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Original Research

Postoperative Outcomes and Recurrence Rate in Laparoscopic Tep Inguinal Hernia Repairs Using Partially Absorbable Meshes: A Retrospective Single-Surgeon Study Over a 5-Year Period

Burcak Kabaoglu,[1] Erman Sobutay,[1] Cagri Bilgic[2]

[1]Department of General Surgery, VKV American Hospital, Istanbul, Türkiye
[2]Department of General Surgery, Medical Park Gebze Hospital, Kocaeli, Türkiye

Abstract

Objectives: This study aimed to evaluate the postoperative outcomes and recurrence rate in laparoscopic inguinal hernia repairs performed over a 5-year period with totally extraperitoneal (TEP) technique and use of partially absorbable meshes.

Methods: A total of 100 patients (mean (SD, min-max) age: 51.0 (14.6, 16-83) years, 91.0% were males) who underwent 150 laparoscopic TEP inguinal hernia repairs (bilateral in 50 patients) with use of the partially absorbable mesh were retrospectively reviewed. Data on patient demographics, hernia characteristics (side, subtype), date of operation, operating time, early and late postoperative complications as well as the recurrence rate were recorded over a 5-year period.

Results: The inguinal hernia was bilateral in 50 (50.0%) patients and indirect hernia was noted in 53 (53.0%) patients, while lipoma was evident in 17 (17.0%) cases. Median operating time was 45.0 min (range, 23.0 to 140.0 min). Overall, seroma occurred in 6 (6.0%) patients and was treated conservatively, while none of patients developed preperitoneal hematoma, infection or persistent chronic inguinal pain. Recurrence rate was 0.67% (1/150 operations) within a median 30.0 months (range, 2 to 60 months) of postoperative follow-up. Bilateral hernia was associated with significantly longer operating time compared to left or right unilateral hernia (median (min-max) 50.0 (34.0-140.0) vs. 40.0 (23-80) and 40.0 (25.0-130.0) min, $p<0.01$ and $p<0.001$, respectively). Operating time was positively correlated both with patient age ($r=0.240$, $p=0.017$) and BMI ($r=0.205$, $p=0.044$).

Conclusion: In conclusion, our findings indicate that laparoscopic TEP inguinal hernia repair with use of the partially absorbable meshes enables a favorable postoperative outcome with minimal early and late postoperative complications and 0.67% recurrence rate over a 5-year period.

Keywords: Inguinal hernia repair, laparoscopic, postoperative complications, recurrence, totally extraperitoneal partially absorbable mesh

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Address for correspondence: Burcak Kabaoglu, MD. Department of General Surgery, VKV American Hospital, Istanbul, Türkiye
Phone: +90 212 444 37 77 **E-mail:** burcakkabaoglu@yahoo.com

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Inguinal hernia repair is a frequently performed operation in the general surgery setting.[1,2] However, despite the advances in treatment modalities and surgical techniques, postoperative recurrence rates still remain high (range, 11 to 13%) which causes substantial socioeconomic burden and increased risk of morbidity from operation for recurrent hernias.[3-5]

Although a wide range of controllable/technical (i.e., surgery technique, mesh-fixation technique, surgeon experience and hospital volume) and noncontrollable/patient-related (i.e., gender, hernia type, hernia anatomy and family disposition) risk factors for recurrence have been proposed, the exact reason for inguinal hernia recurrence remains unknown.[3,6] Inguinal hernia recurrence can occur early (related to technical factors) or later (related to hernia pathophysiology, age or other patient-related factors) in the course of postoperative follow-up after hernia repair.[4,6,7]

The effectiveness of endoscopic/laparoscopic techniques is similar to Lichtenstein repair, while mesh repairs via open or laparoscopic approach are considered superior to "non-mesh" tissue-suture repairs.[8-11] Transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) repairs are the most frequently used laparoscopic approaches in inguinal hernia repair.[12-14] TEP approach necessitates a large caseload for favorable postoperative outcomes, since the preperitoneal space formation in this approach prolongs the operative time and requires a greater expertise than the TAPP approach.[12-14]

Although the standard nonabsorbable heavy polypropylene meshes are the most frequently preferred products in relation to low cost, wide availability and good strength, their main disadvantages involve chronic postoperative pain, foreign body sensation and formation of a firm scar with reduced abdominal wall elasticity.[8-10] Hence, the development of lightweight and ultralightweight meshes enabled the reduction in foreign body feeling and postoperative pain when compared to the heavyweight nonabsorbable mesh, whereas the challenges regarding the intraoperative control and high recurrence rates have become important drawbacks.[10] Accordingly, different composite meshes (partially absorbable prostheses) that combine nonabsorbable materials (i.e., polypropylene) with absorbable materials (i.e., polyglactin) are produced as alternatives to overcome these advantages by improving the intraoperative control and postoperative comfort and also minimizing the recurrence rates.[8-10,15,16] Amongst them, the composite polypropylene and poly-L-lactic acid (PLLA) partially absorbable meshes are considered a good alternative to non-absorbent meshes with lower tissue inflammation response, good biocompatibility and lower recurrence potential.[15,16]

This study aimed to evaluate the postoperative outcomes and recurrence rate in laparoscopic inguinal hernia repairs performed over a 5-year period with TEP technique and use of partially absorbable (polypropylene and PLLA) meshes.

Methods

Study Population

A total of 100 patients (mean (SD, min-max) age: 51.0 (14.6, 16-83) years, 91.0% were males) who underwent 150 laparoscopic TEP inguinal hernia repairs (bilateral in 50 patients) with use of the partially absorbable mesh were retrospectively reviewed in this retrospective single-surgeon study conducted at a tertiary care center between December 2016 and January 2021. Patients aged between 16 and 83 years who underwent primary inguinal hernia repair for uni- or bilateral inguinal hernia with a defect <3 cm were included in the study. Patients with previous history of preperitoneal hernia repair, TAPP repair surgery or lower abdominal surgery and those receiving antiaggregant and anticoagulant therapy were excluded.

This study was conducted in accordance with the ethical principles stated in the "Declaration of Helsinki" and approved by the Koc University Ethics Committee (Date of Approval: 30.12.2022, Protocol no: 2022.486.IRB1.195).

Assessments

Data on patient demographics (age, gender), body mass index (BMI, kg/m^2), hernia characteristics (side, subtype), date of operation, operating time, early (hematoma and seroma formation, infection) and late (persistent chronic inguinal pain) postoperative complications, as well as the recurrence rate of hernias during postoperative follow-up period were recorded.

Surgery

All operations were performed under general anesthesia and by the same surgeon who is experienced in laparoscopic hernia repair. After bupivacaine hydrochloride infiltration to the periumbilical area, the anterior rectus sheath was opened for placement of a 10 mm Hasson trocar, using the same side of hernia (larger hernia in bilateral cases). Afterward, the optical cavity was maintained by carbon dioxide insufflation and additional two 5 mm trocars from midline (lower was 4 cm above pubic bone, and superior one minimum 6 cm above the lower) were inserted as work ports. Myopectineal orifices were explored posteriorly, followed by complete reduction of inguinal sacs and cord lipomas (if present). Following reduction of all hernias and hemostasis, 12x15 cm 75% absorbable PLLA - 25% polypropylene (Cousine Biotech 4D) composite meshes were

laid over hernia site without fixation and preperitoneum was out under direct observation, ensuring that hernia sac and cord lipomas were placed proximal to the mesh. Skin closure was performed with 3/0 Monocryl. Oral intake was allowed 4 hours after the operation, and patients were discharged from the hospital after an overnight stay. Postoperative follow-up was performed on the 7th day, 1st month, 6th month and 1st year visits and then the annual visits in the ambulatory setting.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 19.0 (IBM Corp., Armonk, NY). Chi-square (χ^2) test was used for the comparison of categorical data, while numerical data were analyzed using One-way ANOVA for variables with normal distribution and with Mann-Whitney U and Kruskal Wallis tests for non-normally distributed variables. Correlation analysis was performed via Spearman's correlation analysis. Data were expressed as mean (standard deviation, SD), median (min-max) and percent (%) where appropriate. $p<0.05$ was considered statistically significant.

Results

Baseline Characteristics

Mean patient age was 51.0 (SD 14.6, range 16.0 to 83.0) years, and 91.0% of patients were males. The inguinal hernia was bilateral in 50 (50.0%) patients and indirect hernia was noted in 53 (53.0%) patients, while the right (30.0%) and left (20.0%) hernias or direct (28.0%) and direct-indirect (19.0%) hernias were less commonly noted (Table 1).

Lipoma was evident in 17 (17.0%) cases overall, and 10 (58.8%) were related to indirect or bilateral hernias (Table 1).

Follow-up Data on Postoperative Complications and Recurrence

Median operating time was 45.0 min (range, 23.0 to 140.0 min). Overall, seroma occurred in 6(6.0%) patients and was treated conservatively, while 4 (66.7%) of 6 seroma cases were related to direct hernia or bilateral hernia. None of patients had preperitoneal hematoma, infection or persistent chronic inguinal pain. Recurrence was noted only in 1 (0.7%) patient (a 39-year-old male patient with bilateral [left direct, right indirect] hernia) at 11 months after the hernia repair for the left direct hernia. Overall, the recurrence rate was 0.7% (1/150 operations), and no recurrence was noted in the remaining (99.9%) patients within a median 30.0 months (range, 2 to 60 months) of postoperative follow-up (Table 2).

Table 1. Baseline characteristics

Patient characteristics	
Age (year)	
Mean (SD)	51.0 (14.6)
Median (min-max)	51.0 (16.0-83.0)
Gender, n (%)	
Female	9 (9.0)
Male	91 (91.0)
BMI (kg/m^2)	
Mean (SD)	25.7 (4.2)
Median (min-max)	25.3 (17.7-44.5)
Hernia side, n (%)	
Left	20 (20.0)
Right	30 (30.0)
Bilateral	50 (50.0)
Hernia subtype, n (%)	
Direct	
Total	28(28.0)
Left	9 (9.0)
Right	6 (6.0)
Bilateral	14(14.0)
Indirect	
Total	53 (53.0)
Left	12 (12.0)
Right	22 (22.0)
Bilateral	20 (20.0)
Direct-indirect	19 (19.0)
Lipoma, n (%)	17 (17.0)
Per hernia subtype	
Direct	6 (35.3)
Indirect	10 (58.8)
Direct-indirect	1 (5.9)
Per hernia side	
Left	4 (23.5)
Right	3 (17.6)
Bilateral	10 (58.8)

Patient Characteristics and Operating Time with Respect to Hernia Side and Subtype

Bilateral hernia was associated with significantly longer operating time compared to left or right unilateral hernia (median (min-max) 50.0 (34.0-140.0) vs. 40.0 (23-80) min, $p<0.01$ and vs. 40.0 (25.0-130.0) min, $p<0.001$, respectively). Indirect hernia was associated with younger patient age (mean (SD) 46.1 (13.9) vs. 52.8 (12.2) years, $p<0.05$) and significantly lower BMI (median (min-max) 24.7 (17.7-36.0) vs. 27.0 (20.3-44.5) kg/m^2, $p<0.05$) compared to direct hernia (Table 3).

There was no significant gender influence on hernia side or subtype (Table 3).

Table 2. Follow-up data on postoperative complications and recurrence

Year of operation	
2016	7 (7.0)
2017	19 (19.0)
2018	24 (24.0)
2019	30 (30.0)
2020	20 (20.0)
Follow-up duration (months)	
Mean (SD)	30.7 (15.7)
Median (min-max)	30.0 (2.0-60.0)
Operating time (min)	
Mean (SD)	51.1 (20.3)
Median (min-max)	45.0 (23.0-140.0)
Postoperative seroma, n (%)	6 (6.0)
Per hernia subtype	
Direct	4 (66.7)
Indirect	0 (0.0)
Direct-indirect	2 (33.3)
Per hernia side	
Left	2 (33.3)
Right	0 (0.0)
Bilateral	4 (66.7)
Recurrence for 150 operations, n (%)	
Yes	1 (0.67)
No	149 (99.33)

Operating Time with Respect to Year of Operation, Patient Age and BMI

Although no significant difference was noted in average operating time according to year of operation, the maximum operating time tends to increase from 2016 (median 50 min (range, 35.0 to 70.0 min)) to 2020 (median 44.0 min (range, 30 to 115 min)). Operating time was positively correlated both with increasing patient age (r=0.240, p=0.017) and BMI (r=0.205, p=0.044) (Table 4).

Discussion

In this study assessing the laparoscopic inguinal hernia repairs over a 5-year period, using TEP technique with the partially absorbable meshes was associated with a favorable postoperative outcome in terms of early (hematoma and seroma formation, infection) and late (persistent chronic inguinal pain) postoperative complications along with recurrence rate of 0.67%.

PLLA prostheses have been demonstrated to have good rigidity and biocompatibility in vivo and in vitro,[15] while composite use of polypropylene and PLLA mesh is suggested to enable a better tolerance, due to a low macrophage response with absence of mesh shrinkage and decreased adhesion to the tissue, enabling reduced long-term pain and prevention of recurrence in inguinal hernia repair.[17] The size (12x15 cm) of composite polypropylene and PLLA mesh used in our study is in agreement with the standard mesh size (10x15 cm) recommended in the guidelines for TEP, while using smaller meshes is considered a significant risk factor for recurrence.[3,4,18] Consistent with our findings, in a retrospective analysis of 469 laparoscopic TEP inguinal repairs, use of 75% resorbable mesh (monofilament polypropylene and PLLA mesh) was reported to be associated with ease of application and less postoperative complication rates (seroma, hematoma) than polypropylene mesh.[16]

Indeed, the optimal mesh type in hernia repair in terms of prevention of postoperative complications and recurrence remains controversial.[10] In a study with 388 patients who underwent TEP inguinal hernia repair, the median recurrence rate after hernia was reported to be 2.1%, and to be lower in the subgroup of absorbable mesh (1.0%) vs. nonabsorbable mesh (5.3%).[19] In a retrospective study of 64 TEP inguinal hernia repairs using either ProFlex (a partially absorbable mesh) or nonabsorbable lightweight

Table 3. Patient characteristics and operative time respect to hernia side and subtype

	Gender, n (%)				Age (year)			BMI (kg/m²)			Operating time (min)		
	n	Female	Male	p[1]	n	Mean (SD)	p[2]	n	Median (min-max)	p[3]	n	Median (min-max)	p[3]
Hernia side													
Left	20	4 (20.0)	16 (80.0)	0.157	20	47.9 (15.7)	0.061	19	24.1 (18-36)	0.309	20	40.0 (23-80)*	0.001
Right	30	2 (6.7)	28 (93.3)		30	47.3 (13.3)		28	25.9 (17.7-33.6)		29	40.0 (25.0-130.0)**	
Bilateral	50	3 (6.0)	47 (93.4)		50	54.4 (14.4)		50	25.5 (18.3-44.5)		50	50.0 (34.0-140.0)	
Hernia subtype													
Direct	28	2 (7.1)	26 (92.9)	0.208	28	52.8 (12.2)[q]	<0.001	27	27.0 (20.3-44.5)[q]	0.040	28	40.0 (25.0-115.0)	0.237
Indirect	53	7 (13.2)	46 (86.8)		53	46.1 (13.9)		51	24.7 (17.7-36.0)		53	45.0 (23.0-95.0)	
Both	19	0 (0.0)	19 (100.0)		19	61.7 (13.9)[qq]		19	25.3 (22-30.4)		19	52.0 (28.0-140.0)	

[1]Chi square test; [2]ANOVA; [3]Kruskal-Wallis test; *p<0.01 and **p<0.001 compared to bilateral hernia; [q]p<0.05 and [qq]p<0.001 compared to indirect hernia.

Table 4. Operating time with respect to year of operation, patient age and BMI

	Operating time (min), median (min-max)
Year of operation	
2016	50.0 (35.0-70.0)
2017	52.0 (25.0-83)
2018	46.0 (25.0-140.0)
2019	45.0 (23.0-130)
2020	44.0 (30-115)
p[1]	0.504
Correlations	
Age	
r	0.240
P[2]	0.017
BMI	
r	0.205
P[2]	0.044

BMI: body mass index; r: correlation coefficient; [1]Kruskal Wallis test; [2]Spearman correlation analysis.

mesh, no significant differences were reported in operation time, hospital stay or postoperative complications between mesh types, while one patient in the nonabsorbable mesh group had a recurrence during follow-up.[10] In another study with 950 patients undergoing endoscopic TEP, use of ULTRAPRO (partially absorbable) or Prolene mesh revealed no significant differences in terms of pain, foreign body feeling, or time to return to work between mesh subgroups 3 months after the TEP repair.[20] In a study with 300 patients, laparoscopic TEP inguinal repair with 3D mesh without mesh fixation was reported to be a safe procedure with low rates of seroma formation (n=6, 2%), preperitoneal hematoma (n=1) and chronic pain (n=1), while the inguinal hernia recurrence was noted only in one patient within a median 48 months (range, 6 to 104 months) of follow-up.[21] Meta-analyses also revealed controversial data. Some meta-analyses indicated no increase in the recurrence rates with use of lightweight and large-pore meshes or with use of standard polypropylene mesh vs. lightweight Vypro II Mesh for the laparoscopic TEP and TAPP inguinal hernia repair,[22,23] along with similar rates of pain, urinary tract infection, and seroma but the significantly lower feeling of a foreign body with Vypro II Mesh vs. standard polypropylene mesh.[23] However, other meta-analyses indicated that the heavyweight mesh had a clear advantage over lightweight mesh for the recurrence in the laparoscopic inguinal hernia repair, particularly in non-fixated mesh direct repairs and/or large hernia defects, while the two types of prosthetic meshes were considered to be equivalent in terms of postoperative pain, seroma, foreign body sensation and infection.[24-26]

In the current study, the primary inguinal hernia was bilateral or indirect in almost half of patients, while right and left hernia or direct hernia were less commonly noted.

Notably, the preference for TEP (bilateral and primary inguinal hernias) and TAPP (unilateral and recurrent inguinal hernia repairs) differs with respect to hernia types.[14] Justifying this approach, TEP and TAPP approaches for inguinal hernia repairs have been consistently reported to be equivalent in terms of operating time, complication and recurrence rates, regardless of underlying hernia type and pathology.[8,12,14,18,27,28] Nonetheless, laparo-endoscopic bilateral inguinal hernia repair is considered particularly challenging operation necessitating an experienced and trained surgeon due to increased complexity of the hernia surgery.[29,30] Our findings related to favorable postoperative outcome after TEP laparoscopic inguinal hernia repair with use of partially absorbable mesh seem notable in this regard, given that rate of bilateral inguinal hernias (50.0%) in our series was higher than those reported (28%) in laparo-endoscopic approach from registry analyses.[28-30]

Data from the registry studies revealed significantly higher recurrence rate after the primary operation for direct inguinal hernia than for indirect inguinal hernia, emphasizing the importance of following a meticulous surgical approach for direct/medial inguinal hernia repair.[3,4,31-34] In an analysis of Danish Hernia Database in 85,314 male patients, the recurrence rate after elective primary inguinal hernia repair (overall: 3.8% over a 15-year period) was significantly higher for direct vs. indirect inguinal hernias (5.2 vs. 2.7 %), while a direct inguinal hernia at primary operation was also found to be a substantial risk factor for recurrence (HR 1.90, 95% CI 1.77-2.04), possibly due to distinct changes in connective tissue composition in case of direct inguinal hernia.[3,33] Hence, the complete reduction of the sac to prevent the development of seroma and recurrence is considered crucial for direct laparoendoscopic hernioplasty, since the direct hernia sac may persist giving rise to a pseudo-recurrence or the pressure exerted on this area may push the mesh further resulting in recurrence.[4,18,35]

In addition, preperitoneal lipoma is suggested to be carefully considered during laparoendoscopic hernioplasty given that it is easily overlooked at the time of operation resulting in unsatisfactory postoperative outcome with potential risk of future pseudo-recurrence, despite a non-dislocated correctly positioned mesh.[4,36,37] The complications after laparoscopic inguinal repair such as seroma formation were also reported to be significantly associated with increased risk of inguinal hernia recurrence,[38] while PLLA

patch is considered a safe option in laparoscopic inguinal hernia repair not only for its applicability in short time with less pain but also for lower rate of seroma formation.[16]

In this regard, the successful postoperative outcome with minimal postoperative complications and 0.67% rate of recurrence after laparoscopic TEP inguinal hernia repair with use of partially absorbable composite mesh (polypropylene-absorbable PLLA) in our study seems notable given that direct hernia and lipoma, as risk factors for recurrence, were evident in 28.0% and 17.0% of patients, respectively. Moreover, most of lipomas were related to indirect or bilateral hernias, while most of seromas were related to direct or bilateral hernias.

In our study, all patients were operated by the same surgeon throughout the study period, minimizing the impact of surgeon biases regarding the surgical time and mesh handling techniques on postoperative recurrence outcome.[8,10] Although no significant difference was noted in operating time over years, the maximum operating time tends to increase from 2016 to 2020 (70 min to 115 min). In fact, 26% higher relative risk of reoperation for recurrence was reported for patients with an operating time <36 min than those with an operating time of >66 min, emphasizing the role of hernia surgeon's experience in avoidance of speed with maintained thoroughness during the entire surgical procedure.[39] In the Swedish Hernia Register, the surgeons who carried out one to five laparoscopic hernia repairs in a year were reported to have significantly higher recurrence rates than experienced surgeons who carried out more repairs.[40] The laparoscopic inguinal hernia surgery is associated with a longer curve than open procedures, while the TEP procedure is considered more difficult to learn than TAPP procedure, as stabilization of operating times occur after 40-100 procedures and 30-50 procedures, respectively.[3,41-43]

Hence, the median operating time in our series (45.0 min, range, 23.0 to 140.0 min), representing the single-surgeon experience on TEP laparoscopic inguinal hernia repair with use of partially absorbable mesh over a 5-year period, supports the decrease in the likelihood of reoperation for recurrence with the increasing operating time and the increased experience of the surgeon.[3,4,39,40]

In a systematic review of 75 studies and the data from the Herniamed Hernia Registry on hernia- or patient-related adverse factors on the postoperative outcome of inguinal hernia repair, the direct inguinal hernia, bilateral inguinal hernias, obesity and older patient age were concluded to be associated with increased complexity of hernia surgery.[29] Other studies also reported an increased incidence of surgical and medical complications with a high BMI[44] and a longer operating time[22] along with higher postoperative complication rates following bilateral inguinal hernia repair compared to the unilateral inguinal hernia repair.[28,30] Similarly, in the current study, bilateral hernia was associated with significantly longer operating time than unilateral hernia, while direct hernia was associated with higher BMI and older patient age than indirect hernia. Also, operating time was positively correlated both with patient age and BMI.

Our findings support that males account for over 90% of inguinal hernia procedures,[3] while direct hernia is more common in elderly and indirect hernia in the young.[8,45] Although potential role of inheritable genetic factors has been suggested, the reason for the gender- and age-based predilection in inguinal hernias remains unclarified.[3] Nonetheless, in a meta-analysis of 14 observational studies (378,824 procedures in 375,620 patients), female gender (RR 1.38), direct inguinal hernias at primary procedure (RR 1.91) and operation for a recurrent inguinal hernia (RR 2.2) were concluded to be risk factors for recurrence after inguinal hernia surgery, while neither the age nor the postoperative convalescence had significant impact on the recurrence risk.[46] The authors concluded that the recurrence is most likely a multifactorial event with contribution of technical and patient-related risk factors, which may differ depending on the hernia subtypes and related pathophysiology.[46]

Herniamed Registry revealed that only 57.5% of operations for recurrent inguinal hernia are performed within 10 years, while the remaining 40% are performed after 10–50 years, emphasizing that even a follow-up of 10 years may not reveal the actual recurrence rate.[6] This seems notable given the follow-up period was based on 1 to 5 years in most of the hernia surgery studies.[6,7,47]

Hence, the low recurrence rates over a 5-year period in our study should be interpreted in light of the relatively high recurrence rates reported in registered studies with non-selective patient collectives also recording the later recurrences.[4,6,7]

The major strength of our study is its single-surgeon nature, minimizing the impact of varying surgeon experience on postoperative recurrence outcomes. However, this study has certain limitations. First, due to the retrospective single-center design, relatively low sample size may limit the generalizability of our findings. Second, the relatively short follow-up period insufficient for recording later recurrences as well as the likelihood of more skillful use of PLLA patch by the surgeon after passing the learning curve might have affected our favorable results on the recurrence-free follow-up after laparoscopic inguinal hernia repair.

Conclusion

In conclusion, our findings indicate that laparoscopic TEP inguinal hernia repairs with use of the partially absorbable meshes enable a favorable postoperative outcome with minimal early and late postoperative complications and 0.67% recurrence rate. This seems notable given that direct hernia and lipoma, as risk factors for recurrence, as well as the bilateral hernias increasing the complexity of hernia surgery were evident in a considerable proportion of patients at the time of primary operation. Further longer-term large-scale studies of inguinal laparoscopic TEP repairs with use of partially absorbable meshes are needed that address the recurrence after inguinal hernia surgery in different hernia subtypes with different pathophysiology and the potential emergence of complications or recurrence over many years of follow-up.

Disclosures

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