Original Article

A prospective randomized pilot study comparing transabdominal preperitoneal versus totally extraperitoneal laparoscopic inguinal hernioplasty in recurrent inguinal hernia

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ABSTRACT

Background: Inguinal hernia repair is one of the most common surgeries. About 20% of cases with primary inguinal hernia underwent minimally invasive procedure. Recurrent inguinal hernia (RIH) after minimally invasive surgery has been recorded in about 2% of cases for totally extraperitoneal (TEP) as well as for transabdominal preperitoneal (TAPP) repair.

Aim: To compare the laparoscopic TAPP and TEP repair of inguinal hernia in RIH.

Patients and Methods: This was a prospective randomized study planned for patients diagnosed with RIH. The study population was divided into two groups; group (1) included patients who had the TAPP approach, while group (2) included patients who had TEP approach. The patients were evaluated for postsurgical adverse events such as postoperative pain, recurrence, infection, seromas, and hematomas.

Results: There were significant differences recorded among both groups as regards operative time and postoperative pains, which were significantly increased in the TAPP group compared to TEP group. No significant difference was recorded between the groups regarding operative complications and recurrence rate.

Conclusion: In the context of RIH, both TEP and TAPP repair seem to be efficient approaches with regard to low recurrence rate and minimal complications. However, TEP was associated with minimal pain and short OT.

Key Words: Recurrent inguinal hernia, totally extraperitoneal laparoscopic inguinal hernioplasty, transabdominal preperitoneal.

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INTRODUCTION

Inguinal hernia is a frequent disease affecting about 7.5% of adults globally. Inguinal hernia repair (IHR) has been considered a very common surgery, with over 20 million hernias treated annually[1]. Minimal access surgery has gained much more popularity in numerous regions of surgery[2]. The laparoscopic herniorrhaphy was first recorded in 1992[3]. Then, the evolution of IHR surgeries has continued, with laparoscopic repair nowadays becoming a promising substitute for open surgeries[4].

The benefits of the minimal access surgery involve minimal postoperative pain (POP), POP is very common following open IHR[5], minimal requirement for analgesia, better cosmoses, and rapid return to usual daily activities, and devoid of wound-related adverse events[6]. To our knowledge, transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) have been considered the most frequent laparoscopic approaches in the context of hernioplasty[7].

TAPP has gained much more popularity owing to its simplicity; on the other hand, peritoneal breach is considered the main drawback of this approach[8]. In addition, bowel adhesion to the mesh has also been considered another drawback. To our knowledge, TEP is a difficult approach and needs the surgeon to be alert to uncommon anatomy; on the other hand, it permits direct access to the posterior defect without affection of the peritoneum[9]. Till now, no general agreement on the perfect IHR, that could overcome the possible complications of recurrent inguinal hernia (RIH), wound infections, and pain.

Recurrence following hernia repair could happen at any time following the surgery but occurs at a higher frequency in younger cases and in the initial three years postoperatively[10,11]. The utilization of mesh in IHR, regardless of the performed technique, decreases the frequency of RIH by 62.5% in comparison with suture closure[12,13].

To our knowledge, there are several factors that may interfere with the risk of recurrence, which involve

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technical and nontechnical causes, and the various types of groin hernias most likely have distinct pathophysiologies. It has been demonstrated that optimization of certain patient factors before surgery, together with the improvement of operative approaches, has essential roles in decreasing the risk of RIH development[14].

As a result, we aimed to compare laparoscopic TAPP and TEP repair of inguinal hernia in RIH concerning, operation time, intraoperative and postsurgical adverse events, length of hospital stay (LOS), POP, and rate of RIH with potential predisposing factors that comprise sex, age, BMI, and hernia site.

PATIENTS AND METHODS:

Study design and setting

This study is a prospective randomized pilot study designed for patients diagnosed with RIH who presented to the General Surgery Department, Mansoura University Hospitals, Egypt. The study was submitted for approval by the Institutional Review Board (IRB) (MD.21.03.439), Faculty of Medicine, Mansoura University, and the clinical trials registry in Egypt (NCT06050538). This study is not funded.

Study duration and sample size

The study was conducted from February 2021 to February 2023 on 41 cases that underwent laparoscopic IHR. This big number is explained by being a university hospital (tertiary center), we receive a lot of referred cases from other hospitals and private outpatient clinics. All cases were divided randomly into two groups. Both groups were equal in number (22 patients in each group), but in the TEP group, three patients were excluded (two patients refused to participate after admission, one patient had uncontrolled hypertension).

Sample size calculation was based on the difference in mean visual analog scale (VAS) score between patients with TEP and TAPP for RIH repair, depending on the experience of the surgeon with a difference of 1.14 in mean VAS score. By utilizing G power program, the sample size was calculated according to an effect size of 0.99, by utilizing two-tailed test, alpha-error=0.05, and power=80%, the overall sample size was 17 (n=17).

Study participants

The study comprised cases diagnosed with RIH and managed via either TAPP or TEP repair. We included patients from both sexes diagnosed with unilateral or bilateral RIH, patients between 18 and 70 years old, patients fit for anesthesia, and patients who agreed to contribute to the study. As regards the previous technique, all our cases were recurrent after open hernia repair, but we do not have enough details about the previous operation because all our patients were previously operated outside the hospital.

But we excluded patients unfit for general anesthesia and operation, younger than 18 years or elder than 70 years, patients with complicated hernias, mentally retarded patients, patients with psychiatric troubles and patients refused to contribute to our research.

Objectives

The primary objective was to compare POP between the TAPP and the TEP groups. The secondary objective was to compare OT, intraoperative adverse events (blood loss, bowel, and vascular injuries), postsurgical adverse events (hematomas, seromas, wound infections), LOS, and risk of RIH with potential predisposing factors that involve sex, age, BMI, cord lipomas, and site of the hernia.

Randomization

On the day of surgery, each patient was randomly assigned using the SNOSE approach to either the TEP or the TAPP group. By utilizing a computer-generated random number, an independent clinician who was not comprised in patient care created the randomization sequence. There were opaque sealed envelopes with the randomization code. When opening the package, a junior resident was not actively participating in outcome assessments. Prior to randomization and during the consent process, every patient was informed about the study's goals, methods, and potential risks related to the two approaches (TEP and TAPP).

Surgical procedure

Preoperative preparation

Intravenous antibiotics were administered for all patients at the time of skin incision, and these antibiotics were continued till third postsurgical day in cases who did not have adverse events. On the other hand, in complicated cases, antibiotic administration was continued according to the patient's condition. In addition, culture and sensitivity were performed if required. A single prophylactic dosage of LMWH subcutaneous was ordered when indicated.

Operative techniques

Technique of transabdominal preperitoneal repair

The procedure involved inducing pneumoperitoneum using a Veress needle in the left hypochondrial region, modifying intraabdominal pressure to 14mmHg, and introducing a 12-mm port for the camera. Exploration of both inguinal regions and abdominal assessment was done. A transverse peritoneal incision was made, and preperitoneal space dissection was started laterally at the retro-inguinal space of Bogros. The hernial sac was dissected away from spermatic cord structures. A 15x12cm polyprolene mesh was placed in the preperitoneal space, fixed using tackers which were placed in Cooper's ligament medially and above ileo pectineal line laterally.

The peritoneal flap was sutured, port site closure was done using Vicryl sutures, and skin closure was done using a skin stapler.

Technique of totally extraperitoneal repair

The preoperative preparation and patient positioning were identical to the TAPP technique. A skin incision was made above the umbilicus, and subcutaneous fat was divided by blunt dissection to reach the anterior rectus sheath. A 12mm trocar was introduced into the PPS, and carbon dioxide was insufflated. The symphysis pubis was identified and exposed, followed by dissection of the pectineal ligament and inferior epigastric blood vessels. A 5-mm port was placed in the midline, and a third 5mm trocar was introduced midway between the camera port and the suprapubic port. The dissection progressed laterally, keeping the inferior epigastric blood vessels parietal. The peritoneum was peeled distally, and a mesh was introduced through the umbilical port. The fascia of the camera port was stitched, and skin closure was done using Proline 2-0 or skin stapler.

Postoperative management

After the operation, the patients had fluids and analgesics, we encouraged them to early ambulate, scrotal support was recommended to decrease pain and scrotal edema, and patients were asked to resume unrestricted activity as soon as possible. Postsurgical data comprised evaluation of POP, postsurgical adverse events, LOS, time of returning to regular daily activities, chronic groin pain, and recurrence.

Follow-up

In the postsurgical period, the cases were assessed for postsurgical complications such as infection, seromas, and hematomas between the mesh and anterior abdominal wall. In the late postoperative period, a systematic follow-up was conducted 1, 3, and 6 months postoperatively to accurately determine the onset of recurrence and degree of pain. To detect the onset of recurrence, cases were asked for manifestations that comprised the presence of a bulge or pain in the operated groin. Pain was assessed by using a VAS score (0 equals no pain, while 10 is the worst pain).

Ethical consideration

The study design was approved by the IRB, Faculty of Medicine, Mansoura University. Confidentiality was respected. Patients had the right to leave the study at any time.

RESULTS:

Table 1 shows that there was a nonstatistically significant difference between studied groups regarding BMI, with the mean BMI of the TEP group being 27.37±3.55 versus 25.41 kg/m^2 for the TAPP group.

Regarding technical challenges, it was surprising that in most of our cases, our plane of dissection was easily approached as in primary inguinal hernia.

Table 2 revealed a nonstatistically significant difference between the studied groups. Operative complications were distributed as follows (one case CO_2 hypercapnia and one case converted to open in TEP group due to marked dissection of the posterior wall of the inguinal canal with multiple defects that were difficult to manage laparscopically) and for the TAPP group 1 case of visceral injury in the form of urinary bladder injury which underwent laparoscopic repair.

Table 3 showed that there was a statistically significantly higher median postoperative pain score in the TAPP group compared to the TEP group, possibly due to the use of tuckers for fixation of the mesh in the TAPP group, while in the TEP group, there is no need to fixate the mesh. The median length of stay was 3 days for both groups, and the mean TAPP group had a significantly higher operative time (OT). Cord lipoma was present in two cases of the TEP group and four cases of the TAPP group.

Table 4 showed that there was no statistically significant between studied groups as regard postoperative complications with one case hematoma for TEP group and for TAPP group; one case of wound infection, one case hematoma. As regards recurrence rate, there was also no statistically significant difference between both groups, with only one case of the TEP group shows recurrence.

Table 1: Sociodemographic characteristics and BMI of the studied groups

	TEP group (*N*=19)	TAPP group (*N*=22)	Test of significance
Age/years	50.42±8.32	46.64±9.89	*t*=1.31 *P*=0.197
Sex, *n* (%)			
Male	19 (100)	21 (95.5)	FET=0.885
Female	0	1 (4.5)	*P*=1.0
BMI (kg/m^2)	27.37±3.55	25.41±3.42	*t*=1.79 *P*=0.08

FET: Fisher exact test; t: Student t test; TAPP: transabdominal preperitoneal; TEP: totally extraperitoneal.

Table 2: Comparison of operative complications between the studied groups

	TEP group, *N*=19 (%)	TAPP group, *N*=22 (%)	Test of significance
Operative complications	17 (89.5)	21 (95.5)	MC=3.22 *P*=0.359
No	1 (5.3)	0	
CO_2 hypercapnia	1 (5.3)	0	
Converted to open visceral injury	0	1 (4.5)	

TAPP: transabdominal preperitoneal; TEP: totally extraperitoneal.

Table 3: Comparison of postoperative pain, operative time, cord lipoma, and length of hospital stay between studied groups

	TEP group, *N*=19	TAPP group, *N*=22	Test of significance
Postoperative pain score median (minimum–maximum)	4 (3–6)	6 (4–7)	*Z*=4.77 *P*<0.001*
Operative time (min), mean±SD	39.68±6.08	49.27±7.88	*t*=4.31 *P*<0.001*
Length of stay/days median (minimum–maximum)	3 (3–4)	3 (3–6)	*Z*=0.07 *P*=0.944
Cord lipoma			
Negative	17 (89.5)	18 (81.8)	FET=0.478 *P*=0.660
Positive	2 (10.5)	4 (18.2)	

TAPP: transabdominal preperitoneal; TEP: totally extraperitoneal.
*Statistically significant.

Table 4: Comparison of postsurgical complications between the studied groups

	TEP group, *N*=19	TAPP group, *N*=22	Test of significance
Postoperative complications, *n* (%)			MC=0.891 *P*=0.641
No	18 (94.7)	20 (90.9)	
Wound infection	0	1 (4.5)	
Hematoma	1 (5.3)	1 (4.5)	
Recurrence rate, *n* (%)			FET=1.19 *P*=0.463
Negative	18 (94.7)	22 (100)	
Positive	1 (5.3)	0	

TAPP: transabdominal preperitoneal; TEP: totally extraperitoneal.

DISCUSSION

A hernia of the abdominal wall is common in all age groups, especially for patients with an age of more than 45 years. Inguinal hernias represent 3/4 of all abdominal hernias[1]. IHR has been considered a frequent operation, with frequencies ranging from 10 per 100 000 of the population. In addition, men account for 95% of cases that present to primary care, and their incidence increases from 11 per 10 000 person years for those aged 16–24 to 200 per 10 000 person years for those aged 75 or older[15,16]. It has been demonstrated that Lichtenstein tension-free and minimally invasive surgery (MIS), which involves TAPP and TEP, conducted by skillful surgeons, is suggested as the best evidence-based modality for IHR[17].

About 20% of cases with primary inguinal hernia underwent MIS[18]. Causes of this minimal ratio may be due to higher charges and a steep learning curve. On the other hand, novel research revealed that TEP and TAPP appear accompanied by decreased possibility of POP and shorter return to work in comparison with the open tension-free approach[19]. IHR following MIS was recorded in 2% for both TEP and TAPP repair[20]. To our knowledge, mesh type, size, and overlap, the used approach, side, OT, type of anesthesia, contribution to a register database, femoral hernia, proper dissection, space creation, and postsurgical adverse events are recognized as predisposing factors[21,22].

This was a prospective randomized pilot study done to compare laparoscopic TAPP versus TEP IHR in RIH to assess the incidence of RIH, OT, intraoperative adverse events (blood loss, gut, and vascular injuries), and postsurgical adverse events (hematomas, seromas, wound infections), LOS, and postoperative pain.

Concerning demographic data, we found that there was no significant difference between the groups concerning age and sex. Likewise, no significant difference was recorded between the groups regarding BMI.

Köckerling and colleagues conducted their study on 2264 cases with recurrent IHR after preceding primary open surgery; of these 1464 cases underwent the TAPP approach, and 782 cases underwent the TEP hernioplasty. In their study, there was no statistically significant difference in mean age and BMI demonstrated between the recurrent surgeries in TEP and TAPP approach[23]. Choi and colleagues carried out their study on 1065 cases that underwent laparoscopic TEP hernioplasty, of which 100 cases were RIH after open repair, and 965 cases were primary inguinal hernia, with a mean age of patients in both groups of 49.46±16.8 years with no statistically significant difference[24].

We have displayed that there was no statistically significant difference between the studied groups in terms of the affected side, with 50% of the TAPP group on the right side versus 42.1% of the TEP group. Our study demonstrated the nonsignificant difference between the studied groups concerning operative complications. Operative complications were distributed as follows (one case CO_2 hypercapnia and one case converted to open), and for the TAPP group 1 case of visceral injury. As regards intraoperative complications, Köckerling and colleagues demonstrated that there were no statistically significant differences between TEP and TAPP RIH groups[23]. Choi and colleagues have demonstrated that operative complications in the form of peritoneal tearing happened at a higher rate in the RIH group than the primary group (*P<0.001*)[24]. In contrast, Sreekanth displayed that there were no possible intraoperative adverse events recorded in both groups (TEP and TAPP), while the preceding records revealed tissue and vessel injury, and mortality following the laparoscopy approach[25].

With regard to postoperative complications, no significant differences were recorded between both groups regarding wound-related complications (infection, hematoma) and cord lipoma. In agreement, Choi and colleagues revealed that adverse events, which include seromas and wound infections, were similar in both groups[24]. In contrast, Köckerling and colleagues demonstrated that there was a significant decrease in value for TEP compared to TAPP, however this was mostly owing to the changes in seroma frequency which is higher following TAPP group that was affected by the surgical approach, preceding open primary surgery and responded to conservative treatment[23].

Likewise, Aiolfi *et al*.[26] illustrated that there were no significant differences between both groups concerning wound-related complications. Also, Wei *et al*.[27] carried out their study to compare between both approaches and revealed no significant difference with regard to the adverse events and cost between both groups.

Regarding rerecurrence, we have demonstrated that there was no significant difference between both groups as regards recurrence rate (only one case in the TEP group) (*P=0.4*). Köckerling and colleagues also revealed that there was no statistically significant difference between both groups in the context of rerecurrence frequency following recurrent IHR following TEP and TAPP[23]. Similarly, Chen and colleagues and Köckerling and colleagues have displayed that, in their formerly documented studies recording comparable incidence of RIH for TEP and TAPP approaches[23,28]. Also, Wei and colleagues have displayed that there was no significant difference in terms of RIH between the two groups[27]. Additionally, Tyur *et al*.[29] have revealed that there were no statistically significant differences between TEP and TAPP with regards to recurrence rate.

On the contrary, Choi and colleagues reported three (0.28%) cases of RIH happened; two (2%) in the RIH group, and the other happened in the primary hernia group (0.1%) and the difference was statistically significant difference (*P=0.001*)[24]. As regards OT, our study illustrated that OT was significantly increased in the TAPP group than the TEP group (49.27±7.88 vs. 39.68±6.08) (*P<0.001*). Also, they revealed that OT was prolonged (*P<0.001*) for the RIH group than the primary hernia group (28.31 vs. 24.39)[24].

In contrast, Aiolfi and colleagues have found that there were no significant differences between both groups as regards OT[26]. Also, Wei *et al*.[27] have demonstrated that there was no significant difference as regards operation time between the two groups. Surprisingly, Tyur *et al*.[29] have recorded higher OT in the TAPP group compared to the TEP (98.23±9.83 vs. 116.3±12.96) (*P>0.001*).

Concerning pain, our study displayed that POP was significantly increased in the TAPP group in comparison with the TEP group. While, Vinay and Balasubrahmanya have demonstrated that POP in laparoscopic TEP revealed pain score of; 1–2 score (minimal pain) in 39 (86.67%) patients, a 3–4 score (discomfort) in four (8.89%) patients, and 5–6 score (distress) in two (4.4%) patients. TAPP group displayed a pain score that comprised 37 (82.2%) patients 1–2 score, seven (15.56%) patients 3-4 score, and one (2.2%) patient had 5–6 score. In addition, no significant differences were documented between both groups concerning POP (*P=0.62*)[30].

Also, Aiolfi and colleagues have found that there were no significant differences among both groups as

regards operative pain[26]. In the same line, Köckerling and colleagues revealed that there was no statistically significant difference between both groups concerning postoperative pain[23]. Choi and colleagues also demonstrated that there was no statistically significant difference between the recurrent hernia group and the primary hernia group after TEP hernioplasty[24].

The discrepancies in the current study regarding operation time and pain scores could be explained by subgroup analysis performed by Wei *et al*.[27], who displayed that pain scores could be influenced by a lot of clinical parameters and OT was mostly detected by condition and surgeon's skills.

With regard to LOS, our study revealed that there was no significant difference between the groups as regards LOS (*P>0.05*). In accordance, Vinay and Balasubrahmanya have recorded that the average postsurgical LOS in laparoscopic TAPP and TEP groups were 2.48 and 2.16 days, respectively, with no significant difference (*P>0.05*). In addition, they have displayed that the mean periods to return to their everyday activities were 5.34 and 6.76 for TEP and TAPP groups, respectively (*P>0.05*)[30].

CONCLUSION

In the context of RIH, both TEP and TAPP repair seem to be efficient approaches with regard to low recurrence rate and minimal complications. However, TEP was associated with minimal pain and short OT.

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Author contribution: all authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Islam Hisham, Ahmed Negm, Hosam Elghadban, Magdy Basheer, and Mohamed Shetiwy. The first draft of the manuscript was written by Islam Hisham, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Decker E, Currie A, Baig MK. Prolene hernia system versus Lichtenstein repair for inguinal hernia: a meta-analysis. Hernia 2019; 23:541–546.
2. Flyckt RL, White EE, Goodman LR, Mohr C, Dutta S, Zanotti KM. The use of laparoscopy simulation to explore gender differences in resident surgical confidence. Obstet Gynecol Int 2017; 2017:1945801.
3. Ger R, Monroe K, Duvivier R, Mishrick A. Laparoscopic management of inguinal hernias-a preliminary report. In Operative Manual of Endoscopic Surgery. Berlin, Heidelberg: Springer Berlin Heidelberg; 1991. 246–253.
4. Dreuning K, Maat S, Twisk J, van Heurn E, Derikx J. Laparoscopic versus open pediatric inguinal hernia repair: state-of-the-art comparison and future perspectives from a meta-analysis. Surg Endosc 2019; 33:3177-3191.
5. Jeyakumar S, Chitrambalam TG, Chandrasekaran S. Glue versus suture for mesh fixation in open inguinal hernia repair. Int Surg J 2018; 5:1443–1448.
6. Garry R. The benefits and problems associated with minimal access surgery. Austr N Zeal J Obstetr Gynaecol 2002; 42:239–244.
7. Vãrcuæ F, Duåã C, Dobrescu A, Lazãr F, Papurica M, Tarta C. Laparoscopic repair of inguinal hernia TEP versus TAPP. Chirurgia (Bucur) 2016; 111:308–312.
8. Rao AMK. Transabdominal preperitoneal (TAPP) Vs total ext-raperitoneal (TEP) Laparoscopic inguinal hernia repair; a comparative study in terms of operative and postoperative complications. Cell 2014; 966:0300–3062527.
9. Zhou XL, Luo JH, Huang H, Wang YH, Zhang HB. Totally extraperitoneal herniorrhaphy (TEP): lessons learned from anatomical observations. Minim Invasive Surg 2021; 2021:5524986.
10. Taylor, K, Sonderman, KA, Wolf, LL, Jiang, W, Armstrong, LB, Koehlmoos, TP, Rice-Townsend, SE. Hernia recurrence following inguinal hernia repair in children. J Pediatr Surg 2018; 53:2214–2218.
11. El-Dhuwaib Y, Corless D, Emmett C, Deakin M, Slavin J. Laparoscopic versus open repair of inguinal hernia: a longitudinal cohort study. Surg Endosc 2013; 27:936–945.
12. Leblanc, K. Proper mesh overlap is a key determinant in hernia recurrence following laparoscopic ventral and incisional hernia repair. Hernia 2016; 20:85–99.

13. Amato B, Compagna R, Della Corte GA, Martino G, Bianco T, Coretti G, *et al*. Feasibility of inguinal hernioplasty under local anaesthesia in elderly patients. BMC Surg 2012; 12:1–3.

14. Burcharth J. The epidemiology and risk factors for recurrence after inguinal hernia surgery. Dan Med J 2014; 61:B4846.

15. Purkayastha S, Chow A, Athanasiou T, Tekkis P, Darzi. AInguinal hernia. BMC Clin Evid. 2008 Jul 16;2008:0412.

16. Jenkins JT, O'dwyer PJ. Inguinal hernias. BMJ 2008; 336:269–272.

17. Chen DC, Morrison J. State of the art: open mesh-based inguinal hernia repair. Hernia 2019; 23:485–492.

18. Maneck M, Köckerling F, Fahlenbrach C, Heidecke CD, Heller G, Meyer HJ, *et al*. Hospital volume and outcome in inguinal hernia repair: analysis of routine data of 133,449 patients. Hernia 2020; 24:747–757.

19. Aiolfi A, Cavalli M, Del Ferraro S, Manfredini L, Bonitta G, Bruni PG, *et al*. Treatment of inguinal hernia: systematic review and updated network meta-analysis of randomized controlled trials. Ann Surg 2021; 274:954–961.

20. Aiolfi A, Cavalli M, Micheletto G, Lombardo F, Bonitta G, Morlacchi A, *et al*. Primary inguinal hernia: systematic review and Bayesian network meta-analysis comparing open, laparoscopic transabdominal preperitoneal, totally extraperitoneal, and robotic preperitoneal repair. Hernia 2019; 23:473–484.

21. Niebuhr H, Köckerling F. Surgical risk factors for recurrence in inguinal hernia repair – a review of the literature. Innov Surg Sci 2017; 2:53–59.

22. Campanelli G. Basic research, experimental surgery and clinical research: where there is science, there is better treatment. Hernia 2020; 24:681–682.

23. Köckerling F, Bittner R, Kuthe A, Hukauf M, Mayer F, Fortelny R, Schug-Pass C. TEP or TAPP for recurrent inguinal hernia repair – register-based comparison of the outcome. Surg Endosc 2017; 31:3872–3882.

24. Choi YY, Kim Z, Hur KY. Laparoscopic total extraperitoneal repair for incarcerated inguinal hernia. J Korean Surg Soc 2011; 80:426-430.

25. Sreekanth KT. Comparative study of complications following laparoscopic TEP versus TAPP versus open hernioplasty in inguinal hernia repair (doctoral dissertation). Chennai: Stanley Medical College.

26. Aiolfi A, Cavalli M, Del Ferraro S, Manfredini L, Lombardo F, Bonitta G, *et al*. Total extraperitoneal (TEP) versus laparoscopic transabdominal preperitoneal (TAPP) hernioplasty: systematic review and trial sequential analysis of randomized controlled trials. Hernia 2021; 25:1147–1157.

27. Wei FX, Zhang YC, Han W, Zhang YL, Shao Y, Ni R. Transabdominal preperitoneal (TAPP) versus totally extraperitoneal (TEP) for laparoscopic hernia repair: a meta-analysis. Surg Laparosc Endosc Percutan Tech 2015; 25:375–383.

28. Chen LS, Chen WC, Kang YN, Wu CC, Tsai LW, Liu MZ. Effects of transabdominal preperitoneal and totally extraperitoneal inguinal hernia repair: an update systematic review and meta-analysis of randomized controlled trials. Surg Endosc 2019; 33:418–428.

29. Tyur AM, Orban YA, Sallam AM, Sarhan AA. Laparoscopic totally extra-peritoneal (TEP) versus transabdominal pre-peritoneal (TAPP) inguinal hernioplasty. Egypt J Hosp Med 2022; 87:1421–1426.

30. Vinay G, Balasubrahmanya K. Comparative study on laparoscopic transabdominal pre-peritoneal (TAPP) mesh repair and total extra-peritoneal (TEP) repair in inguinal hernia. Madridge J Surg 2018; 1:9–13.