Comparison of endoscopic surgery and Lichtenstein repair for treatment of inguinal hernias

A network meta-analysis

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Abstract

Background: This study aimed to identify the best procedure for addressing inguinal hernias by comparing results after transabdominal preperitoneal (TAPP), totally extraperitoneal (TEP), and Lichtenstein repairs using a network meta-analysis.

Methods: We conducted a systematic search of MEDLINE, Web of Science, the Cochrane Central Library, and ClinicalTrials.gov up to September 1, 2018 for randomized controlled trials (RCTs) comparing the TAPP, TEP, and Lichtenstein procedures. The study outcome were the hernia recurrence, chronic pain, hematoma, seroma, wound infection, operation time, hospital stay, and return-to-work days.

Results: Altogether, 31 RCTs were included in the meta-analysis. The results of this network meta-analysis showed there were no significantly differences among the 3 procedures in terms of hernia recurrence, chronic pain, hematoma, seroma, hospital stays. Lichtenstein had a shorter operation time than TAPP+TEP [MD (95%CrI): 12 (0.51–25.0) vs 18 (6.11–29.0) minutes, respectively] but was associated with more wound infections than TEP: OR 0.33 (95%CrI 0.090–0.81). Our network meta-analysis suggests that TAPP and TEP require fewer return-to-work days [MD (95%CrI): –3.7 (–6.3 to 1.3) vs –4.8 (–7.11 to 2.8) days].

Conclusion: Our network meta-analysis showed that there were no differences among the TAPP, TEP, and Lichtenstein procedures in terms of safety or effectiveness for treating inguinal hernias. However, TAPP and TEP could decrease the number of return-to-work days. A further study with more focus on this topic for inguinal hernia is suggested.

Abbreviations: CrI = credible interval, RCTs = randomized controlled trials, TAPP = transabdominal preperitoneal, TEP = totally extraperitoneal.

Keywords: inguinal hernia, lichtenstein repair, network meta-analysis, outcomes, tAPP, tEP

1. Introduction

Inguinal hernia is one of the most common diseases worldwide, affecting approximately 5% to 10% of the population.[1,2] There are many repair techniques for repairing inguinal hernias.

In addition to the classic open repair, minimally invasive inguinal hernia repairs are increasingly preferred. Proposed by Lichtenstein in 1986, his namesake procedure is the most common open surgery procedure used to repair inguinal hernias. At present, many guidelines refer to the Lichtenstein technique as a standard reference surgical method, which has the advantages of being a short operation time and the need for relatively low surgical skill.[3,4] Lichtenstein performed it under local anesthesia, which is more suitable for high-risk patients. Previous studies, however, showed that the procedure was associated with more chronic pain and a longer return to work than other hernia operations.[5–8]

With the development of laparoscopic techniques, laparoscopic hernia repair is increasingly being used to treat inguinal hernias. Among these techniques, transabdominal preperitoneal (TAPP) repair and totally extraperitoneal (TEP) procedures are the most frequently used laparoscopic hernia repairs. TAPP and TEP repairs have been reported to reduce the occurrence of postoperative pain, shorten the length of the hospital stay, and accelerate the recovery of patients.[9,10] Laparoscopic hernia surgery, however, may increase the incidence of inguinal hematomas and the operation time during the initial learning period because of the high technical requirements and greater medical costs.[9,11] The TAPP repair is associated with a high risk of infection, adhesions, and organ injury. The TEP repair requires higher-grade technique and has a long learning curve.[9,12,13]
As there are still many surgeons who prefer the Lichtenstein procedure, the optimal inguinal hernia repair procedure remains controversial. In the past, although a few of RCT studies compared Lichtenstein, TAPP, and TEP, their lack of adequate sample size and quality has not allowed us to draw a definitive conclusion.

In this study, we reviewed and conducted a network meta-analysis of the TAPP, TEP, and Lichtenstein procedures regarding their safe and effective treatment of inguinal hernias. The aim of this study was to compare TAPP, TEP, and Lichtenstein in a systematic review with network meta-analysis.

2. Materials and methods

2.1. Search strategy

We conducted a network meta-analysis to compare endoscopic surgery and Lichtenstein repair for treatment of inguinal hernias. According to the recommendation of Goossen et al., 2 of the authors independently performed a comprehensive and systematic search of MEDLINE, Web of Science, the Cochrane Central Library, and ClinicalTrials.gov from the time the database was created up to September 2018. The English-language search terms used combinations of the following terms: “hernioplasty,” “tension-free,” “inguinal hernia,” “total extraperitoneal herniorrhaphy,” “TEP,” “transabdominal preperitoneal,” “TAPP,” “Lichtenstein,” “randomized controlled trial,” “controlled clinical trial.” The search was limited initially to publications of RCTs. The references of the articles identified after the initial search were also reviewed manually. The published language was restricted English. Institutional review board approval of our hospital was obtained for this study.

2.2. Inclusion and exclusion criteria

The following inclusion criteria were applied:
1. The RCT must have compared the TAPP, TEP, and Lichtenstein procedures performed for inguinal hernia.
2. The clinical outcomes of this study included operation time, hospital stay, rates of complications such as wound infection, hematoma, and chronic pain.
3. The study must have provided adequate data on the clinical outcomes.

We excluded studies that
1. were non-RCTs, retrospective studies, review articles, case reports, abstracts, editorials, or letters to the editor;
2. had insufficient data on outcome measures.

2.3. Data extraction

Original data were independently extracted from the literature by 2 authors and entered on a standardized form:
1. first author, year of publication, and country where the study took place;
2. type of procedure, sample size, age, sex, and outcomes. If necessary, the author(s) of the study were contacted to obtain the necessary data.

Conflicts in data abstraction were resolved by consensus and by referring to the original article.

2.4. Quality assessment

The authors independently assessed the quality of the literature in accordance with the Cochrane Collaboration Handbook. The assessment tool included the following criteria: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of the results assessment, incomplete data of the results, selective reporting, and other sources of bias. The blinding of included studies were evaluated by the recommendations that published by Pascal Probst et al. Disagreement was decided by discussion with a third investigator.

2.5. Statistical analysis

The odds ratio (OR) for dichotomous data, weighted mean difference (WMD) for continuous data, and 95% credible intervals (CrI) were used to estimate the network-analysis. Heterogeneity within each pair-wise comparison when 2 or more trials were available for the comparison was accessed by Cochran Q test and measured by the $I^2$ statistic. A random-effects model was utilized when statistically significant heterogeneity existed; otherwise a fixed-effects model was utilized. A two-tailed value of $P < .05$ was considered to indicate statistical significance. The network meta-analyses using Bayesian methods was performed using Stata 15 (Stata Corp), JAGS, and R (version x64 3.5.1) with the gemtc package (version 0.8-2) and rjags package (version 4–6) with a random-effects model. The inconsistency of our results was confirmed by the node-splitting method and its Bayesian $P$ value comparing the direct and the indirect estimates for each comparison. The relevant rank plots based on the probability for different endpoints are shown.

3. Results

3.1. Selected studies and characteristics of the trials

On the basis of our search criteria, we yielded 1476 papers from the respective search engines, of which 1064 duplicate articles were excluded. The remaining 406 studies were retrieved for assessment of their titles and abstracts, leaving 31 RCT articles that met the inclusion criteria and were included in the meta-analysis. A detailed flowchart of the selection process is depicted in Figure 1. The baseline characteristics on the included studies were showed in Table 1. Table 2 showed the hernia and mesh type of included studies.

Figure 2 shows the quality assessment of the included studies. The result of included studies quality evaluation showed that some of the literatures had no detailed description of the blinding of participants and personnel (performance bias) and blinding of outcome assessment.

A total of 7 studies compared TAPP with Lichtenstein performed for inguinal hernias. 11 studies compared the TEP procedure with the Lichtenstein repair. 9 studies compared the TAPP with the TEP procedure, and 5 studies compared the TAPP, TEP, and Lichtenstein procedures. The 5594 patients were divided into the TAPP group (n = 1228), TEP group (n = 2067), and Lichtenstein group (n = 2299). The sample sizes ranged from 38 to 1370 patients. The countries in which the included studies were performed were Egypt, Turkey, India, Sweden, United States, Germany, Greece,
Figure 1. Flow diagram of the published articles evaluated for inclusion in this meta-analysis.
Table 1

| Author et al | Year | Country | Intervention | Sample size | Age | Gender(m:f) |
|-------------|------|---------|--------------|-------------|-----|-------------|
| Abbas et al | 2012 | Egypt   | TAPP/Lichtenstein | 88/97 | 35.9 ± 12.10/34.6 ± 11.2 | 66:29/43 |
| Anadil et al | 2004 | Turkey  | TAPP/Lichtenstein | 125 | 41.6 ± 10.8/41.2 ± 10.9 | 25:0/25:0 |
| Bansal et al | 2013 | India   | TAPP/TEP | 154/160 | 43.4 ± 16.4/50.7 ± 17.3 | NA |
| Bringman et al | 2002 | Sweden  | Lichtenstein/TEP | 103/92 | 54 ± 11/55 ± 12 | NA |
| Butler et al | 2007 | USA     | TAPP | 22/22 | NA | NA |
| Butters et al | 2007 | Germany | TAPP/Lichtenstein | 94/93 | 53(30–74)/53(32–74) | 94:09/3:0 |
| Cifci et al | 2015 | Turkey  | TAPP | 31/30 | 45.7 ± 11.1/44.4 ± 15.3 | 26:52:64 |
| Colak et al | 2003 | Turkey  | TAPP/TEP | 67/67 | 51.6 (16–77)/49.4 (21–78) | 62:57/10 |
| Demeulenaere et al | 2006 | Greece  | Lichtenstein/TEP/TEP | 32/26/24 | NA | NA |
| Ekdah et al | 2009 | Sweden  | Lichtenstein/TEP | 70/66/65 | 52 ± 10.1/53 ± 9.6 | NA |
| Gokalp et al | 2003 | Turkey  | Lichtenstein/TEP | 62/61 | 45.0 (18–60)/47.0 (18–59) | 62:61/1:0 |
| Gong et al | 2011 | China   | TAPP | 50/52 | 56 ± 10/57 ± 9 | 50:52:0 |
| Gural et al | 2007 | Turkey  | TAPP/Lichtenstein/TEP | 39/42/40 | 25.72 ± 1.09/22.76 ± 0.3/22.38 ± 0.65 | NA |
| Haraz et al | 2010 | Egypt   | TAPP/Lichtenstein/TEP | 25/25/25 | 36.73 ± 12.06/35.12 ± 10.11 | 25:0/25:0 |
| Helkkinen et al | 1998 | Finland | TAPP/Lichtenstein | 18/20 | 51.0(34–68)/55.5(56–69) | 17:1:2:0 |
| Helkkinen et al | 1998 | Finland | Lichtenstein/TEP | 23/22 | 46(22–48)/44(21–65) | NA |
| Wellwood et al | 2008 | England | TAPP/Lichtenstein/TEP | 200/200 | 52.5 (19–93)/51.5 (19–90) | NA |
| Jeelani et al | 2015 | India   | TAPP | 30/30 | 48.2 ± 13.3/46.7 ± 13.0 | 29:1:3:0 |
| Kouhi et al | 2009 | Finland | Lichtenstein/TEP | 47/49 | 55.8 ± 12.0/57.8 ± 12.6 | 46:1:4:7:2 |
| Krishna et al | 2012 | India   | TAPP | 47/43 | 51.3 ± 13.8/46.8 ± 16 | 47:0:4:2:1 |
| Lal et al | 2003 | India   | Lichtenstein/TEP | 25/25 | 37.8 ± 12.43/36.72 ± 12.08 | 25:0/25:0 |
| Langenveld et al | 2010 | Canada  | Lichtenstein/TEP | 317/323 | 56/55 | NA |
| Lau et al | 2005 | China   | Lichtenstein/TEP | 100/100 | 56 ± 13.1/55 ± 15.5 | 100:0/1:0:0 |
| Hallen et al | 2008 | Sweden  | Lichtenstein/TEP | 81/73 | NA | NA |
| Mesci et al | 2012 | Turkey  | TAPP/TEP | 25/25 | 48.2/46.4 | NA |
| Picchio et al | 1999 | Latvia  | TAPP/Lichtenstein | 52/52 | 57.7 ± 11.0/55.2 ± 12.4 | 37:15:40:12 |
| Pokorney et al | 2008 | Australia | TAPP/Lichtenstein/TEP | 93/98/96 | 49 (21–78)/52 (19–86) | 86:7:6:45 |
| Salmo et al | 2015 | Pakistan | TAPP/Lichtenstein | 30/30 | NA | 30:0:3:0:0 |
| Schenke et al | 1996 | Australia | TAPP/TEP | 28/24 | 39.1 ± 14.3/42.3 ± 11.9 | 24:2:2:2 |
| Wang et al | 2013 | China   | TAPP/Lichtenstein/TEP | 84/84/84 | 46.23 ± 13.20/52.12 ± 17.46/48.25 ± 17.09 | 70:14:71:13:69:15 |
| Zhu et al | 2009 | China   | TAPP/TEP | 20/20 | 62.3 ± 12.3/60.2 ± 9.7 | 19:1:2:0:0 |

*a* range.

NA = not available, TAPP = transabdominal preperitoneal, TEP = totally extraperitoneal.

China, Finland, Canada, Latvia, Austria, and Pakistan. Figure 3 depicts the studies reporting outcomes.

### 3.2. Hernia recurrence

Hernia recurrence had been tallied in 15 two-arm studies and 3 three-arm studies, which were pooled for analysis. The overall comparisons of hernia recurrence in this study seemed to be the least following TAPP (Fig. 4A), but there were no significant differences among the TAPP, TEP, and Lichtenstein procedures—unless otherwise specified, hereafter expressed as the odds ratio and credible interval [OR (95% Crl): 1.7 (0.56–5.5), 0.85 (0.26–2.0), and 0.51 (0.13–1.4), respectively] (Fig. 5A).

### 3.3. Chronic pain

In all, 17 trials provided data regarding chronic pain. The rank probability results showed that the Lichtenstein repair was associated with the greatest chronic pain (Fig. 4B). However, the pooled network meta-analysis showed no statistically significant difference among the 3 procedures: 0.51 (0.13–1.7), 0.62 (0.20–1.40), and 1.2 (0.29–4.7), respectively (Fig. 5B).

### 3.4. Hematoma

Data regarding hematoma were provided in 18 studies. There was no significant difference between the 3 groups: 0.68 (0.26–1.7), 0.61 (0.32–1.4), and 0.90 (0.29–2.4), respectively (Fig. 5C). A rank plot shows that the TAPP procedure may be associated with the highest incidence of hematoma formation (Fig. 4C).

### 3.5. Seroma

In a comparison of the incidence of seromas, we found that the seroma rates among the 3 procedures were similar: 0.98 (0.31–3.0), 1.4 (0.56–4.2), and 1.4 (0.50–5.1), respectively (Fig. 5D). However, a rank plot showed that TEP had produced the highest number of seromas of all the procedures (Fig. 4D).

### 3.6. Wound infection

Pooled network analysis showed that the risk of wound infection after the Lichtenstein procedure was higher than that for TEP [0.33 (0.09–0.81)], although there were no significant differences between the TAPP and Lichtenstein procedures [0.50 (0.14–1.6)] or the TAPP vs TEP procedures [0.66 (0.15–2.2)] (Fig. 6A). The rank plot showed that the Lichtenstein repair was associated with more wound infections (Fig. 4E).

### 3.7. Operation time

The results of the meta-analysis revealed that open surgery had the shortest operation time (Fig. 4F), although there was a
| Author            | Intervention | Hernia type | Mesh type                                                                 |
|-------------------|--------------|-------------|---------------------------------------------------------------------------|
| Abbas et al       | TAPP/Lichtenstein | NA         | Polypropylene mesh (7 × 14 cm²)                                           |
| Anadol et al      | TAPP/Lichtenstein | NA         | Polypropylene mesh (10 × 8 cm²)                                           |
| Bansal et al      | TAPP/TEP     | NA         | Lichtenstein: polypropylene mesh                                          |
| Bringman et al    | Lichtenstein/TEP | Indirect 56/49 | TAPP: polypropylene mesh (10 × 8 cm²)                                     |
|                   |              |            | TEP: polypropylene mesh (15 × 10 cm²)                                     |
|                   |              |            | Lichtenstein: polypropylene mesh (10 × 15 cm²)                            |
|                   |              |            | TEP polypropylene mesh (7.5 × 15 cm²)                                     |
| Bøller et al      | TAPP/TEP     | NA         | Femoral /1                                                               |
| Butters et al     | TAPP/Lichtenstein | NA         | Polypropylene mesh                                                        |
| Ciftci et al      | TAPP/TEP     | NA         | Polypropylene mesh (15 × 8 cm²)                                           |
| Colak et al       | Lichtenstein/TEP | Unilateral 56/39 | Polypropylene mesh (7 × 12 cm²)                                          |
| Dedemadi et al    | Lichtenstein/TEP | II 18/14/16 | Lichtenstein: polypropylene mesh                                          |
|                   |              |            | TAPP: polypropylene mesh (8.5 × 15 cm²)                                   |
|                   |              |            | TEP: polypropylene mesh (8.5 × 15 cm²)                                   |
|                   |              |            | Polypropylene mesh (12 × 15 cm²)                                          |
| Gokalp et al      | Lichtenstein/TEP | NA         | Polypropylene mesh                                                        |
| Gong et al        | TAPP/TEP     | Indirect 35/7 | Polypropylene mesh (8 × 12 cm²)                                          |
|                   |              |            | TEP: polypropylene mesh (8 × 12 cm²)                                      |
|                   |              |            | TEP: polypropylene mesh (8 × 12 cm²)                                      |
| Gural et al       | TAPP/Lichtenstein/TEP | I, II, III, and IIIB | Polypropylene mesh (6 × 12 cm²)                                          |
| Hallen et al      | Lichtenstein/TEP | NA         | NA                                                                        |
| Harmza et al      | TAPP/Lichtenstein/TEP | Ia | NA                                                                        |
| Heikkinen et al   | TAPP/Lichtenstein | NA         | NA                                                                        |
| Heikkinen et al   | Lichtenstein/TEP | NA         | NA                                                                        |
| Jeelani et al     | TAPP/TEP     | NA         | NA                                                                        |
| Kouba et al       | Lichtenstein/TEP | Indirect 20/16 | Polypropylene mesh (8 × 12 cm²)                                          |
|                   |              |            | Olypropylene mesh                                                       |
| Krishna et al     | TAPP/TEP     | NA         | Polypropylene mesh (10 × 15 cm²)                                          |
| Lai et al         | Lichtenstein/TEP | NA         | Polypropylene mesh (12 × 14 cm²)                                          |
| Langveld et al    | Lichtenstein/TEP | Unilateral 202/284 | Lichtenstein: polypropylene mesh                                         |
| Lau et al         | Lichtenstein/TEP | II 57/44/9 | Lichtenstein: polypropylene mesh (8 × 6 cm²)                              |
|                   |              |            | TEP: polypropylene mesh (12 × 15 cm²)                                     |
|                   |              |            | TEP: polypropylene mesh (10 × 14 cm²)                                     |
| Mesci et al       | TAPP/TEP     | Indirect 12/12 | Polypropylene mesh (10 × 15 cm²)                                          |
|                   |              |            | TEP: mesh (12 × 14 cm²)                                                   |
|                   |              |            | Lichtenstein: polypropylene mesh                                          |
| Picchio et al     | TAPP/Lichtenstein | Indirect 40/37 | Polypropylene mesh (7 × 12 cm²)                                          |
| Pokorny et al     | TAPP/Lichtenstein/TEP | Right 58/42/20 | Polypropylene mesh                                                        |
| Salma et al       | TAPP/Lichtenstein | NA         | Polypropylene mesh                                                        |
| Schrenk et al     | TAPP/TEP     | Indirect 19/18 | Polypropylene mesh                                                        |
|                   |              |            | NA                                                                        |
| Wellwood et al    | TAPP/Lichtenstein | Unilateral 177/176 | Lichtenstein: polypropylene mesh (10 × 15 cm²)                            |
|                   |              |            | TAP: polypropylene mesh (15 × 10 cm²)                                     |
|                   |              |            | Lichtenstein: polypropylene mesh                                          |
|                   |              |            | TEP: Vypro II mesh (12 × 15 cm²)                                          |
|                   |              |            | TEP: Vypro II mesh (10 × 12 cm²)                                          |
| Zhu et al         | TAPP/TEP     | NA         | NA                                                                        |

a Nyhus class.
NA = not available, TAPP = transabdominal preperitoneal, TEP = totally extraperitoneal.
statistically significant difference, expressed as the mean difference and the 95% CI [MD (95%CI)] between TAPP [18 (6.11–29.0) minutes] and TEP [12 (0.51–25.0) minutes]. There was no significant difference between TAPP and TEP in terms of the operation time [−5.2 (−17.0 to 6.4) minutes] (Fig. 6B).

3.8. Hospital stay

Ten studies involving 9 two-arm studies and 1 three-arm study were pooled to compare the hospital stays. The pooled analysis showed that the Lichtenstein repair has the longest hospital stays (Fig. 4G), although there was no significant difference among the 3 groups [MD (95%CI)]: −0.31 (−0.73 to 0.015) days, −0.33 (−0.77 to 0.018) days, and −0.031 (−0.28 to 0.25) days, respectively (Fig. 6C).

3.9. Return-to-work days

A total of 13 trials provided data regarding return-to-work days. The network meta-analysis showed that the Lichtenstein repair was associated with the most return-to-work days [MD (95% CI)] compared with TAPP [−3.7 (−6.3 to 1.3) days] and TEP [−4.8 (−7.11 to 2.8) days] (Fig. 4H). There was no significant difference between TAPP and TEP [−1.1 (−3.6 to 1.2)] (Fig. 6D).

4. Discussion

Our current analysis showed that there were no significant differences among the 3 procedures in terms of hernia recurrence, chronic pain, hematoma or seroma formation, or hospital stay. The TAPP and TEP procedures were associated with a longer operation time than the Lichtenstein repair, although the laparoscopic procedures reduced the time to return to work.

Recurrence is a major outcome measure when choosing the inguinal hernia repair technique and is often frustrating to the surgeons. Studies have reported that 13% of inguinal hernias are recurrent.[48] Previous studies reported that hernias recurred mostly within 2 years postoperatively.[49] Previous studies comparing the rates of inguinal hernia conducted by Eklund et al showed that TEP was associated with a high 5-year cumulative recurrence rate.[10,26] Wei et al were the first to recommended TAPP over TEP for hernia repair because of its low recurrence rate, although the differences in recurrence rates between TAPP and TEP are not significant.[50] Our network meta-analysis showed that TAPP may have the highest recurrence rate, but there were no significant differences among the 3 procedures. Wound infection was considered a factor in hernia recurrence by some researchers. El-Dhuwai et al found that the laparoscopic techniques were associated with lower incision infection rates than open hernia repair.[51] However, various studies that have focused on the topic showed no difference between laparoscopic and open surgery regarding wound infections.[11,52–54] In our study, the Lichtenstein procedure produced the highest wound infection rate, yet the recurrence rate was comparable with those of the other procedures. Another factor that may be associated with hernia recurrence is hematoma/seroma formation. Theoretically, the occurrence of seroma and hematoma may lead to an increase in the displacement of hernia patches, which increases the risk of postoperative recurrence.[55,56] Nevertheless, the subject remains controversial. Our study showed that TAPP had the highest hematoma formation rate and TEP the highest seroma formation rate, but the differences among repair types were not significant. Data from several studies suggested that laparoscopic hernia repair was associated with higher rates of hematoma and seroma.

Figure 2. Consensus risk-of-bias assessment of the included studies. Green=low risk; yellow=unclear; red=high risk.
Köckerling et al revealed that TAPP may be associated with higher rates of seroma formation after recurrent hernia repair. As noted in a study conducted by Schmedt et al, hematomas and seromas may be present but unnoticed. It should be noted, however, that the included studies displayed heterogeneity regarding mesh type and type of fixation.

Chronic pain has an incidence of 16% to 53%, and 2% to 5% of these patients state that it had an obvious impact on their daily activities. The International Association for the Study of Pain has defined chronic pain following hernia repair as groin pain lasting 3 months after surgery. A meta-analysis conducted by Scheuermann et al revealed that TAPP has a significantly lower chronic pain rate than that of the Lichtenstein procedure. There are no similar results reported for comparisons TAPP vs TEP or TEP vs Lichtenstein. Aasvang et al showed that the chronic pain rate was...
significantly lower following TAPP.\cite{64} TEP inguinal hernia repair has been preferred by many surgeons because its posterior surgical approach may reduce the possibility of chronic pain.\cite{4,11,65,66} Our network meta-analysis revealed that the Lichtenstein repair may be the most prone to causing chronic pain after surgery. TAPP is second, with TEP the least likely to result in chronic pain. TEP may cause less chronic pain than TAPP because of the reduced amount of dissection of the parietal peritoneum.\cite{8,21} This conclusion, however, is controversial. On the basis of 10 RCT studies, Wei et al showed that there was no difference in chronic pain between TAPP and TEP.\cite{50}

Figure 5. Forest plot for comparison of postoperative endoscopic examination. (A) Hernia recurrence. (B) Chronic pain. (C) Hematoma. (D) Seroma.
The pooled data showed that laparoscopic surgery allowed significantly shorter times to return to work compared with the Lichtenstein procedure. In another meta-analysis, the authors concluded that there was no significant difference in the postoperative recovery time between the TAPP and Lichtenstein repairs.\cite{8} In line with previous studies, our analysis showed that laparoscopic hernia surgery has a longer operation time. Most previous studies did not distinguish between TAPP and TEP.
whereas our study compared the operating time of 3 types of surgery. Previous observational studies have suggested that TAPP may have a shorter operative time than TEP.\[8,6\] The special anatomy and space creation by TEP, however, may increase the difficulty of surgery and require a longer learning curve. The results of the current study showed that TAPP was associated with a shorter operation time, although the difference was not statistically significant.

There are some limitations of this study. It is the first comparison of the Lichtenstein, TAPP, and TEP procedures. Although the latest RCTs are included, there are still some shortcomings. First, the quality of most of the included studies was low or moderate, which could influence the results. Second, the definition of chronic pain and its measuring methods should be standardized, which has not yet occurred. Third, the types of hernia, the types of mesh, and the follow-up times varied in the included studies.

5. Conclusion
Our network meta-analysis showed that there were no differences among the TAPP, TEP, and Lichtenstein procedures for inguinal hernias in terms of safety and efficiency. However, TAPP and TEP decreased the number of return-to-work days. It is obvious that more research on this topic is needed before we can identify the optimal surgery for inguinal hernias.

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