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Evaluation of outcomes of totally extraperitoneal laparoscopic repair using 2D and 3D mesh in the treatment of direct inguinal hernia

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Abstract

Objective: *To investigate certain clinical and paraclinical characteristics of patients with direct inguinal hernia and to evaluate long-term outcomes after totally extraperitoneal laparoscopic hernia repair combined with either 3D or 2D mesh prosthesis.* ***Subject and method:*** *A cross-sectional descriptive study combined with a prospective, uncontrolled interventional design was conducted on 69 male patients with 76 hernia sacs, who underwent elective surgery using the totally extraperitoneal (TEP) approach with either a 3D anatomically contoured mesh or a flat 2D mesh, from January 2019 to December 2024.* ***Result:*** *The study involved 69 male patients with direct inguinal hernia, with a mean age of 61.5 ± 13.1 years. Most patients were admitted due to a groin bulge (91.3%), typically appearing during ambulation or exertion (93.4%). According to the Nyhus classification, type IIIA was predominant (63.2%). The mean operative time was 59.2 ± 18.6 minutes for unilateral and 105.3 ± 30.1 minutes for bilateral hernias. The 3D mesh group had significantly shorter operative and mesh placement times than the 2D mesh group. The overall intraoperative and early postoperative complication rate was 18.8%, with peritoneal tears being the most common (8.7%). Early postoperative outcomes were rated as "good" in 89.9% of cases, higher in the 3D mesh group (94.3%) than in the 2D mesh group (85.3%).* ***Conclusion:*** *Totally extraperitoneal laparoscopic repair using 3D mesh for direct inguinal hernia demonstrated superior outcomes compared to 2D mesh, with shorter operative time, fewer complications, and better early postoperative results.*

Keywords: *Direct inguinal hernia, totally extraperitoneal laparoscopic repair, synthetic mesh.*

I. Background

Inguinal hernia, particularly direct inguinal hernia, is a common surgical condition with a rising incidence. Total extraperitoneal laparoscopic hernia repair (TEP) has become the standard treatment for inguinal hernia due to its minimally invasive nature, lower complication rates, and faster recovery compared to conventional open surgery [1], [2]. A critical factor in the success of TEP is the choice of synthetic mesh used to reinforce the abdominal wall. While flat 2D meshes are widely used, anatomically contoured 3D meshes have been introduced and may offer improved clinical outcomes [3], [4].

Several studies have demonstrated that 3D meshes result in lower recurrence rates and reduced postoperative pain compared to 2D meshes [3]. Additionally, 3D meshes facilitate easier surgical handling and better integration with surrounding tissues, potentially leading to

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improved long-term outcomes [4]. However, long-term comparative data on TEP using 2D versus 3D mesh in direct inguinal hernia repair remain limited. Therefore, further evaluation is necessary to assess and compare the long-term effectiveness of these two mesh types.

For this reason, we conducted the study titled: "Evaluation of Outcomes of Total Extraperitoneal Laparoscopic Repair Using 2D and 3D Mesh in Direct Inguinal Hernia", with the following objectives:

1) To investigate clinical and paraclinical characteristics of the patient group;

2) To evaluate the surgical outcomes of TEP using 2D and 3D mesh in direct inguinal hernia repair.

2. SUBJECT AND METHOD

Study Population

The study included 69 patients with 76 direct inguinal hernias who underwent elective total extraperitoneal (TEP) laparoscopic repair using either 3D mesh (3DMAX™ Mesh) or flat 2D mesh (Premilene Mesh) between January 2019 and December 2024.

Inclusion Criteria

Patients with a first-time diagnosis of direct inguinal hernia.

Underwent TEP laparoscopic repair with either 3D mesh (3DMAX™ Mesh/Bard-France) or flat 2D mesh (Premilene Mesh/B-Braun-Germany).

Provided informed consent to participate in the study.

Exclusion Criteria

Indirect, recurrent, incarcerated, or strangulated inguinal hernias.

Combined inguinal-femoral hernias.

History of pelvic surgery, recent localized or systemic pelvic infection, or prior pelvic radiotherapy.

Severe comorbid conditions or active malignancies.

Patients who declined to participate.

Study Design

This is a cross-sectional descriptive study with a prospective, non-controlled interventional component.

Sample Size

Sample size was calculated using the formula:

$$N = ((Z_{1-\alpha/2})^2 \times (1 - p)) / (p \times d^2)$$

Where:

N: minimum sample size required for the study

Z: confidence level at 95% (Z = 1.96)

p: success rate of laparoscopic inguinal hernia surgery (p = 0.96, based on Umberto Bracale [5])

d: relative margin of error, set at 0.05

The minimum sample size calculated was 65. Ultimately, 69 patients were included.

Sampling Method

Convenience sampling was used to include all patients meeting the inclusion criteria during the study period (January 2019 to December 2024).

Data Collection and Analysis

Surgical Technique

All patients underwent total extraperitoneal (TEP) laparoscopic repair using either 2D or 3D mesh. The 2D mesh used was Premilene mesh (B. Braun, 15 × 7.5 cm). The 3D mesh used was polypropylene 3DMAX™ Mesh (Bard-Davol, France), available in two sizes: small (8.5 × 13.7 cm) and large (10.8 × 16 cm), anatomically contoured to fit the inguinal floor.

Study Indicators

Patient characteristics: age, gender, clinical features (reason for admission, nature of the hernia mass, hernia grade).

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Early outcomes: postoperative pain duration, time to first flatus, early complications, hospital stay, and early surgical outcome classified into four categories:

Good: No early postoperative complications.

Fair: Complications that required no intervention (e.g., transient thigh numbness, self-resolving hematoma or scrotal seroma, managed conservatively).

Average: Complications requiring intervention but not reoperation (e.g., urinary retention requiring catheterization, scrotal hematoma/seroma needing aspiration, superficial wound infection requiring opening).

Poor: Reoperation required or patient death.

Data Processing

Data were analyzed using SPSS version 22.0. Quantitative variables were expressed as mean ± standard deviation (SD). Qualitative variables were expressed as percentages.

3. Result

Table 1. Clinical characteristics and hernia classification

Characteristic	Number	Percentage (%)
Age distribution		
<40 years	4	5.8
40-<60 years	25	36.2
60-<80 years	35	50.7
≥80 years	5	7.3
Mean age ± SD (range)	61,5±13,1 (36-92)	
Gender	69	100% nam
Reason for admission		
Inguinal bulge	63	91.3
Bulge with pain	6	8.7
Hernia characteristics		
Appears on standing/straining	71	93.4
Constantly present	5	6.6
Nyhus classification		
Type I	3	3.9
Type II	20	26.3
Type IIIA	48	63.2
Type IIIB	5	6.6

Comment: All patients were male, with a mean age of 61.5 ± 13.1 years. The primary presenting symptom was a painless inguinal bulge (91.3%), usually appearing during standing or exertion (93.4%). The majority of hernias were classified as Nyhus type IIIA (63.2%), predominantly affecting those aged ≥60 years (58%).

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Table 2. Operative time and mesh placement

Characteristic	3D Endoscopy Group	2D Endoscopy Group	Total
Operative time (minutes) (average ± SD) (min-max)			
Unilateral	52,4±16,8 (30-110)	67,5±20,4 (35-130)	59,2±18,6 (30-130)
Bilateral	85,2±22,3 (60-125)	125,5±25,7 (110-150)	105,3±30,1 (60-150)
Mesh placement time (minutes)			
Mean ± SD (range)	7,1±2,0 (4-11)	9,8±2,5 (6-18)	8,4±2,7 (4-18)

Comment: The average operative time was 59.2 ± 18.6 minutes for unilateral hernia repair and 105.3 ± 30.1 minutes for bilateral repair. The mean mesh placement time was 8.4 ± 2.7 minutes. In the 3D group, the mean operative times were 52.4 ± 16.8 and 85.2 ± 22.3 minutes for unilateral and bilateral cases, respectively, with a mesh placement time of 7.1 ± 2.0 minutes. In the 2D group, corresponding times were 67.5 ± 20.4 and 125.5 ± 25.7 minutes, and 9.8 ± 2.5 minutes for mesh placement.

Table 3. Intraoperative incidents and early posto perative complications

		3D group (n = 35)		2D group (n = 34)		Overall (n = 69)	
		n	%	n	%	n	%
Intraoperative incidents	Peritoneal tear	3	8,6	3	8,8	6	8,7
	Vascular injury	0	0	1	2,9	1	1,4
Early postoperative complications	Urinary retention	0	0	2	5,9	2	2,9
	Wound hematoma	1	2,9	1	2,9	2	2,9
	Inguinal hematoma	0	0	1	2,9	1	1,4
	Scrotal/testicular swelling	1	2,9	2	5,9	3	4,3
	Subcutaneous emphysema	0	0	1	2,9	1	1,4

Comment: The overall rate of intraoperative incidents and early complications was 18.8%, with peritoneal tear being the most common intraoperative incident (8.7%). Early complications included urinary retention (2.9%), hematoma (2.9%), scrotal/testicular swelling (4.3%), and subcutaneous emphysema (1.4%).

Table 4. Early postoperative outcomes

Result	3D group (n=35)		2D group (n=34)		Overall (n=69)	
	n	%	n	%	n	%
Good	33	94,3	29	85,3	62	89,9
Fair	2	5,7	4	11,8	6	8,7
Average	0	0,0	1	2,9	1	1,4
Poor	0	0,0	0	0,0	0	0,0

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Comment:Most patients (89.9%) had a "good" early postoperative outcome, with a higher proportion in the 3D group (94.3%) compared to the 2D group (85.3%). "Fair" outcomes accounted for 8.7%, and "average" for 1.4%. No cases were rated as "poor".

4. Discussion

Our study demonstrates that total extraperitoneal laparoscopic repair using both 2D and 3D meshes yields favorable outcomes in the treatment of direct inguinal hernia, with a low complication rate and acceptable operative times. All patients in the study were male, with a mean age of 61.5 ± 13.1 years. Previous studies have consistently reported a higher incidence of inguinal hernia in males. Burcharth et al. noted that inguinal hernia predominantly affects men and accounts for the majority of hernia surgeries performed [6].

The most common reason for hospital admission was a painless inguinal bulge (91.3%), typically appearing during standing or physical exertion (93.4%). These findings are consistent with earlier research, which indicates that uncomplicated inguinal hernias are usually painless and present as reducible groin swellings that vary with posture [7].

From a technical perspective, the average operative time for unilateral hernias was 59.2 minutes, while bilateral cases averaged 105.3 minutes. Compared to the findings by Brandt-Kerkhof, who followed patients over 13 years, laparoscopic techniques can achieve similar or even shorter operative times depending on surgical expertise and hernia type [8]. These results highlight the potential for further refinement of surgical techniques to optimize both efficiency and clinical outcomes.

Intraoperative complications occurred in 8.7% of cases, with peritoneal tears being the most common (8.7%). Early postoperative complications included urinary retention (2.9%), wound hematoma (2.9%), scrotal/testicular swelling (4.3%), and subcutaneous emphysema (1.4%). These rates are lower than those reported in previous studies, such as Koppatz et al. (2019), where the overall complication rate was 18%. This discrepancy may be attributed to differences in surgical technique and mesh material used [9].

Assessment of early postoperative outcomes revealed a "good" outcome rate of 89.9%, with a higher rate in the 3D mesh group (94.3%) compared to the 2D mesh group (85.3%). These findings align with those of Zhu et al. (2024), who reported that 3D mesh was associated with lower postoperative pain, reduced recurrence, and better clinical outcomes. This highlights the importance of not only surgical technique but also mesh design and the patient's recovery capacity in determining treatment success [10].

5. Conclusion

This study confirms that total extraperitoneal laparoscopic repair using either 2D or 3D mesh is a safe and effective approach for the treatment of direct inguinal hernia, with a low complication rate. The use of 3D mesh, in combination with laparoscopic techniques, contributes to shorter operative times and improved early outcomes. These findings provide practical evidence to support the optimal choice of surgical method and mesh material in current inguinal hernia management.

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