Comparative study between transabdominal preperitoneal laparoscopic repair of inguinal hernia: totally sutured technique versus using tacks technique

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Received: 13 April 2022
Revised: 28 April 2022
Accepted: 08 May 2022
Published: 04 January 2023

The Egyptian Journal of Surgery 2023, 41:781–788

Background
There are different options for mesh fixation and peritoneal flap (PF) closure in the laparoscopic transabdominal preperitoneal (TAPP) approach for inguinal hernia repair. There is no best operative technique with wide variations in these options. In our study, we aimed to compare the outcomes of totally sutured technique (for mesh fixation and PF closure) and the tacks technique in TAPP laparoscopic inguinal hernia repair regarding operative time, cost benefits, and postoperative complications.

Patients and methods
This is a prospective randomized controlled study performed at Ain Shams University Hospitals between February 2019 and February 2022. It included 80 patients diagnosed as having an inguinal hernia and underwent laparoscopic TAPP repair. The patients were divided equally into two groups according to the method of mesh fixation and PF closure: group A: totally tacks and group B: totally sutured.

Results
We had a highly significant difference between both groups regarding operative time (87.5 min in group A vs. 117 min in group B). We had a nonsignificant difference between both groups regarding operative complications. Both groups did not show a significant difference in the hospital stay (25.6 h in group A vs. 23.6 h in group B). There was a nonsignificant difference between both groups in inguinoscrotal edema/hematoma, surgical-site infection, and recurrence. There was a nonsignificant difference between both groups in early postoperative pain, while the late pain was significantly less in the suture group. Regarding the cost analysis, group B was cost-effective compared with group A.

Conclusion
Although the totally sutured technique (for mesh fixation and PF closure in laparoscopic TAPP inguinal hernia repair) was a significantly longer in operative time, it provided a significant improvement in late postoperative pain with a significantly lower cost than the tack technique with no significant difference in recurrence at short-term follow-up.

Keywords:
laparoscopic hernia repair, mesh fixation, peritoneal flap closure, transabdominal preperitoneal repair

Egyptian J Surgery 2023, 41:781–788

1110-1121

Introduction

Inguinal hernias account for 75% of abdominal-wall hernias with a lifetime risk of 27% in males and 3% in females [1]. There are many approaches for inguinal hernia repair. American College of Surgeons and National Institute of Clinical Excellence consider tension-free repair (Lichtenstein repair) as the gold standard for open-hernia repair [2,3].

After the introduction of tension-free repair for inguinal hernia with the use of polypropylene mesh, recurrence rates decreased to be less than 5% with an improvement in patient satisfaction better than that obtained by the traditional tension-producing techniques [4]. Although open tension-free repair remains the gold standard for hernia repair, laparoscopic repair in the hands of experienced surgeons has an excellent result in comparison with open repair [5].

Laparoscopic inguinal hernia repair was first described by Ger, and it was preferred for its advantages with the

easier repair of a recurrent hernia, reduced recovery time with earlier return to full activity, less immediate and chronic pain, the ability to manage bilateral hernias, the performance of a simultaneous diagnostic laparoscopy, and improved cosmoses [6].

There are different techniques for laparoscopic repair of inguinal hernias, the most common ones are transabdominal preperitoneal (TAPP) repair and totally extraperitoneal (TEP) repair [3]. Laparoscopic repair by the TAPP approach (first reported by Arregui and colleagues) involves laparoscopic dissection of the preperitoneal space and placement of a large mesh along the posterior abdominal wall, thereby covering the hernia posterior to the defect. The two principal steps in TAPP repair are good fixation of the mesh without rolling beside closure of peritoneal flap (PF) to cover the mesh completely [7].

There are many options for mesh fixation and PF closure, including tacks (nonabsorbable or absorbable), sutures, self-fixing meshes, and glues. However, there is no agreement about the best option, and the choice of options often depends on surgeons' personal preference [8].

The aim of this study was to compare the outcome of totally sutured technique (for mesh fixation and PF closure) and the totally tacks technique in laparoscopic TAPP inguinal hernia repair regarding operative time, cost benefits, and postoperative complications.

Patients and methods

Study design

This study was a prospective randomized controlled study performed at Ain Shams University Hospitals between February 2019 and February 2022. It included 80 patients with an inguinal hernia who underwent laparoscopic TAPP repair. All cases were operated on by the same surgical team. The study was approved by the Ethical Committee of the General Surgery Department and written informed consent was obtained from all participants after receiving an explanation of the study.

Eligibility criteria

We included cases with primary unilateral inguinal hernia (direct or indirect), male or female, and with ages between 18 and 65 years old. And we excluded the cases with prior pelvic surgery or surgery in the preperitoneal space, cases with bilateral or recurrent inguinal hernias, cases with complicated inguinal hernia, and concomitant laparoscopic surgery with hernia repair (as cholecystectomy). Also, we excluded cases with contraindications for laparoscopy (such as bleeding tendency and decompensated cardiac or respiratory disease), cases with American Society of Anesthesia score III, IV, or V (unfit for general anesthesia).

Then, the included cases were divided by randomized method (closed envelops) into two groups, group A: the control group included 40 patients who underwent laparoscopic TAPP repair by totally tacks, and group B: the experimental group included 40 patients who underwent laparoscopic TAPP repair by totally sutured.

Preoperative assessment

Full clinical history and clinical examination (general and local) were done in all cases to diagnose the inguinal hernia. Routine preoperative blood tests (complete blood picture, coagulation profile, liver, and kidney-function tests), and pelviabdominal ultrasound were done in all cases to confirm the diagnosis.

Surgical technique

All cases were instructed to void the urine immediately before the surgery. General anesthesia was administered routinely. The patient was positioned in a supine Trendelenburg position tilting the table to the opposite side of the hernia with adducted both arms. The monitor was placed caudally at the patient's feet, and the surgeon stands at the opposite side of the hernia, while the assistant surgeon stands at the ipsilateral side. After draping the skin of the abdomen, genitalia, and upper thighs, insufflation of the abdomen was created by introducing a veress needle to the left subcostal region. Then, a 10-mm port for the camera (30° angled laparoscope) was introduced at the umbilicus and two additional 5-mm ports were introduced bilaterally in a horizontal plane with the umbilicus. First, laparoscopic exploration of the intra-abdominal cavity and both inguinal regions was done to confirm the diagnosis, the type, and the bilaterality of the hernia. The inguinal peritoneum was marked by diathermy at the site of incision from the anterior–superior iliac spine to the lateral-edge medial umbilical ligament, 2 cm above the internal ring. Incision of the peritoneum was done at this marked line by hook diathermy above the internal ring preserving the inferior epigastric vessels (IEVs). Then, dissection (blunt and sharp) was done in the avascular preperitoneal space to create PF. This dissection was achieved medial to IEVs reaching the symphysis pubis, Cooper's ligament, and iliopubic tract and then lateral to IEVs exposing the iliopsoas muscle with overlying nerves (the femoral branch of the genitofemoral and lateral cutaneous nerves of the thigh). Then, in indirect hernia cases, the sac was dissected from the spermatic cord structures in male patients (vas deferens and gonadal vessels), while in female patients, the round

ligament was clipped and divided. Dissection of the indirect hernia sac was done carefully to preserve the cord structures and the testis in cases of inguinoscrotal hernias. While in direct hernia cases, the sac was dissected from the transversalis fascia. Dissection was limited inferiorly to the iliopubic tract to avoid triangles of doom and pain. The hernia sac was well dissected and reduced enough to avoid rolling of the inferior edge of the mesh. In cases with a large inguinoscrotal hernia sac, it was difficult and dangerous to mobilize the whole sac, so herniotomy was done (Fig. 1).

After dissection of the PF, a 10×15-cm multifilament polypropylene mesh (Prolene; Ethicon, New Jersey, USA) was placed and fixed. In group A, it was fixed by 3–5 nonabsorbable tacks (ProTack 5 mm; Covidien), the first tack at Cooper's ligament and the others at the upper part of the mesh above the iliopubic tract. While in group B, it was fixed by two sutures (polypropylene 2/0, Prolene; Ethicon), one at Cooper's ligament and the other at the upper part of the mesh above the iliopubic tract (Fig. 2). The PF was closed over the mesh using nonabsorbable tacks in group A, while in group B, it was closed by sutures (vicryl 2/0; Ethicon), in a continuous manner (Fig. 3). We did not leave any gaps with peritoneal closure to avoid the possibility of bowel herniation and obstruction. Decompression of the abdomen was done under vision with compression of the scrotum to deflate both abdominal and scrotal cavities.

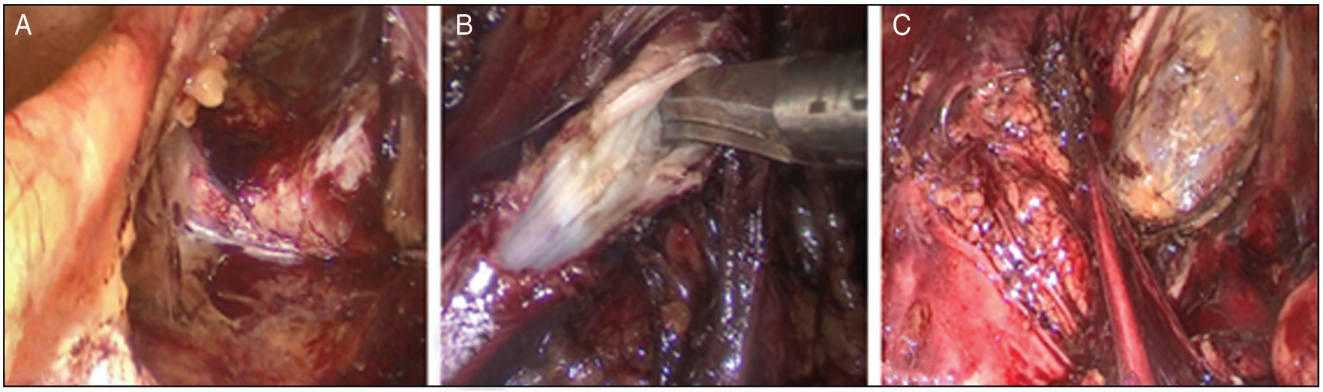
Postoperative assessment

Patients started oral fluids once audible intestinal sounds and good intravenous analgesics were administered. Dressing of port wounds was done and patients were discharged after one day of postoperative admission, unless complication was suspected.

Follow-up

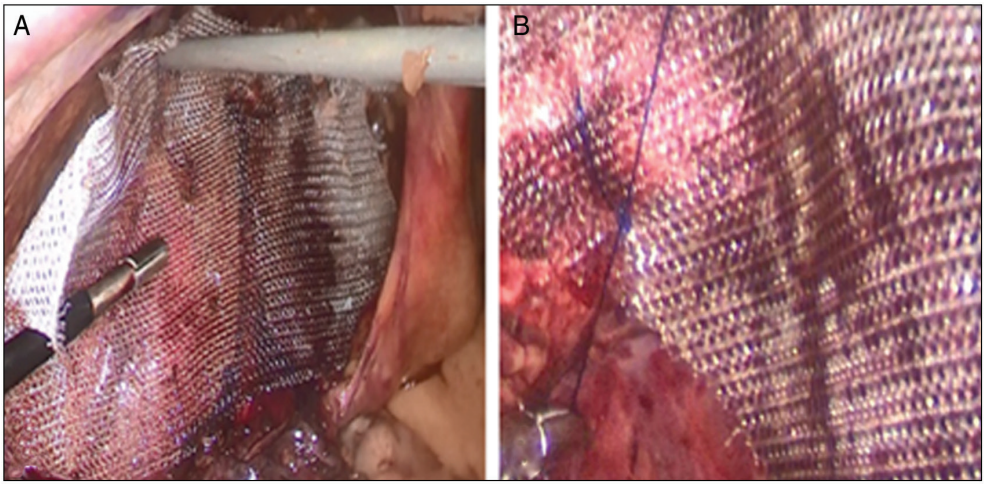
Patients were followed up after discharge in the outpatient clinic at 1 week, 1 month, 2 months, 3 months, 6 months, and 12 months to assess surgical-

Figure 1



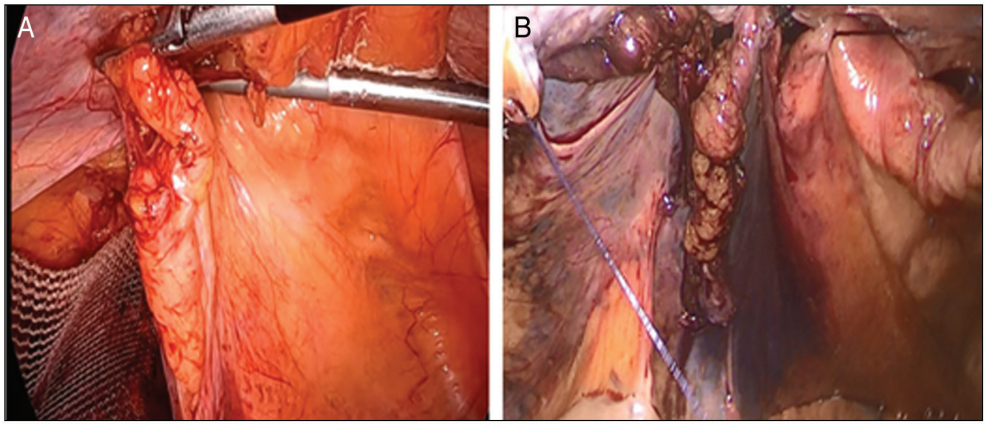
(a) Medial dissection till pubic bone. (b) Dissection of the sac and then herniotomy. (c) Complete dissection of the sac.

Figure 2



(a) Mesh fixation with tack. (b) Mesh fixation with prolene suture.

Figure 3



(a) Closure of PF with tack. (b) Closure of PF with vicryl suture. PF, peritoneal flap.

site complications, early and late postoperative pain, and recurrence of the hernia.

Data collection and outcome

We collected the following data from our cases: patient characteristic data (age, sex, BMI, diabetes mellitus, smoking, chronic obstructive pulmonary disease, and type and side of the hernia), the operative data (operative time, intraoperative complications such as bleeding or bowel and urinary bladder injury, and conversion from laparoscopic to open technique and from sutures to tacks technique), and the postoperative data [postoperative pain by using visual analog scale (VAS), hospital stay, surgical-site infection (SSI), inguinoscrotal edema or hematoma, cost analysis, and recurrence].

Postoperative pain was defined as pain involving the groin, scrotum, or thigh. VAS is a validated, subjective measure for acute and chronic pain. Scores were recorded by making a handwritten mark on a 10-cm line that represents a continuum between no pain and worst pain.

Cost analysis was done with our local currency (Egyptian pound) and converted to American dollar. We depended on the cost of material used for mesh fixation and PF closure because all other costs of laparoscopy, medications, mesh type, and hospitalization are almost the same in both techniques. Recurrence was detected clinically and confirmed by ultrasound. Then, all the previous data were collected to compare both techniques.

Data management and analysis

Data were revised, coded, entered on a computer, and analyzed using SPSS, version 26 for Windows (SPSS Inc., Chicago, Illinois, USA). Quantitative data were described as mean and SD. Student *t* test was used for comparing quantitative variables between two study groups. χ^2 and Fisher exact tests were used to test the association between qualitative variables. *P* value less than or equal to 0.05 was considered significant and *P* value less than or equal to 0.001 was considered highly significant.

Results

Our study included 80 cases of laparoscopic TAPP repair of inguinal hernia. Patients were divided into two groups (40 patients in each), group A (totally tacks) and group B (totally sutured). There was a nonsignificant statistical difference in both groups regarding the demographics of the patients, comorbidities, and preoperative data as shown in Table 1.

The operative time showed a highly significant difference in favor of group A than group B (87.5 vs. 117 min, respectively). Regarding the intraoperative complications, we had one (2.5%) case of intraoperative bleeding in group B (due to IEV injury and controlled by clips) versus no cases in group A with a nonsignificant difference. We did not have any cases of bowel or bladder injuries in our study. All cases were completed laparoscopically with no open conversion (Table 2).

Regarding the postoperative data, we did not have a significant difference between both groups in the hospital stay (25.6 h in group A vs. 23.6 h in group B). There was a nonsignificant difference between both groups in inguinoscrotal edema/hematoma and SSI. The cases of SSI were due to mesh infection that was suspected by groin pain and edema and confirmed by ultrasound. All cases of inguinoscrotal edema/hematoma and SSI were successfully managed conservatively by antibiotics and anti-edema medication with no readmission. We had only one (2.5%) case of recurrence in group A versus

Table 1 Patients' demographics, comorbidities, and preoperative data

Variables	Group A (totally tacks) (40)	Group B (totally sutured) (40)	Test value	*P* value	Significance
Age (mean ±SD)	40 ± 10.61	37.15 ± 12.81	1.179	0.242*	NS
Sex [*n* (%)]					
Male	39 (97.5)	40 (100)	1.013	0.314**	NS
Female	1 (2.5)	0			
BMI (mean±SD)	31.4 ± 4.76	33.23 ± 4.57	1.750	0.084*	NS
ASA score [*n* (%)]					
ASA1	33 (82.5)	30 (75)	0.672	0.412**	NS
ASA2	7 (17.5)	10 (25)			
Smoking [*n* (%)]	14 (35)	9 (22.5)	1.526	0.217**	NS
COPD [*n* (%)]	2 (5)	4 (10)	0.346	0.556**	NS
DM [*n* (%)]	6 (15)	9 (22.5)	0.738	0.390**	NS
Type of the hernia (inguinal/inguinoscrotal) [*n* (%)]					
Inguinal	30 (75)	34 (85)	1.250	0.264**	NS
Inguinoscrotal	10 (25)	6 (15)			
Side of the hernia [*n* (%)]					
Right	18 (45)	21 (52.5)	0.450	0.502**	NS
Left	22 (55)	19 (47.5)			
Type of the hernia (direct/indirect/pantaloon) [*n* (%)]					
Indirect	35 (87.5)	33 (82.5)	1.877	0.391**	NS
Direct	4 (10)	7 (17.5)			
Pantaloon	1 (2.5)	0			

ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; NS, nonsignificant.
*Student *t* test.
**χ^2 test.

Table 2 Intraoperative data

Variables	Group A (totally tacks) (40) [*n* (%)]	Group B (totally sutured) (40) [*n* (%)]	Test value	*P* value	Significance
Operative time mins (mean±SD)	87.5 ± 2.36	117 ± 4.39	38.084	<0.001*	HS
Bleeding [*n* (%)]	0	1 (2.5)	1.013	0.314**	NS

HS, highly significant; NS, nonsignificant.
*Student *t* test.
**χ^2 test.

Table 3 Postoperative complications and recurrence

Variables	Group A (totally tacks) (40) [*n* (%)]	Group B (totally sutured) (40) [*n* (%)]	Test value	*P* value	Significance
Hospital stay in hours (mean±SD)	25.6 ± 2.59	23.6 ± 2.82	3.305	0.001*	NS
Scrotal edema or hematoma	3 (7.5)	2 (5)	0.213	0.644**	NS
SSI	3 (7.5)	1 (2.5)	0.346	0.556**	NS
Recurrence	1 (2.5)	0	00	1.000**	NS

NS, nonsignificant; SSI, surgical-site infection.
*Student *t* test.
**χ^2 test.

no cases in group B (Table 3). The case of recurrence underwent open-repair surgery. Regarding the cost analysis, each case in the tack group needed one tack gun that costs 530$, while each case in group B needed one prolene suture and one vicryl suture (10$).

Postoperative pain was controlled by nonsteroidal anti-inflammatory medications in all cases with no need for opioids. By using VAS for postoperative pain assessment, there was no significant difference between both groups from the first postoperative day up to 2 months, but there was a significant difference in favor of the suture group from 3 months to 1 year postoperative as shown in Table 4.

Discussion

The laparoscopic approach became the preferred choice in inguinal hernia repair, especially in recurrent and bilateral hernias [9]. With increasing the number of laparoscopically operated inguinal hernias, many questions aroused regarding the postoperative

Table 4 Postoperative visual analog scale score

Pain VAS score (mean±SD)	Group A (totally tacks) (40)	Group B (totally sutured) (40)	Test value	*P* value	Significance
Before discharge	2.43±0.71	2.15±0.58	1.894	0.062*	NS
1 week	1.38±0.49	1.18±0.55	1.718	0.090*	NS
1 month	0.83±0.68	0.75±0.59	0.530	0.598*	NS
2 months	0.55±0.55	0.38±0.49	1.499	0138*	NS
3 months	0.3±0.46	0.1±0.31	2.280	0.026*	S
6 months	0.2±0.41	0.05±0.22	2.056	0.043*	S
12 months	0.15±0.36	0.025±0.16	2.003	0.049*	S

NS, nonsignificant; S, significant; VAS, visual analog score.
*Student *t* test.

recurrence and complication rates, especially postoperative pain [10]. This prospective study was the first one comparing the outcomes of the totally sutured technique (for mesh fixation and PF closure) and the totally tacks technique in laparoscopic TAPP inguinal hernia repair regarding operative time, cost benefits, and postoperative complications.

Regarding the mean operative time in our study, we had a highly significant difference between both groups in favor of the tack group (87.5 min in tack groups vs. 117 min in the suture group). The ergonomics of intracorporeal knotting of prolene suture in mesh fixation need more time than tacking or even transfascial extracorporeal knotting. In a study conducted by Ross and colleagues (a prospective comparative study between tack, suture, and staplers for PF closure in laparoscopic TAPP), their mean operative time in tack cases was 108 min (more than ours, but they had 61.2% of tack cases with bilateral hernia while we excluded them from our study). While their mean operative time in suture cases was 97 min, less than ours, but they used tacks for mesh fixation [11].

In our study, we had only one (2.5%) case in the suture group with intraoperative bleeding due to IEV injury. Otherwise, we did not have other intraoperative complications such as bowel, urinary bladder, and neurovascular injuries. These complications are mostly noncommon with well-experienced surgeons. In many studies conducted in laparoscopic inguinal hernia repairs (TAPP or TEP with different methods of mesh fixations or PF closure), they did not develop any intraoperative complications [11–13]. In a study conducted by Yu *et al.* [14] (a comparative study between tack and glue for mesh fixation in laparoscopic TEP hernias), they had only 0.3% of their cases with IEV injury. The awareness with abnormal obturator artery and triangles of pain and doom was the main factor for uncommon intraoperative complications.

Regarding the mean hospital stay, we had a nonsignificant difference between both groups (25.6 h in the tack group vs. 23.6 h in the suture group). And this result matched with many studies such as the one by Yu *et al.* [14], in which their main hospital stay in the tack group was 21.2 h and in the glue group was 23.7 h. In Darwish *et al.* [13] study (a prospective comparative study between fixation and nonfixation of mesh in laparoscopic TAPP), their mean hospital stay in laparoscopic TAPP repair with tack was 1.9 days. Laparoscopic inguinal hernia is a day-case surgery due to less postoperative pain and wound complications [3].

Regarding the postoperative complication in our study, there was no significant difference between both groups in scrotal edema/hematoma (7.5% in tack group vs. 5% in suture group) and SSI (7.5% in tack group vs. 2.5% in suture group). In Yu *et al.* [14] study, they had 13.9% of tack groups with postoperative seroma or hematoma. In Kumar *et al.* [12] study (a prospective comparative study between tack and transfascial suture for mesh fixation in laparoscopic TEP), they had a nonsignificant difference between tack and suture groups in postoperative seroma and SSI (5% in tack group vs. 4% in suture group), and these results are close to ours. In Ross *et al.* [11] study, their overall postoperative complications were 4.9% slightly less than ours. In our study, the suture group was cost-effective compared with the tack group.

Regarding postoperative pain, we used the VAS score that is a simple score for postoperative pain assessment, and we did not find a significant difference between both groups in early pain (up to 2 months postoperative), while the pain score was significantly less in suture group at 3, 6, and 12 months postoperative. Chronic inguinodynia is the most common and annoying complication after inguinal hernia repair. There are many factors contributing to this problem as mesh placement (especially heavyweight, multifilament mesh), which can produce an inflammatory response, sutures or tacks for mesh fixation, and PF closure, which may cause nerve entrapment, hematoma or osteitis, and missed lipoma in the inguinal canal [10,15].

In Darwish *et al.* [13] study, they found that early and late pain was significantly higher with mesh fixation than with nonfixation. In another study conducted by Langenbach and Berengolts [10], they found that the pain decreased significantly with lightweight absorbable mesh. Moreover, the type of mesh fixation and PF closure (penetrating or not, permanent or not) is a predictor for postoperative pain, especially late pain [16]. Penetrating methods such as tack or sutures may cause nerve entrapment, hematoma, or osteitis more than nonpenetrating ones [16]. In Ross *et al.* [11] and Alabi *et al.* [16] studies, they found that chronic pain was significantly less with glue fixation than with tack. Theoretically, permanent fixation can produce more pain than the nonpermanent one such as absorbable tack, but in a study done by Andresen *et al.* [17], they had a nonsignificant difference between permanent and nonpermanent method of mesh fixation in chronic pain after laparoscopic TAPP repair.

When comparing the tack and suture fixation in postoperative pain, we considered the late pain more than the early one because early pain is more subjective and may be postulated to other factors. In literature, there was a variation between tack and suture in early and late pain, some showed a significant difference between both methods in favor of suture, and some showed a nonsignificant difference. In Kumar *et al.* [12] study, the pain started to be significantly higher in tack after 1 month, but at 6 months, there was no significant difference between both methods. While in Ross *et al.* [11] study, the difference in pain became nonsignificant between both methods after 1-month postoperative. In Oguz *et al.* [18] study (comparative study between tack and suture for PF closure in laparoscopic TAPP), the difference became nonsignificant after 1 week. In our study, although VAS score decreased over time in both groups to accepted low result, it was significantly less in the suture group from 3 months up to 12 months of follow-up, mostly because all previous studies used transfascial extracorporeal knotting, while we used intracorporeal one that may be less tight knot decreasing the incidence of nerve entrapment. Moreover, these different studies used different methods for pain analysis.

We had no significant difference between both groups in recurrence [only one (2.5%) case in the tack group]. The recurrence in laparoscopic inguinal hernia repair is relatively low (0–4%) [18]. The main predisposing factors of recurrence are an improper surgical technique for dissection of a wide PF for proper mesh placement covering all hernia defects, mesh folding or twisting, missed hernias, or mesh lifting secondary to hematoma formation and improper PF closure [16]. Many studies showed that neither mesh fixation, type of mesh nor method of fixation, or PF closure were significant factors for hernia recurrence after laparoscopic inguinal hernia repair operated by a well-experienced surgeon [12,13,18].

A relatively small sample size and short-term follow-up were the limitations in our study. Also, more objective scores (than VAS), including the return to normal activity, can be used for better postoperative assessment. We think that with larger sample size, more objective score, and longer follow-up duration, our result will become more solid statistically.

Conclusion

Although the totally sutured technique (for mesh fixation and PF closure in laparoscopic TAPP inguinal hernia repair) was a significantly longer in operative time, it provided a significant improvement in late postoperative pain with a significantly lower cost than the tack technique with no significant difference in recurrence at short-term follow-up.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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