LESS

Original Article

Laparosc Endosc Surg Sci 2024;31(2):50–56
DOI: 10.14744/less.2024.79095

Comparison of three-dimensional mesh (3D mesh) without fixation versus polypropylene mesh with fixation in patients of inguinal hernia undergoing totally extraperitoneal repair

Nail Omarov,[1] Elnur Huseynov,[2] Ayşegül Bahar Özocak[1]

[1]Department of General Surgery, Hınıs Şehit Yavuz Yürekseven State Hospital, Istanbul, Türkiye
[2]Department of General Surgery, Avrupa Safak Hospital, Istanbul, Türkiye

ABSTRACT

Introduction: We aimed to compare the results of patients who underwent inguinal hernia repair with non-fixation pre-shaped three-dimensional (3D) mesh and fixation with polypropylene meshes (PPM) using the totally extraperitoneal (TEP) method.

Materials and Methods: A total of 96 patients who underwent laparoscopic hernia repair with the diagnosis of inguinal hernia between April 2019 and September 2023 were retrospectively analyzed. The patients were divided into two groups according to the mesh type used: staple fixation (SF) group (n=52), in which light-weight PPM was used, and non-staple fixation (NSF) group (n=44), in which pre-shaped 3D mesh was used. Patients' age, sex, body mass index (BMI), ASA score, comorbidities, hernia type, Visual Analog Scale (VAS) score at rest (VAS-rest) and while in motion (VAS-act), and chronic groin pain (CGP) were recorded. Postoperative follow-ups were performed at one, four weeks and three, and 12 months.

Results: The surgical time was found to be shorter in NSF group patients than in the SF group (p=0.011). In the SF group, four patients developed seroma, one patient developed urinary retention, and two patients developed hematoma. In the NSF group, seroma developed in three patients, urinary retention developed in two patients, and one hematoma was observed. Recurrence was observed in two patients in the SF group at 10 and 14 months, and in one patient in the NSF group at eight months. In the NSF group, groin pain was found less frequently on Day 1 and at Week 1 than in the SF group, indicating a statistically significant difference (p<0.001 and p<0.001, respectively).

Conclusion: Applying pre-shaped 3D mesh without any fixation is a safe and applicable method in inguinal hernia surgery. We recommend this method, as CGP is less than the polypropylene mesh fixation method and does not increase recurrence. This method can be performed by experienced surgeons with low complication rates.

Keywords: CGP, NSF, SF, TEP, VAS-act, VAS-rest, Comorbidities, Hernia, Laparoscopic, Mesh, Postoperative, Recurrence, Seroma, Surgical time, Three-dimensional, Urinary retention

Received: 02.04.2024 **Revision:** 07.04.2024 **Accepted:** 12.06.2024
Correspondence: Nail Omarov, M.D., Department of General Surgery, Hınıs Şehit Yavuz Yürekseven State Hospital, Istanbul, Türkiye
e-mail: dr.omarov86@gmail.com

Introduction

Inguinal hernia surgery is still one of the most common surgical procedures worldwide. It was first applied laparoscopically in the 1990s.[1] A Cochrane database study revealed the advantages of laparoscopic inguinal hernia repair compared to open surgery.[2] Transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) approaches are the most commonly applied techniques of laparoscopic inguinal hernia surgery. Although many techniques have been reported in the literature regarding mesh types and fixation methods applied in surgery, no definitive conclusion has been reached. Chronic groin pain (CGP) and recurrence rates after laparoscopic inguinal hernia surgery determine the success of this technique.[3] Regardless of the technique, the incidence of CGP in patients after these surgeries is, on average, 5-10%.[4] This situation negatively affects the quality of life after surgery. The definition of CGP is defined by the Association for the Study of Pain as groin pain that persists for more than 3 months after inguinal hernia surgery.[5] Nerve damage during dissection, thermal nerve injury, and entrapment of the nerves in fixation devices can be listed as the causes of groin pain. Apart from nerve injuries, stapling may lead to inflammation of the ligamentous insertions around the pubic symphysis, causing somatic pain. Metallic tacks were used in the early years for mesh fixation in the preperitoneal area. This has been seen as the main cause of pain. In order to protect patients from CGP, many techniques have been developed for mesh fixation, and absorbable tacks, fibrin glue, and cyanoacrylate have been tried, and apart from this, the results of self-gripping mesh and non-fixation pre-shaped three-dimensional (3D) mesh have been evaluated in studies.

Polypropylene meshes (PPMs) are made of prolene fibers arranged in a network with pores of differing sizes. They are classified on the basis of density of material and its surface area as heavyweight (90 gm/sq meter to 100 gm/sq meter); middleweight (45 gm/sq meter); and lightweight (less than 45 gm/sq meter).[6,7] The pre-shaped 3D mesh was first used in 1998 by Dr. Pajotin. Its most important features include the fact that it is anatomically designed, easily positioned, and fixation-free in nature with reduced pain.[8,9] In the present study, we aimed to compare the results of patients who underwent inguinal hernia repair with non-fixation pre-shaped 3D mesh and fixation with PPM using the TEP method.

Materials and Methods

This retrospective study was conducted at Erzurum Hınıs Şehit Yavuz Yürekseven State Hospital and Istanbul Avrupa Şafak Hospital General Surgery Department between April 2019 and September 2023. Patients who were operated on for bilateral, unilateral, and recurrent inguinal hernia by three surgeons were reviewed. Patients who underwent inguinal hernia repair with pre-shaped 3D mesh and lightweight PPM were identified. Patients who underwent TAPP, had cancer concurrent with inguinal hernia, and could not be followed up were excluded from the study. The primary outcome was CGP and hernia recurrence, while the secondary outcomes included surgical time, pain score, hospital stay, wound and mesh-related seroma, hematoma, urinary retention, and orchitis. During the study period, a total of 145 patients were identified where laparoscopic hernia repair was performed with the diagnosis of inguinal hernia. Of these patients, 96 who were eligible for the study were included. A total of 49 ineligible cases were excluded from the study. The study flowchart is shown in Figure 1.

The patients were divided into two groups according to the mesh type used: staple fixation (SF) group (n=52) in which lightweight PPM was used and non-staple fixation (NSF) group (n=44) in which pre-shaped 3D mesh was used.

A written informed consent was obtained from each patient. The study protocol was approved by the Ethics Committee of the University of Health Sciences, Erzurum Faculty of Medicine (Date: 13.03.2024, Decision No: 2024/03-42). The study was conducted in accordance with the principles of the Declaration of Helsinki.

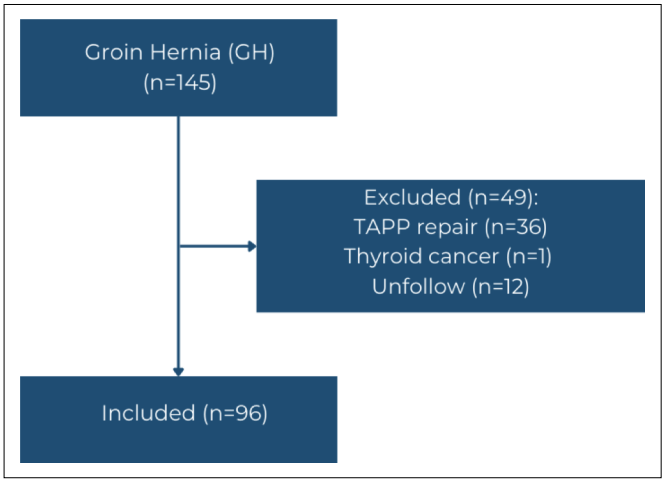

Figure 1. Study flowchart.

Data Collection and Assessment

Patients' age, sex, body mass index (BMI), ASA score, comorbidities, hernia type, Visual Analog Scale (VAS) score at rest (VAS-rest), and while in motion (VAS-act) were recorded. The pain was measured on postoperative Day 1 and after one week using the VAS ranging from no pain "0" to worst pain "10". Intraoperative and postoperative data were noted. Postoperative follow-ups were performed at one, four weeks, and three and 12 months. The VAS score was evaluated. Follow-ups were carried out at the outpatient clinic, and patients who could not attend the check-up were contacted by phone, and their information was updated. The patient's recurrence was decided based on the repeat examination and the patients' expression of swelling in the groin. In suspicious cases, further examination was performed by requesting superficial organ ultrasonography.

Operative Technique

All laparoscopic TEP repairs were performed under general anesthesia. With a single video monitor at the foot end of the patient, a 2-cm transverse infraumbilical incision was made extending from the midline to the opposite side of the hernia. Blunt dissection was performed to expose the anterior sheath. Once the rectus abdominis muscle was exposed, it was swept laterally to expose the posterior rectus sheath. A 10-mm, 30° telescope was inserted and used to bluntly dissect the areolar tissue in the preperitoneal space. Low-pressure pneumoperitoneum was created. Two 5-mm ports were inserted between the symphysis pubis and umbilicus, on the midline. The cord structures were dissected free of peritoneal attachments, and the sac reduced back to the peritoneal cavity. After all possible hernia sites (indirect, direct, and femoral) were made visible, the mesh placement stage was started. The mesh was placed between the peritoneum and transversalis fascia. After mesh placement, the preperitoneal space was deflated under observation. Pneumoperitoneum is released gradually. The infraumbilical trocars site was closed with a 2-0 Vicryl.

Mesh Types and Placement

In the SF group, a lightweight PPM was used, with a size of 15x12 cm, and fixed with staple tacks. In the NSF group, 8.5x13.7 cm knitted polypropylene pre-shaped mesh (3DMax™-Mesh) was used, which does not require fixing with staple tacks. The pre-shaped 3D mesh eliminates the need for tools such as sutures, tacks, or staplers, thus eliminating potential nerve damage. The meshes are curled to the middle from the upper and lower edges when outside the body. The meshes that were sent from the 10-mm trocar were positioned centrally to cover the inner inguinal ring, and medially to cover the pubic tubercle. With the help of blunt instruments such as a grasper, the upper fold of the rounded mesh was fixed. The lower fold was unrolled until it went below the peritoneal reflection and then the upper fold was opened to cover all potential hernia sites. The pre-shaped 3D mesh was gently pressed with the grasper to make it adhere to the surrounding tissues. Usually, three tacks were sufficient to secure the standard PPM mesh to the os pubis, the Cooper ligament, and the top of the iliopubic tract. After surgery, the patients were monitored in the ward. The oral regimen was started on the same day, and the patients were discharged the next day.

Statistical Analysis

Statistical analysis was performed using IBM SPSS for Windows version 22 software (IBM Corp, Armonk, NY, USA). Descriptive data were expressed as mean and standard deviation (SD), median (min-max), or number and frequency, where applicable. The independent sample t-test was used to compare the quantitative continuous data between the two groups. The difference between repeated measurements within the group was analyzed by the paired group test. A p-value of <0.05 was considered statistically significant.

Results

A total of 118 inguinal hernia repairs were performed, both unilateral and bilateral. No statistically significant difference was observed in terms of the patients' demographic data, BMI, American Society of Anesthesiologists (ASA) score, hernia characteristics, preoperative pain score, and comorbidities (Table 1).

Peri- and postoperative data are given in Table 2. There was a statistically significant difference between the groups in terms of the surgical time. The surgical time was found to be shorter in NSF group patients than in the SF group ($p=0.011$). In the SF group, four patients developed seroma, one patient developed urinary retention, and two patients developed hematoma. In the NSF group, seroma developed in three patients, urinary retention developed in two patients, and one hematoma was observed. Pa-

Table 1. Preoperative data

Variables	SF (n=52) n (%)	NSF (n=44) n (%)	p
Age (min-max)	41.32+11.56 (23-68)	43+12.37 (26-70)	0.531
Sex			0.625
Male	48 (92.3)	41 (93.1)	
Female	4 (7.6)	3 (6.8)	
BMI	29.35+3.21 (22.5-38.2)	28.65+2.43 (21.4-37.6)	0.310
ASA score			0.525
1	45 (86.5)	39 (88.6)	
2	7 (13.4)	5 (11.3)	
Hernia characteristics			0.254
Unilateral	42 (80.7)	32 (72.7)	
Bilateral	10 (19.2)	12 (27.2)	
Recurrent	7 (13.4)	4 (9.09)	
Preoperative pain scores			
VAS-rest	1.425+1.321 (0-4)	1.235+1.12 (0-4)	0.345
VAS-act	3.550+1.354 (1-6)	3.940+1.250 (2-6)	0.210
Comorbidities			0.212
Hypertension	8 (15.3)	9 (20.4)	
Lung disease	4 (7.6)	2 (4.5)	
Diabetes mellitus	6 (11.5)	5 (11.3)	
Benign prostatic hyperplasia	2 (3.8)	1 (2.2)	
Smoking	43 (82.6)	36 (81.8)	
Obesity	15 (28.8)	10 (22.7)	

SF: staple fixation; NSF: non-staple fixation; VAS: Visual Analog Scale; VAS-rest: Score at rest; VAS-act: Score at motion.

Table 2. Peri- and postoperative data

Variables	SF (n=52) n (%)	NSF (n=44) n (%)	p
Mean Length of Surgery (minute)	50.75+18.8 (39-91)	42.82+16.54 (30-69)	0.021
Postoperative early complications			0.545
Seroma	3 (5.7)	1 (2.2)	
Hematoma	2 (3.8)	0 (0)	
Urinary retention	1 (1.9)	1 (2.2)	
Orchitis	0 (0)	(0)	
Length of hospital stay (day)	1.65+0.45 (1-3)	1.15+0.15 (1-2)	0.325
Follow-up duration (month)	31.5+9.46 (12-45)	29.8+7.25 (11-41)	0.156
Recurrence	2 (3.8)	1 (2.2)	0.612

SF: staple fixation; NSF: non-staple fixation.

tients with seroma were followed, no additional intervention was performed, urine evacuation was performed with a temporary Foley catheter for urinary retention, and patients who were followed for hematoma were discharged without any additional intervention. Recurrence was observed in two patients in the SF group at 10 and 14 months, and in one patient in the NSF group at eight months.

Considering the postoperative first day and first week VAS scores, there was a significant decrease in both groups compared to the preoperative period. In the NSF group, groin pain was found less frequently on Day 1 and at Week 1 than in the SF group, indicating a statistically significant difference ($p<0.001$ and $p<0.001$, respectively) (Table 3). Both groups were given 4x1,000 mg paracetamol IV as an analgesic during their postoperative follow-up and 4x1,000 mg paracetamol oral for one week after discharge.

Discussion

The main goal of inguinal hernia surgeries is to shorten surgical time, repair with the correct technique, ensure low morbidity, early return to daily life, less pain, acceptable cost, better cosmetic result, and low recurrence. The most important developments in this regard are the mesh-applied tension-free anterior hernia repair described by Lichtenstein in the late 1980s and the introduction of laparoscopic methods in the 1990s.[10,11] Studies comparing laparoscopic inguinal hernia repair with classical open hernia repair have shown that the minimally invasive approach contributes greatly to patients' early comfort, less postoperative pain, shorter hospital stay, and faster return to work.[12-14] Particularly, the use of meshes in inguinal hernia surgeries has reduced recurrence rates.[15] Choosing the right mesh determines the surgical results as much as the surgical technique.[16] The ideal mesh implant would be chemically inert, resistant to stress, pliable, non-carcinogenic, hypoallergenic, and resistant to modification by body tissue.[17]

Chronic groin pain morbidity has come to the fore in the long term, particularly due to the decrease in recurrence rates with prosthetic mesh materials. Therefore, studies on the choice of mesh used in inguinal hernia repair continue. Many studies have demonstrated that CGP complications are lower in TEP and TAPP techniques compared to open hernia repair.[18-20]

Apart from this, laparoscopic hernia surgery has a positive effect on the quality of life (QoL) scores of patients.[21] Choosing non-fixation mesh in laparoscopic hernia repair reduces CGP and also reduces costs due to not using fixation staplers.[3] Non-fixation mesh can be applied safely in both TAPP and TEP methods.[22] In addition, since there is no need for mesh fixation after surgery, the need for analgesics is reduced due to less pain.[23] Büyükkaşık et al.[24] compared fixation and non-fixation groups using standard PPM in inguinal hernia repair and found that there was less pain in the non-fixation group one month after discharge. In another study using NSF, repair with preshaped 3D mesh was safe, reduced the CGP rate and morbidity, and shortened the operating time.[25] Tiwari et al.[26] evaluated the pain, recurrence, and morbidity results after inguinal hernia repair with 3D mesh in a prospective observational study and published its positive results. In our study, only patient groups with similar demographic and hernia characteristics who underwent TEP were evaluated. Although there was a significant improvement in both groups compared to the preoperative period, considering the VAS score on Day 1 and Week 1 after surgery, the pain in the NSF group was statistically significantly less than the SF group. However, no significant difference was observed between the groups at Month 3.

Considering the surgical times between the NSF group and the SF group, it was found to be shorter in the NSF group, indicating a statistically significant difference. These results were similar to the studies conducted by Cucuk et al.[27] and Birk et al.[28]

Table 3. Mean VAS scores

Variables	SF	NSF	p
VAS-rest	1.425+1.321 (0-4)	1.235+1.12 (0-4)	0.345
VAS-act	3.550+1.354 (1-6)	3.940+1.250 (2-6)	0.210
VAS 1st day (POD1)	1.150+0.450 (0-2)	0.710+0.115 (0-1)	0.012
VAS 1st week	0.630+0.420 (0-2)	0.210+0.310 (0-1)	0.001
VAS 3rd month	0.361+0.471 (0-2)	0.135+0.211 (0-2)	0.872

SF: staple fixation; NSF: non-staple fixation; VAS: Visual Analog Scale; VAS-rest: Score at rest; VAS-act: Score at motion; POD1: postoperative day 1.

Many complications may occur in the early period after laparoscopic inguinal hernia surgery. The rates of seroma, hematoma, and urinary retention developing in both groups of patients after surgery were found to be low and consistent with the literatüre.[28,29] Therefore, no statistically significant difference was observed between the groups in the hospitalization period of the patients. Moreover, the use of non-fixation mesh is considered a safe method, as it does not increase recurrence rates. [10] The recurrence rate after pre-shaped 3D mesh repair has been reported as 0 to 3.3% during 12 to 26 months of follow-up in different studies in the literature.[25,30,31] Cucuk et al.[28] used NSF self-gripping mesh during a mean follow-up period of 25.8 months, and no recurrence was observed. In our study, the follow-up period in the SF and NSF groups was 31.5±9.46 months and 29.8±7.25 months, respectively, and the recurrence was seen in two (3.8%) and one patient (2.2%), respectively. Recurrence occurred at 14 and 16 months in the SF group and at 12 months in the NSF group, and the patients were reconstructed with the TAPP method. These results are consistent with the literature.

Of note, as in all surgeries, minimally invasive surgery is preferred in inguinal hernia surgery, and with the development of technology, studies comparing laparoscopic inguinal hernia repair with robotic repair have begun to be reported in recent years.[32]

Nonetheless, the main limitation to our study is its retrospective design with a relatively small sample size. Therefore, we believe that prospective studies in larger series are needed. In addition, it is necessary to evaluate the 10-year results of NSF pre-shaped 3D mesh follow-up period. We suggest that the study yielded a positive effect in terms of evaluating the results by performing TEP laparoscopically with a single technique and excluding patients who underwent TAPP from the study.

Conclusion

In conclusion, applying pre-shaped 3D mesh without any fixation is a safe and applicable method in inguinal hernia surgery. We recommend this method, as CGP is less than the polypropylene mesh fixation method and does not increase recurrence. This method can be performed by experienced surgeons with low complication rates.

Disclosures

Ethichs Committee Approval: The study protocol was approved by the Ethics Committee of the University of Health Sciences, Erzurum Faculty of Medicine (Date: 13.03.2024, Decision No: 2024/03-42). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Funding: This study received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Authorship Contributions: Concept – N.O.; Design – N.O.; Supervision – N.O., E.H., A.B.O.; Materials – N.O.; Data collection and/or processing – N.O., E.H., A.B.O.; Analysis and/ or interpretation – E.H., A.B.O.; Literature search – N.O., E.H., A.B.O.; Writing – N.O.; Critical review – N.O.

References

1. Arregui ME, Davis CJ, Yucel O, Nagan RF. Laparoscopic mesh repair of inguinal hernia using a preperitoneal approach: A preliminary report. Surg Laparosc Endosc 1992;2(1):53–8.
2. McCormack K, Scott NW, Go PM, Ross S, Grant AM; EU Hernia Trialists Collaboration. Laparoscopic techniques versus open techniques for inguinal hernia repair. Cochrane Database Syst Rev 2003;2003(1):CD001785.
3. Bittner R, Arregui ME, Bisgaard T, Dudai M, Ferzli GS, Fitzgibbons RJ, et al. Guidelines for laparoscopic (TAPP) and endoscopic (TEP) treatment of inguinal hernia [International Endohernia Society (IEHS)]. Surg Endosc 2011;25(9):2773–843.
4. Wantz GE. Laparoscopic hernioplasty without staples. J Am Coll Surg 1999;188(5):531.
5. Stabilini C, van Veenendaal N, Aasvang E, Agresta F, Aufenacker T, Berrevoet F, et al. Update of the international HerniaSurge guidelines for groin hernia management. BJS Open 2023;7(5):zrad080.
6. Bruce J, Poobalan AS, Smith WC, Chambers WA. Quantitative assessment of chronic postsurgical pain using the McGill Pain Questionnaire. Clin J Pain 2004;20(2):70–5.
7. Doctor HG. Evaluation of various prosthetic materials and newer meshes for hernia repairs. J Minim Access Surg 2006;2(3):110–6.
8. Welty G, Klinge U, Klosterhalfen B, Kasperk R, Schumpelick V. Functional impairment and complaints following incisional hernia repair with different polypropylene meshes. Hernia 2001;5(3):142–7.
9. Pajotin P. Laparoscopic groin hernia repair using a curved prosthesis without fixation. J Coelio Chirurgie 1998;28:64–8.
10. Koch CA, Greenlee SM, Larson DR, Harrington JR, Farley DR.

Randomized prospective study of totally extraperitoneal inguinal hernia repair: Fixation versus no fixation of mesh. JSLS 2006;10(4):457–60.
11. EU Hernia Trialists Collaboration. Repair of groin hernia with synthetic mesh: Meta-analysis of randomized controlled trials. Ann Surg 2002;235(3):322–32.
12. Surgit O. Single-incision Laparoscopic surgery for total extraperitoneal repair of inguinal hernias in 23 patients. Surg Laparosc Endosc Percutan Tech 2010;20(2):114–8.
13. EU Hernia Trialists Collaboration. Laparoscopic compared with open methods of groin hernia repair: Systematic review of randomized controlled trials. Br J Surg 2000;87(7):860–7.
14. Gong K, Zhang N, Lu Y, Zhu B, Zhang Z, Du D, et al. Comparison of the open tension-free mesh-plug, transabdominal preperitoneal (TAPP), and totally extraperitoneal (TEP) laparoscopic techniques for primary unilateral inguinal hernia repair: A prospective randomized controlled trial. Surg Endosc 2011;25(1):234–9.
15. Li J, Wang X, Feng X, Gu Y, Tang R. Comparison of open and laparoscopic preperitoneal repair of groin hernia. Surg Endosc 2013;27(12):4702–10.
16. Vrijland WW, van den Tol MP, Luijendijk RW, Hop WC, Busschbach JJ, de Lange DC, et al. Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2002;89(3):293–7.
17. Champault G, Bernard C, Rizk N, Polliand C. Inguinal hernia repair: The choice of prosthesis outweighs that of technique. Hernia 2007;11(2):125–8.
18. Harrell AG, Novitsky YW, Cristiano JA, Gersin KS, Norton HJ, Kercher KW, et al. Prospective histologic evaluation of intraabdominal prosthetics four months after implantation in a rabbit model. Surg Endosc 2007;21(7):1170–4.
19. Bracale U, Sciuto A, Andreuccetti J, Merola G, Pecchia L, Melillo P, et al. Laparoscopic recurrent inguinal hernia repair during the learning curve: It can be done? Ann Ital Chir 2017;88:62–6.
20. Eklund AS, Montgomery AK, Rasmussen IC, Sandbue RP, Bergkvist LA, Rudberg CR. Low recurrence rate after laparoscopic (TEP) and open (Lichtenstein) inguinal hernia repair: A randomized, multicenter trial with 5-year follow-up. Ann Surg 2009;249(1):33–8.
21. Wennergren JE, Plymale M, Davenport D, Levy S, Hazey J, Perry KA, et al. Quality-of-life scores in laparoscopic preperitoneal inguinal hernia repair. Surg Endosc 2016;30(8):3467–73.
22. Smith AI, Royston CM, Sedman PC. Stapled and nonstapled laparoscopic transabdominal preperitoneal (TAPP) inguinal hernia repair. A prospective randomized trial. Surg Endosc 1999;13(8):804–6.
23. Taylor C, Layani L, Liew V, Ghusn M, Crampton N, White S. Laparoscopic inguinal hernia repair without mesh fixation, early results of a large randomised clinical trial. Surg Endosc 2008;22(3):757–62.
24. Buyukasik K, Ari A, Akce B, Tatar C, Segmen O, Bektas H. Comparison of mesh fixation and non-fixation in laparoscopic totally extraperitoneal inguinal hernia repair. Hernia 2017;21(4):543–8.
25. Mir I, Nafae A, Malyar A, Nafae M, Watali Y, Farooq M. An experience of short-term results of laparoscopic inguinal hernioplasty using 3D mesh in a developing country. Int J Clin Med 2015;6(1):64–9.
26. Tiwari P, Lankar J, Reddy PK. Contoured 3D mesh in laparoscopic inguinal hernia repair: Does it reduce inguinodynia. MOJ Surg 3 2016;3(4):97–103.
27. Cucuk OC, Barbaros U. Comparison of the clinical outcomes of self-gripping mesh versus staple fixation mesh in laparoscopic inguinal hernia repair. Ann Ital Chir 2023;94:82–9.
28. Birk D, Hess S, Garcia-Pardo C. Low recurrence rate and low chronic pain associated with inguinal hernia repair by laparoscopic placement of Parietex ProGrip™ mesh: Clinical outcomes of 220 hernias with mean follow-up at 23 months. Hernia 2013;17(3):313–20.
29. Chalkoo M, Mir MA, Makhdoomi H. Laparoscopic transabdominal preperitoneal mesh hernioplasty: A medical college experience. Surg Sci 2016;7(2):107–13.
30. Messaris E, Nicastri G, Dudrick SJ. Total extraperitoneal laparoscopic inguinal hernia repair without mesh fixation: Prospective study with 1-year follow-up results. Arch Surg 2010;145(4):334–8.
31. Hoque S, Hasan R, Hossain I. Short-term result of laparoscopic totally extraperitoneal inguinal herniorraphy. Chattagram Maao Shishu Hosp Med Coll J 2013;12(1):30–3.
32. Morrell ALG, Morrell Junior AC, Mendes JMF, Morrell AG, Morrell A. Robotic TAPP inguinal hernia repair: Lessons learned from 97 cases. Rev Col Bras Cir 2021;48:e20202704.