0%	
	Yes	n	1	0	1	
		%	100.0%	0.0%	100.0%	
Recurrence	No	n	48	49	97	1
		%	49.5%	50.5%	100.0%	
	Yes	n	2	1	3	
		%	66.7%	33.3%	100.0%	
Chronic Pain	No	n	46	43	89	.262
		%	51.7%	48.3%	100.0%	
	Yes	n	4	7	11	
		%	36.4%	63.6%	100.0%	
Sensory Impairment	No	n	49	49	98	1
		%	50.0%	50.0%	100.0%	
	Yes	n	1	1	2	
		%	50.0%	50.0%	100.0%	
Fisher's Exact Test; Significant if p-value < 0.05						

Table 4: Comparison between the groups for difference in factors and outcomes (n = 100)

Score	Group	Mean	SD	p-value
Age	3D Mesh	54.00	±9.55	.475
	Polypropylene Mesh	52.30	±13.78	
BMI	3D Mesh	26.850	±3.90	.583
	Polypropylene Mesh	27.334	±4.82	
Operative Time (Mins)	3D Mesh	48.96	±4.30	**< .001**
	Polypropylene Mesh	69.46	±8.85	
Mesh Fixation Time (Mins)	3D Mesh	10.90	±3.79	**< .001**
	Polypropylene Mesh	14.60	±4.66	
Immediate Pain Score	3D Mesh	2.58	±1.45	**< .001**
	Polypropylene Mesh	4.80	±1.78	
Duration of Stay	3D Mesh	3.16	±0.61	**< .001**
	Polypropylene Mesh	4.24	±0.51	
Welch's T Test; Significant if p-value < 0.05				

Table 3 shows that seroma formation in post op complication was found to be significant statistically in the 3D mesh group compared to the polypropylene mesh group ($p = 0.028$). However, no significant differences were observed between the groups regarding hematoma, recurrence, chronic pain, or sensory impairment ($p > 0.05$).

Table 4 shows that 3D mesh group showed significantly lower operative time, mesh fixation time, immediate postoperative pain score, and duration of hospital stay compared to the polypropylene mesh group

DISCUSSION:

Our study shows that the mean age in 3D mesh group is 54±9.55 and in polypropylene mesh group as 52.30±13.78 which is in line with the study done by moghadam et al[(10)] shows the mean age in 3D mesh and polypropylene mesh group as 53.10±8.72 and 53.15±13.69 Our study shows that the mean operative time for laparoscopic inguinal hernia repair was 48.96 ± 4.30 minutes with 3D mesh and 69.46 ± 8.85 minutes with polypropylene mesh. In contrast, several previous studies have shown lesser operative times for both mesh. Sajid Ali et al. (2020) show that the mean operative time as 43.2 ± 13.01 minutes for 3D mesh and 46.2 ± 14.31 minutes for polypropylene mesh, while Rashid T et al. (2017) shows the mean operative time for 3D mesh as 42.7 ± 13.01 and 45.1 ± 15.57 minutes for polypropylene mesh. Similarly, Nail Omarov (2024) documented a mean surgery duration of 42.82 ± 16.54 minutes for non-self-fixating (3D) mesh and 50.75 ± 18.8 minutes for self-fixating polypropylene mesh. (1,3,11) The observed differences in operative time may be due to surgeon experience, severity of the disease, and other factors such as age, comorbidities.

Our study showed that the mean mesh fixation time was 10.90 ± 3.79 minutes for 3D mesh and 14.60 ± 4.66 minutes for polypropylene mesh, whereas the study done by Sajid Ali et al. (2020) shows that the mesh fixation time as 10.3 ± 4.27 minutes for 3D mesh and 14.6 ± 2.74 minutes for polypropylene mesh, while the study done by Rashid T et al. (2017) shows it as 10.6 ± 4.31 minutes for 3D mesh and 14.4 ± 2.74 minutes for polypropylene mesh, which are in line with our results.(3,11) The mesh fixation time was similar to previous studies because both meshes are easy to handle, the same fixation methods were used, and standard surgical steps were followed. Also, the surgeries were performed by experienced surgeons, and the patients and hernia types were largely similar, which helped keep the fixation time consistent.

Our study demonstrated that the mean hospital stay was 3.16 ± 0.61 days for patients undergoing laparoscopic inguinal hernia repair with 3D mesh and 4.24 ± 0.51 days for patients treated with polypropylene mesh. In contrast, Several previous studies have shown shorter hospital stay for both mesh types. The study done by Rashid T et al. (2017) shows the mean hospital stays as 1.7 ± 0.69 days for 3D mesh and 2.2 ± 0.55 days for polypropylene mesh, while Nail Omarov et al. (2024) shows it as 1.15 ± 0.15 days for 3D mesh and 1.65 ± 0.45 days for polypropylene mesh. Similarly, the study done by Abhijit Bhagel et al. (2018) shows the mean hospital stay as 1.83 ± 0.53 days for 3D mesh and 3.27 ± 0.91 days for polypropylene mesh, and Sajid Ali et al. (2020) reported mean hospital stay as 1.9 ± 0.71 days for 3D mesh and 2.4 ± 0.57 days for polypropylene mesh.(1,3,11,12) The longer hospital stay found in our study may be due to differences in institutional discharge policies, postoperative pain management protocols, patient comorbidities, severity and complexity of the disease.

In our study, hernia recurrence was observed in 2 patients (4%) who underwent repair with 3D mesh and in 1 patient (2%) treated with polypropylene mesh. Comparable findings have been reported in earlier studies. Nail Omarov et al (2024) reported recurrence rates of 3.8% in the polypropylene mesh group and 2.2% in the 3D mesh group. Similarly, Abhijit Bagul et al. (2018) shows that the recurrence rate using polypropylene mesh was 1.3%, while no recurrences were found in the 3D mesh group. (1,12) The minor variations in recurrence rates found across studies may be due to poor follow-up, patient compliance with postoperative advice, and individual patient risk factors, including obesity and connective tissue disorders.

Our study showed that seroma formation was observed in five patients who underwent laparoscopic inguinal hernia repair using polypropylene mesh, whereas no cases of seroma was found in patients operated with 3D mesh. On comparing with the study done by Nail Omarov et al. (2024) seroma have occurred in three patients in the polypropylene mesh group and with one patient in 3D mesh group. Similarly, Sajid Ali et al. (2020) observed seroma formation in one patient with 3D mesh and two patients with polypropylene mesh. (1,11). The occurrence of seroma associated with polypropylene mesh may be due to greater tissue dissection, increased foreign-body reaction, mesh stiffness, and the need for fixation, whereas the anatomical structures and reduced fixation time for 3D mesh may help minimize dead space and postoperative fluid collection.

CONCLUSION:

This retrospective study shows that laparoscopic inguinal hernia repair using 3D mesh is associated with

significantly better post operative complication on comparing with Laparoscopic inguinal hernia repair surgery with polypropylene mesh. Patients in the 3D mesh group had shorter operative time, reduced mesh fixation time, lower immediate postoperative pain scores, and shorter hospital stay, all of which were statistically significant. Although recurrence rates were low and comparable between the two groups, seroma formation was significantly higher in the polypropylene mesh group, while no seroma was observed with 3D mesh. Overall, the study concludes that 3D mesh provides good clinical advantage over polypropylene mesh. Even though the cost of 3D mesh is high, 3D mesh may provides faster patient recovery, making it a good option for laparoscopic inguinal hernia repair.

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