Tzu Chi Medical Journal 2019; 31(4): 244–253

Original Article

Comparison of short- to mid-term efficacy of nonfixation and permanent tack fixation in laparoscopic total extraperitoneal hernia repair: A systematic review and meta-analysis

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Received : 21-Feb-2018
Revised : 04-Apr-2018
Accepted : 18-Apr-2018

Abstract

Objective: We systematically reviewed the literature and pooled data for a meta-analysis to compare the efficacy and safety of mesh fixation and nonfixation in laparoscopic total extraperitoneal (TEP) hernia repair. **Materials and Methods:** We performed a systematic search of PubMed® and a Cochrane review for all randomized controlled trials that compared the efficacy and complications of mesh fixation versus nonfixation in TEP hernia repair. The evaluated outcomes included perioperative (operative time and conversion rate) and postoperative parameters (pain scores, duration of hospital stay, surgical complications including seroma, delayed return of bladder function, chronic pain, and recurrence). Cochrane Collaboration Review Manager Software (RevMan®, version 5.2.6) was used for statistical analysis. **Results:** Ten trials met the inclusion criteria and were included in a pooled analysis. In total, 1099 patients (1467 hernias) had received TEP hernia repair (748 and 719 hernia defects in the nonfixation and fixation groups, respectively). The nonfixation group required shorter operative time (weighted mean difference [WMD] = −2.36 min, $P = 0.0006$) and had less pain on postoperative day 1 (WMD = −0.44, $P = 0.04$) than the fixation group. No significant differences were observed between groups with regard to conversion rate, hospital stay, recurrence rate, or complication rate. However, the incidence of postoperative urine retention was higher in the fixation group (odds ratio = 0.26, $P = 0.03$). **Conclusion:** For patients with a nonrecurrent uncomplicated hernia defect with the size <3 cm, nonfixation yielded comparable efficacy with mesh fixation, but less short-term postoperative pain, and a lower risk of urine retention. In addition, the nonfixation method involved a shorter operative time and lower costs. However, no difference in the incidence of chronic pain was observed.

Keywords: *Fixation, Inguinal hernia, Laparoscopy, Total extraperitoneal*

Introduction

The laparoscopic approach is characterized by a recurrence rate equivalent to that of open hernia repair, and it ensures better convalescence and less postoperative discomfort [1,2]. Despite these advantages, some patients experience short-term postoperative groin discomfort, sometimes progressing to chronic pain. The titanium tack used for mesh fixation is associated with nerve injury that causes postsurgical groin pain. Therefore, several alternative methods such as fibrin glue and an absorbable tack have been adopted to reduce postoperative groin pain. Reviewing the literature about the fixation methods in total extraperitoneal (TEP), three meta-analyses have evaluated the benefits of fixing the mesh with fibrin glue and concluded that there was a lower incidence of chronic pain without compromising efficacy [3-5]. One retrospective study compared the result of fibrin glue with absorbable tacks [6].

Nonfixation of the mesh is considered a means of avoiding fixation device-associated chronic pain, but the higher risk of recurrence has been the main concern among surgeons. Sajid *et al*. and Teng *et al*. have performed meta-analyses to compare efficacy and safety between fixation and nonfixation methods, and they both concluded that the nonfixation group showed no observable benefit with regard to postsurgical pain [7,8]. However, these findings have been challenged due to heterogeneity in the surgical approaches and the small

Access this article online

Quick Response Code:

Website: www.tcmjmed.com

DOI: 10.4103/tcmj.tcmj_47_18

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How to cite this article: Lo CW, Tsai YC, Yang SS, Hsieh CH, Chang SJ. Comparison of short- to mid-term efficacy of nonfixation and permanent tack fixation in laparoscopic total extraperitoneal hernia repair: A systematic review and meta-analysis. Tzu Chi Med J 2019;31(4):244-53.

number of enrolled patients. Sajid *et al*. enrolled patients who had received either transabdominal preperitoneal (TAPP) or TEP hernia repair and did not perform a subgroup analysis [7], whereas Teng *et al*. enrolled only patients who had received TEP surgery but included only small number of patients [8]. The controversy has not subsided, and more randomized controlled studies have addressed the topic. We performed an updated systematic review of the literature and a meta-analysis to compare the surgical efficacy and safety of fixation and nonfixation methods in laparoscopic TEP hernia repair.

Materials and Methods

Literature review

The strategies for searching and selecting the studies complied with the rules in the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement explanation, elaboration document, and checklist. Studies were identified by searching in PubMed® (date range: January 1990 to April 2016).

We used the terms "hernia or hernioplasty" and "fix or fixation or stapled or tack or staple" as keywords for a literature search in February 2018. The Medical Subject Headings terms including ventral hernia, incisional hernia, trauma, and umbilical hernia were excluded. We also searched the references of SAGES guidelines and the guidelines of the Hernia Surge Group.

Study selection

Randomized controlled trials (RCTs) comparing patients who had undergone laparoscopic TEP hernia repair with or without mesh fixation were included in the study.

Data extraction and quality assessment

We extracted the following information from each study: Patient characteristics (age, sex, body mass index, and laterality), study design, method of approach, inclusion and exclusion criteria, perioperative parameters (operative time, conversion to open surgery, and location and type of hernia), postoperative pain scale, length of hospital stay, time to return to daily activity, postoperative complications (seroma or hematoma, acute urine retention, and recurrence), and follow-up period. Two authors, C.W. Lo and S.J. Chang, evaluated the quality of the studies. The risk of bias in the included trials was assessed according to the following: Allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and random sequence generation.

Data synthesis and analysis

The end-points synthesized for analysis included operative time, length of hospital stay, time to return to daily activity, pain scale, and recurrence. We conducted the analysis using a statistical package (Review Manager®, version 5.2.6, Cochrane Collaboration, Oxford, England). Meta-analysis was performed using the fixed-effect method if no significant heterogeneity existed. The random effect method was used when statistically significant heterogeneity was present ($P < 0.10$). The continuous variables and dichotomous outcomes are presented as a weighted mean difference (WMD) and odds ratios (ORs), respectively, in the summary statistics. Chi-square statistical tests (Q statistics) and an I^2 test were used to assess heterogeneity among controlled trials.

Results

Figure 1 depicts the flowchart for searching, screening, and selecting published studies. The initial search strategy yielded 446 abstracts. After excluding 410 titles or abstracts that were irrelevant to the study topic, we retrieved the full text of 36 studies for evaluation. Case reports, review articles, and meta-analyses were excluded. Two studies enrolling TAPP hernia repair patients were also excluded. We also included one study from the reference of the enrolled studies [9]. Finally, 10 comparative trials were included for subsequent analysis [9-18].

In total, 1099 patients with 1467 hernia defects (748 hernia defects in the nonfixation group and 719 hernia defects in the fixation group) were included in the pooled analysis. Table 1 presents the designs and inclusion/exclusion criteria of the studies as well as a comparison of baseline patient characteristics between the fixation and nonfixation groups. Perioperative parameters, medical devices, and mesh size and content are shown in Table 2.

Perioperative parameters

The perioperative parameters, including operative time, conversion rate, postoperative pain score, chronic pain, seroma or hematoma, urine retention, time to return to daily activity, and recurrence reported by the included trials, are listed in Table 2.

Operative time

Among the included studies, Moreno-Egea *et al*. reported the operative time for unilateral and bilateral hernia [11]. Ferzli *et al*. and Taylor *et al*. did not report the standard deviation, and were excluded from the pooled analysis [10,14]. There were six studies included in the pooled analysis comparing operative time. There was no significant heterogeneity among the trials ($\chi^2 = 4.01$, $P = 0.68$, $I^2 = 0\%$). Operative time was longer in the mesh fixation group (WMD = 2.26 min, 95% confidence interval [CI] = −3.71 to −1.01, $Z = 3.42$, $P = 0.0006$) [Figure 2a].

Postoperative pain

Seven studies reported the postoperative pain scale. Garg *et al*., Koch *et al*., and Buyukasik *et al*. adopted different pain score scales and were not included in the pooled analysis [13,15,18]. Garg *et al*. used a pain scale from 1 (no pain) to 5 (unbearable pain) [15], whereas Koch *et al*. adapted the Likert scale and Buyukasik *et al*. adapted the Numeric Rating Scale to evaluate postoperative pain [13,18].

Four studies reported the visual analog scale (VAS) score on postoperative day 1 (POD1) [9,11,12,17]. The pooled results revealed moderate heterogeneity among the trials ($\chi^2 = 7.47$, $P = 0.06$, $I^2 = 60\%$) and significantly less pain on POD1 in the nonfixation group (WMD = −0.44, $Z = 2.11$, $P = 0.04$) [Figure 2b].

Only two studies reported the VAS score at POD7. The pooled results showed low heterogeneity among the trials ($\chi^2 = 0.00$, $P = 0.95$, $I^2 = 0\%$) [Figure 2c], and there was no significant difference in the pain scale on POD7.

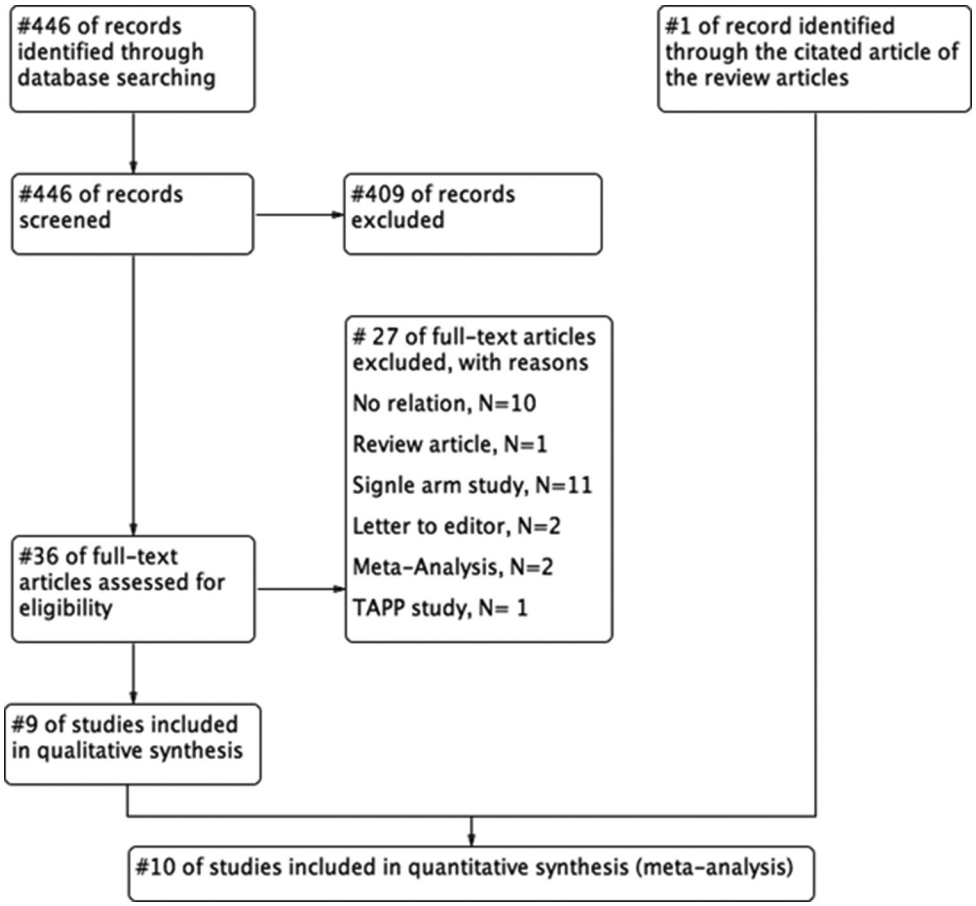

Figure 1: Flowchart for selection of trials

Chronic pain

Only three studies reported the incidence of chronic pain, with varying definitions. Moreno-Egea *et al*. defined chronic pain as the presence of pain in the inguinal/scrotal/mid-thigh area, as reported by patients and located through physical examination [11]. Parshad *et al*. defined it as pain lasting for >8 weeks in the vicinity of the repair or along the endangered nerve territory that required an analgesic or hindered physical activity [12]. Koch *et al*. did not specifically define chronic pain [13]. The pooled results disclosed no significant heterogeneity among the trials (χ^2 = 0.23, P = 0.63, I^2 = 0%). There was no significant difference with regard to the incidence of chronic pain (OR = 1.80, 95% CI = 0.45–7.13, P = 0.41) [Figure 2d].

Time to return to daily activity

Four studies reported the time needed to return to daily activity [9,10,12,15]. There was no significant heterogeneity among the trials (χ^2 = 2.56, P = 0.46, I^2 = 0%) or significant differences in the time to return to daily activity between the two groups (WMD = 0.03 days, Z = 0.21, P = 0.83) [Figure 3a].

Complications and conversions

Conversion

Except for Koch *et al*., who reported one conversion during operation, no conversions were reported in the other studies [13].

Postoperative seroma or hematoma

Six studies reported the incidence of postoperative seroma or hematoma [9,10,12,15-17]. The incidences of seroma or hematoma were 5.5% (16/289) and 3.9% (10/258) in the nonfixation and fixation groups, respectively. There was no significant heterogeneity (χ^2 = 2.33, P = 0.80, I^2 = 0%) and no significant difference in the incidence of hematoma or seroma between the two groups (OR = 1.38, 95% CI = 0.62–3.05, P = 0.43) [Figure 3b].

Postoperative urine retention

Four studies reported the incidence of urine retention [13,15,17,18]. The incidence of delayed return of bladder function was 4.56% (9/197) in the nonfixation group and 14.5% (29/200) in the fixation group. Moderately significant heterogeneity was observed (χ^2 = 3.69; P = 0.16, I^2 = 46%). There was a significantly lower incidence of urine retention in the nonfixation group (OR = 0.26, 95% CI = 0.08–0.88, P = 0.03) [Figure 3c].

Recurrence

All 10 studies reported recurrence within the follow-up period 10 [9-18]. The incidence of recurrence was 0.53% (4/748) in the nonfixation group and 0.14% (1/719) in the fixation group. There was no significant heterogeneity (χ^2 = 2.10, P = 0.35, I^2 = 5%) and no significant difference in recurrence between the two groups (OR = 2.27, 95% CI = 0.51–10.12, P = 0.28) [Figure 3d].

Table 1: Characteristics of included trials

Author/year	Study method/ blinding	Inclusion criteria	Exclusion criteria	Group	Total hernia number	Total patient number	Gender (male/ female)	Age	Lateralization Right/left/bilateral Unilateral/bilateral	Hernia type Indirect/ direct/both
Ferzli *et al*., 1999 [10]	RCT/patients	Primary inguinal hernia, >18 years old	Recurrent hernia Previous abdominal operation	Nonfixation Fixation	50 50	49 43	49/0 43/0	53 55	20/30 26/24	33/16/1 23/20/7
Moreno-Egea *et al*., 2004 [11]	RCT/patients	Inguinal hernia	Femoral hernia, emergent operation, strangulation or scrotal hernia, high anesthetic risk, neoplasm, acute infection, mental incompetence	Nonfixation Fixation	111 118	85 85	79/6 78/7	56.9±16.3 53.8±15.6	37/22/26 31/21/33	67/44 84/34
Parshad *et al*., 2005 [12]	RCT/patients	Inguinal hernia	Incarcerated hernia, previous low abdominal surgery, recurrent hernia	Nonfixation Fixation	29 34	25 25	N/A N/A	47.16±16.40 46.40±15.19	N/A N/A	N/A N/A
Koch *et al*., 2006 [13]	RCT/patients	Inguinal hernia Male: 18-100 years old	Low abdominal surgery patients (s/p low anterior resection or radical prostatectomy) or coagulopathy Risk for general anesthesia	Nonfixation Fixation	27 26	20 20	N/A N/A	54.6±16.1 56.3±11.5	20/0 20/0	12/12/2 (1 femoral) 10/13/3
Li *et al*., 2007 [9]	RCT/N/A	Inguinal hernia, 25-80 years old	Hernia defect >4 cm, incarcerated hernia, previous low abdominal surgery, infection, coagulopathy, or immune compromise	Nonfixation Fixation	33 34	30 30	26/4 28/2	58±15 61±15	27/3 26/4	N/A N/A
Taylor *et al*., 2008 [14]	RTC/double blind	Inguinal or femoral hernia, >18 years old	Cognitive impairment, dementia, previous operation, or risk for general anesthesia	Nonfixation Fixation	500	360	92% male	59.6 59.3	N/A N/A	N/A N/A
Garg *et al*., 2011 [15]	RCT/patients	Primary inguinal hernia >16 years old	Incarcerated, strangulated or recurrence, previous low abdominal surgery, not suit for anesthesia	Nonfixation Fixation	96 98	52 52	49/3 51/1	51.9±16.8 47.2±12.9	N/A N/A	N/A N/A
Claus *et al*., 2016 [16]	RCT/N/A	Unilateral inguinal hernia	Large (L3/M3), incarcerated, previous pelvic surgery, coagulopathy, risk of general anesthesia	Nonfixation Fixation	50 10	50 10	44/6 10/0	51.1±15.7 49.0±14.0	N/A N/A	N/A N/A

Contd...

Table 1: Contd...

Author/year	Study method/ blinding	Inclusion criteria	Exclusion criteria	Group	Total hernia number	Total patient number	Gender (male/ female)	Age	Lateralization Right/left/bilateral Unilateral/bilateral	Hernia type Indirect/ direct/both
Ayyaz *et al*., 2015 [17]	RCT/patients	Inguinal hernia 16-70 years old	Large, incarcerated, strangulated hernia	Nonfixation	31	31	28/3	31.3±12.5	21/10	25/6
				Fixation	32	32	28/4	44.6±16.3	22/10	26/6
Buyukasik *et al*., 2017 [18]	RTC/patients	Primary inguinal hernia 20-45 years old	Chronic disease/ recurrent hernia	Nonfixation	68	50	50/0	31.1±12.8	N/A	26/30/12 (2 femoral)
				Fixation	70	50	50/0	27.3±7.0	N/A	30/28/8 (2 femoral)

N/A: Not available, RCT: Randomized controlled trials

Analysis of recurrence

A total of five patients had recurrence. Moreno-Egea *et al*. reported three cases of recurrent hernia because of a large inguinal hernia defect, which was repaired using the open method [11]. Taylor *et al*. reported one patient with recurrence due to lateral mesh folding (indirect type), repaired using the TAPP method [14]. Ayyaz *et al*. reported that one patient had recurrence, without mentioning its characteristics, and it was repaired using the TEP method [17].

Discussion

The controversy over whether mesh should be fixed during TEP hernia repair remains unresolved, despite two meta-analyses addressing this topic. Therefore, we performed an updated systematic review and included more patients (1099 patients with 1467 diagnosed hernia defects, that is, 748 hernia defects in the nonfixation group and 719 in the fixation group) to evaluate whether the mesh should be fixed during TEP. The results revealed only a nonsignificant difference in the recurrence rate between patients with or without mesh fixation. The significant benefit of the nonfixation method includes shorter operative time, lower pain score on POD1, less incidence of urine retention, and lower costs (no fixation device), although we did not calculate the difference in cost.

The results of our meta-analysis pooling 10 RCTs showed a nonsignificant higher risk of recurrence in the nonfixation group (OR = 2.27, 95% CI = 0.512–10.21, P = 0.28). The mean TEP recurrence rate from the literature review was only 0.54% [19]. However, due to the low recurrence rate in TEP hernia repair, this result should be interpreted carefully.

In the long-term follow-up results, Messenger *et al*. and Eklund *et al*. found that the recurrence rate ranged from 1.1% to 3.5% at 5 years with the permanent tack fixation method [20,21]. The recurrence rate even reached 4% within the 10-year follow-up period studied by Staarink *et al*. [22]. Golani and Middleton performed TEP hernia repair using the nonfixation method, and they reported that the recurrence rate was 1.5% for 649 repairs with a mean 6.3-year follow-up period [23]. The time of postoperative recurrence in the included trials varied from 2 weeks to even 4 years. Hence, a short follow-up could lead to underestimation of the recurrence rate. In our study, the recurrence rate was only 0.15% in the fixation group and 0.53% in the nonfixation group. Half of the 10 trials had a follow-up period of <1 year [Table 3], and three studies also excluded large hernia defects, which might likewise cause the recurrence rate to be underestimated. A RCT to detect a 0.39% reduction in recurrence with an alpha value of 0.05 and beta value of 0.2 would require the enrollment of 5976 participants. Only multicenter trials could enroll such a large number of patients. Nevertheless, the recurrence rate was quite low in both groups and the difference was not clinically significant.

Among the included trials, there were four cases of recurrent hernia in the nonfixation group and one in the fixation group (4/748 vs. 1/719). One patient had lateral recurrence because of mesh folding, and two patients with three sites of recurrence had mesh displacement because of a large medial defect. The higher rate of medial recurrence was comparable with a prospective cohort study and registered hernia data from Sweden [24,25]. The risk of mesh displacement in the nonfixation method was low, as reported by Claus *et al*. However, they excluded patients with large hernia defects (>3 cm) [16]. None of the included trials reported surgical results for variable hernia size. The simulation model by Schwab *et al*. also showed a marked dislocation of the mesh under physiological pressure, and more protrusion was seen in the nonfixation group [26]. Thus, there was no evidence to support the greater safety of the nonfixation method in large hernia defects.

Taylor *et al*. demonstrated a significant correlation between the number of tacks and postoperative pain: Postoperative pain was evident when there were more than six tacks [14]. Because of heterogeneity among the trials (variable hernia types, dosage and route of analgesic agent, and pain scale), we only had limited data for meta-analysis. These results revealed less postoperative pain only on POD1 (WMD = 0.44, 95% CI = −0.85 to −0.3, P = 0.04), but with a comparable pain score on POD7. Furthermore, there was no significant difference in the incidence of chronic pain.

In animal studies of laparoscopic hernia repair, mesh fixation itself was not needed to prevent recurrence and ensure sufficient strength after 2 weeks of observation [26-28]. In the initial postoperative period, the fixation device may have

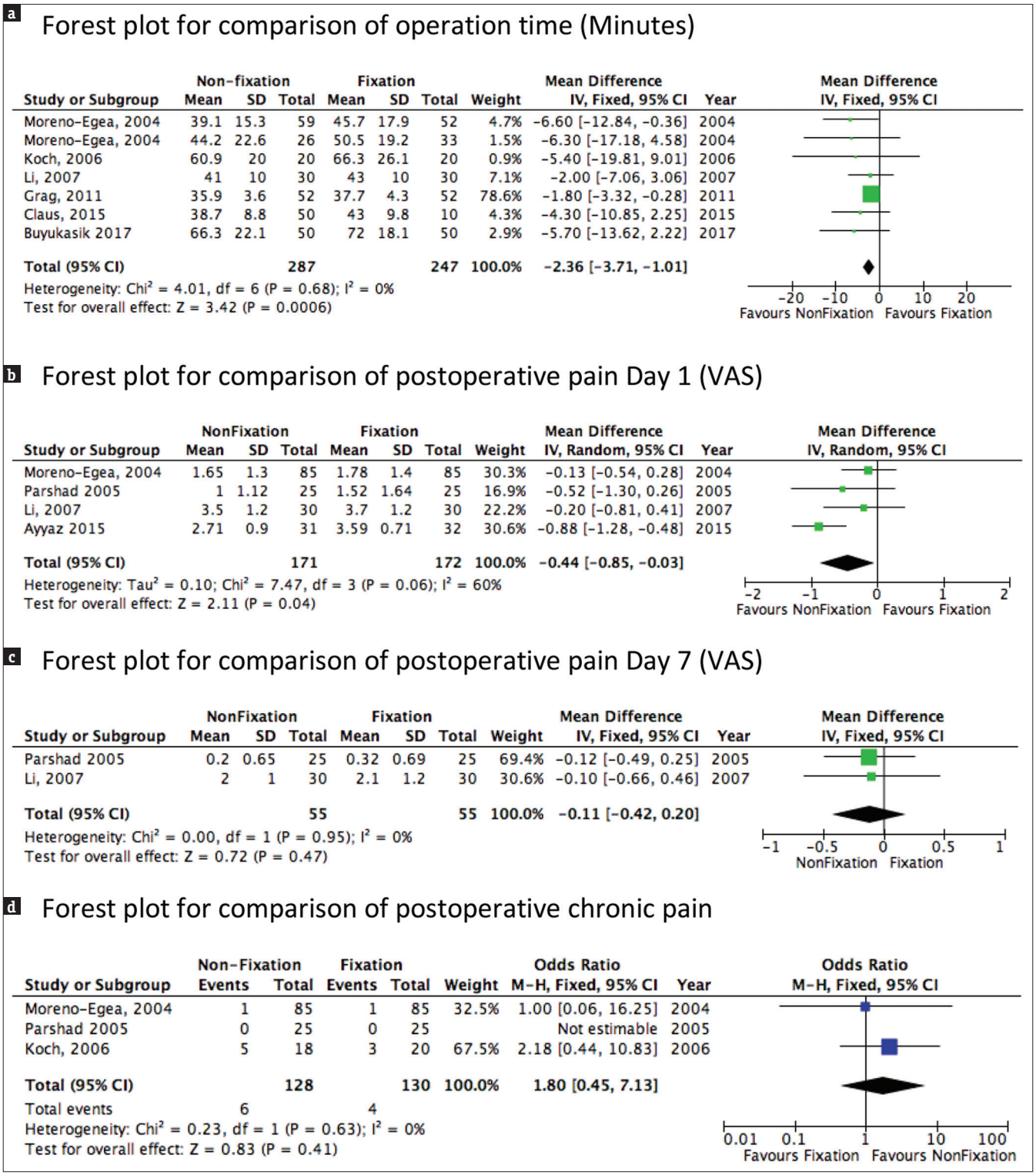

Figure 2: Forest plot for comparison between fixation and nonfixation in total extraperitoneal hernia repair (a) operation time (minutes) (b) postoperative day 1 pain scale (c) postoperative day 7 pain scale (d) postoperative chronic pain

to exert unnecessarily high shearing force against abdominal pressure to maintain the mesh location. The higher pain score on POD1 in the fixation group may be related to the shearing force from increased intra-abdominal pressure, especially with movement, as Li *et al*. reported [9]. In addition to the nonfixation method, the no penetrating method was also considered as an alternative means of reducing postoperative pain; but there have only been limited trials, and sufficient evidence is lacking [3,5]. Until now, no head-to-head randomized trials have compared biochemical glue with the nonfixation method in terms of the incidence of short-term or chronic postoperative pain.

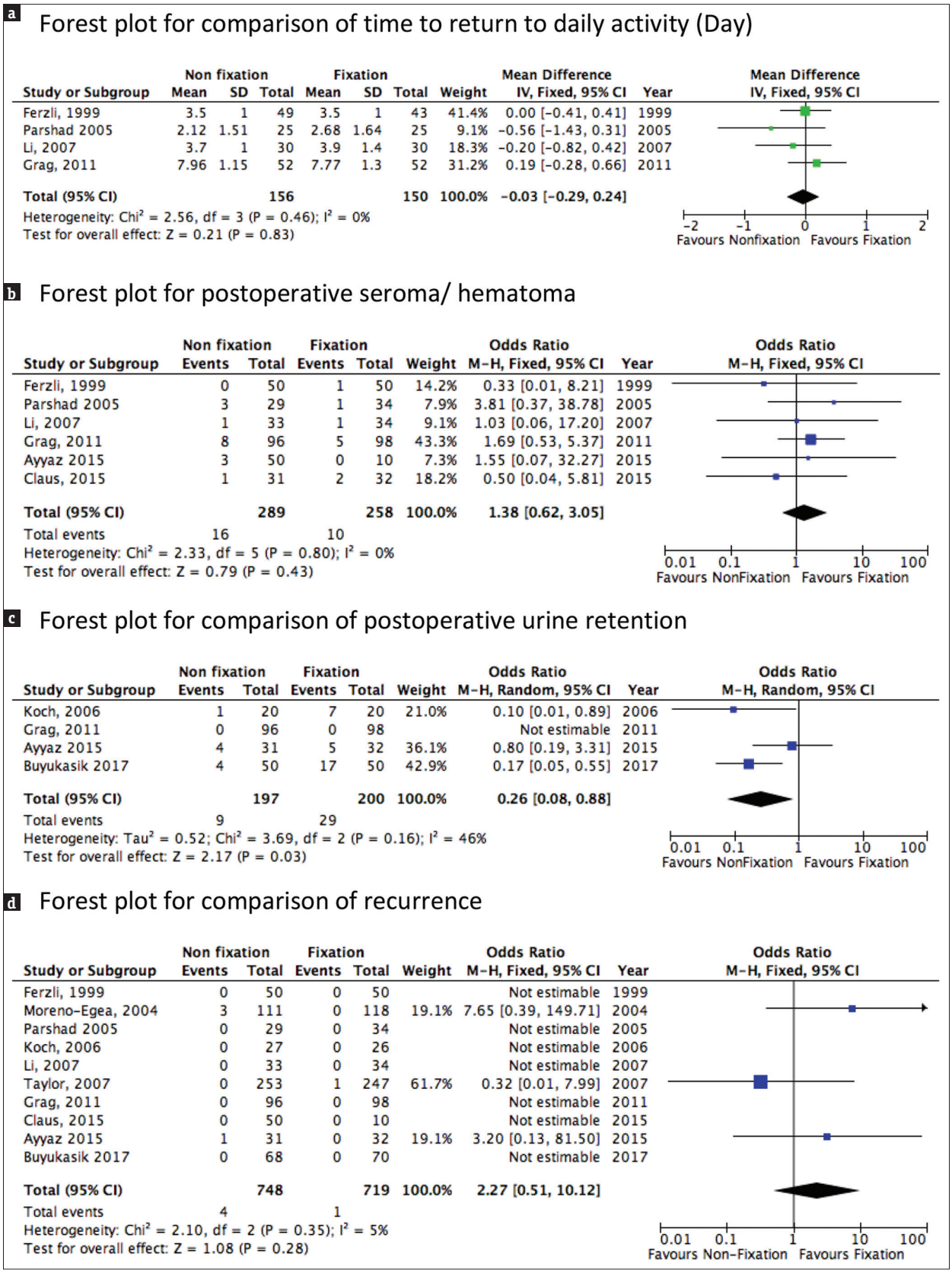

Figure 3: Forest plot for comparison between fixation and nonfixation in total extraperitoneal hernia repair (a) time back to daily activity (day) (b) postoperative seroma/ hematoma (c) postoperative urine retention (d) recurrence

Table 2: Perioperative parameters: medical device, mesh size/content, and follow-up protocol

Author/year	Anesthesia	Trocar size	Contralateral exposure	Mesh type	Mesh size	Fixation device	Fixation number/location	Follow-up protocol
Ferzli *et al*., 1999 [10]	ETGA	3 trocars Size: 11-10-5	Nil	Polyprolylene	6×6 inch^2	Endoscopic hernia stapler	Pubic symphysis Cooper's ligament Transverse abdominis×2 *n*=4	1st, 3rd, 6th weeks 6th months and 12th months
Moreno-Egea *et al*., 2004 [11]	ETGA/SA	3 trocars Size: N/A	Nil	Parietex (3D anatomic mesh)	6×4 inch^2	N/A	Cooper ligament, rectus muscle, and transversus abdominis *n*: Determined	1st week 1st 6th, 12th, and 24th months
Parshad *et al*., 2005 [12]	ETGA	N/A	Nil	Polypropylene	15×11-13 cm^2	N/A	N/A	1st week 1st, 4th, 7th, and 10th months
Koch *et al*., 2006 [13]	ETGA	3 trocars Size: N/A	Yes	Polypropylene (fixation) 3D max (nonfixation)	15×10 cm^2	Spiral tacks	Cooper's ligament and anterior abdominal wall *n*: 5-8	1st, 4th, and 12th months
Li *et al*., 2007 [9]	ETGA	3 trocars Size: N/A	N/A	Vitro II or prolene	15×10 cm^2	Autosutrue or endopath EMS	N/A	1th, 2nd, 3rd, and 7th days
Taylor *et al*., 2008 [14]	ETGA	3 trocars 10-5-5	N/A	Polypropylene	15×10 cm^2	Autosuture protack	Above iliopubic tract *n*: Determined	N/A
Garg *et al*., 2011 [15]	SA	3 trocars 10-5-5	Pending on patients	Polypropylene	15×10 cm^2	Protack	Lacunar ligament and anterior abdominal wall *n*=2	1st week, 1st month, 1st year, and 2nd year
Claus *et al*., 2016 [16]	ETGA	3 trocars Size: 10-5-5	N/A	Polypropylene	12-15 cm^2	Absorbable tack	Above iliopubic tract *n*: Determined	N/A
Ayyaz *et al*., 2015 [17]	ETGA	3 trocars Size: 10-5-5	N/A	Polypropylene	6×4 inch^2	Metallic tacks	Cooper's ligament and above ASIS *n*: 2	6th month, 1st, 2nd, and 5th years
Buyukasik *et al*., 2017 [18]	ETGA	3 trocars Size: 10-5-5	N/A	Prolene, ethicon, Polypropylene mesh	15×10 cm^2	Protack	Cooper's ligament and anterior abdominal wall *n*: 4-7	1st, 6th, and 12th months

N/A: Not available, 3D: Three dimensional, ETGA: Endotracheal tube general anesthesia, SA: Spinal anesthesia, ASIS: Anterior superior iliac spine

Risk factors for postoperative urine retention included male sex, old age, type of surgery, comorbidities, preoperative symptoms, administration of excessive intravenous fluid, longer duration of surgery and effects of anesthesia, postoperative pain, and the narcotic agent used after operation [19,29,30]. Previous meta-analyses failed to show a significant difference for the risk of postoperative urine retention between the two groups, due to the low incidence and small number of cases. Moreover, they did not mention the incidence of urine retention [31]. In our study, the fixation group had a high incidence of postoperative urine retention of up to 14.5%, compared with 4.56% in the nonfixation group. Ayyaz *et al*. and Buyukasik *et al*. reported a higher incidence of postoperative urine retention. A review of the demographic data indicated that these two studies enrolled younger patients to receive hernia repair. We attempted to perform a meta-regression to determine the incidence of urine retention with regard to age or pain scale, but failed because of the different pain scales used and the fact that only four trials reported urine retention. In our clinical experience, the degree of pain is much severer in younger than in older patients. A higher dosage of narcotic agents or raised sympathetic tone might explain the higher incidence of postoperative urine retention in younger patients [32]. Nevertheless, the enrolled studies did not mention whether urethra catheterization was performed before or during operation. In addition, most of the studies did not mention the analgesic agents used. The reasons for acute urine retention may require large-scale studies to analyze the risk factors and etiology of postoperative urine retention.

Except for acute postoperative urine retention, other postoperative complications including chronic pain, seroma, or hematoma revealed no significant difference between the two groups. The operative time was significantly shorter in the nonfixation group (WMD = 2.26 min, P = 0.001, I^2 = 0%, χ^2 = 3.30) mainly because tack application was unnecessary. However, the time saved was short and without clinically significance.

Table 3: Operation time, conversion rate, and postoperative results

Author/year	Group	Operation time	Conversion	Pain score Day 1	Pain score 1st week	Pain score 1st month	Chronic pain	Seroma/ hematoma	Urine retention	Return to daily activity	Follow-up (months)	Recurrence
Ferzli *et al*., 1999 [10]	Nonfixation	35	0	N/A	N/A	N/A	N/A	0	N/A	3.5±1	Mean: 8	0
	Fixation	38	0					1	N/A	3.5±1		0
Moreno-Egea *et al*., 2004 [11]	Nonfixation	39.1±15.3 44.2±22.6	0	1.65±1.3	N/A	0.14±1.7	1	N/A	N/A	N/A	Mean: 36±12	3
	Fixation	45.7±17.9 50.5±19.2	0	1.78±1.4	N/A	0.16±0.6	1	N/A	N/A	N/A		0
Parshad *et al*., 2005 [12]	Nonfixation	N/A	0	1.00±1.12	0.20±0.65	N/A	0	3	N/A	2.12±1.51	Mean: 23.98±9.9	0
	Fixation	N/A	0	1.52±1.64	0.32±0.69	N/A	0	1	N/A	2.68±1.63	Mean: 27.47±8.6	0
Koch *et al*., 2006 [13]	Nonfixation	60.9±20.0	N/A	N/A	1.2±1.0	0.3±0.8	5/18	N/A	1	N/A	6-30 months	0
	Fixation	66.3±26.1	N/A	N/A	1.5±1.3	0.8±1.7	3/20	N/A	7	N/A	Median: 9	0
Li *et al*., 2007 [9]	Nonfixation	41±10	N/A	3.5±1.2	2.0±1.0	N/A	N/A	1	N/A	3.7±1.0	12-24	0
	Fixation	43±10	N/A	3.7±1.2	2.1±1.2	N/A	N/A	1	N/A	3.9±1.4	months	0
Taylor *et al*., 2008 [14]	Nonfixation	N/A	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Median: 16 6-13 months	0
	Fixation	N/A	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Mean: 8.2	1
Garg *et al*., 2011 [15]	Nonfixation	35.9±3.6	0	1.42±0.5	1.34±0.6	1.17±0.4	N/A	8	0	7.96±1.15	25-29	0
	Fixation	37.7±4.3	0	1.31±0.4	1.25±0.5	1.06±0.2	N/A	5	0	7.77±1.3	months	0
Claus *et al*., 2016 [16]	Nonfixation	38.7±8.8	0	N/A	N/A	N/A	N/A	3	N/A	N/A	Mean: 26.2 Follow up	0
	Fixation	43.0±9.8	0	N/A	N/A	N/A	N/A	0	N/A	N/A	3 months at least	0
Ayyaz *et al*., 2015 [17]	Nonfixation	N/A	0	2.71±0.9	N/A	N/A	0	1	4	N/A	Follow up	1
	Fixation	N/A	0	3.59±0.71	N/A	N/A	0	2	5	N/A	5 years at least	0
Buyukasik *et al*., 2017 [18]	Nonfixation	66.3±22.1	0	1.3±1.2	N/A	1.5±1.2	N/A	N/A	5	N/A	12 months	0
	Fixation	72.0±18.1	0	1.9±1.6	N/A	0.3±0.8	N/A	N/A	17	N/A		0

Moreno-Egea *et al*. adapt pain scale: VAS (0-10), Parshad *et al*. adapt pain scale: VAS (0–10), Koch *et al*. adapt pain scale: Likert scale (0–10), Li *et al*. adapt pain scale: VAS (0–10), Garg *et al*. adapt pain scale: Self-defined pain scale: (0–5), Ayyaz *et al*. adapt pain scale: VAS (0–10), Buyukasik *et al*. adapt pain scale: Numeric Rating Scale: (0–10). N/A: Not available, VAS: Visual analog scale

Three studies compared the costs of nonfixation and fixation, and the major differences lay in the cost of tacks. Since the nonfixation method provides the same efficacy as permanent fixation, nonfixation is less expensive. Postoperative urine retention and pain may also lead to an extended hospital stay and higher costs may, therefore, be expected. However, we did not perform a calculation of the cost difference and an economic analysis because of differences between health-care systems.

Limitations

There are several limitations in the current study. First, the included studies did not perform subgroup analyses according to the type and size of hernias, lacking the original data. Moreover, a surgeon's experience may affect the results, but it is not possible to analyze this. Third, the enrolled patients were heterogeneous because of different inclusion or exclusion criteria. Fourth, some studies did not provide data with a standard deviation, and some data were incomplete. Fifth, the variable duration of the follow-up period in the included studies greatly influenced the incidence of recurrence. Finally, although we found a higher incidence of postoperative pain, the included studies did not specify their pain control protocol and most of the studies were single-blinded (patients). The possibility of bias could affect the results of the meta-analysis.

Despite these limitations, the current study included 10 high-quality RCTs and numerous patients, providing a comprehensive review of updated evidence to support the suggestion that hernia repair without mesh fixation may be indicated in selected patients.

Conclusion

Nonfixation of the mesh provided comparable surgical efficacy as compared with fixation and served as a reliable alternative. The benefits of nonfixation included lower incidence of postoperative urine retention, less short-term postoperative pain, and lower costs.

Acknowledgment

This manuscript was edited by Wallace Academic Editing.

Financial support and sponsorship

Nil.

Conflicts of interest

There is no conflicts of interest.

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