Review

Transabdominal preperitoneal versus totally extraperitoneal repair of inguinal hernia: a meta-analysis of randomized studies

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Endoscopy; Laparoscopy; Transabdominal preperitoneal; Totally extraperitoneal; Transabdominal preperitoneal inguinal hernia repair; Totally extraperitoneal repair

Abstract

BACKGROUND: The aim of the present study was to comparatively evaluate the outcomes of laparoscopic transabdominal preperitoneal inguinal hernia repair and totally extraperitoneal repair.

METHODS: The electronic databases of Medline, EMBASE, and the Cochrane Central Register of Controlled Trials were searched, and a meta-analysis of randomized clinical trials was undertaken.

RESULTS: Seven studies comprising 516 patients with 538 inguinal hernia defects were identified. A shorter recovery time (P = .02) was found for totally extraperitoneal repair in comparison with transabdominal preperitoneal inguinal hernia repair (weighted mean difference = −.29; 95% confidence interval [CI], −.71 to .07) although the length of hospitalization (P = .89) was similar in the 2 treatment arms (weighted mean difference = .01; 95% CI, −.13 to .15). Operative morbidity (P = .004) was higher for the preperitoneal approach (odds ratio = 2.15; 95% CI, 1.29 to 3.61). No differences were found with regard to the incidence of recurrence, long-term neuralgia, and operative time.

CONCLUSIONS: Current evidence suggests similar operative results for endoscopic and laparoscopic inguinal hernia repair, with a trend toward higher morbidity for the preperitoneal approach. Randomized trials with a longer-term follow-up are needed in order to assess the effect of each approach on the prevention of recurrence.

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The introduction of synthetic materials in the surgical treatment of inguinal hernia has resulted in a significant decrease of recurrence rates during the past few decades.1 Since the early 1990s, laparoscopic techniques have entered the field of general surgery; the first cases of minimally invasive inguinal hernia repair were reported in 1994. Transabdominal preperitoneal (TAPP) inguinal hernia repair includes laparoscopic exploration of both inguinal areas and a further incision to the overlying peritoneal sheet in order to explore the myopectional orifices, to reduce hernia...
These 2 endoscopic modalities have been shown to reduce early postoperative pain,1–7 and considerable data support an earlier return to normal activities in comparison with open mesh repair.8–10 Furthermore, endoscopic repair allows revision surgery of recurrent hernias after anterior repair without the need to transect scar tissue, which has been shown to result in improved pain scores,11,12 although data on the incidence of rerecurrence are controversial.12–14

Both endoscopic modalities have gained wide popularity throughout the surgical community. Despite this rapid widespread use of minimally invasive techniques, recent guidelines issued by the International Endohermia Society underscored the lack of high-quality comparative evidence between endoscopic and laparoscopic inguinal hernia repair.15 A meta-analytic comparison of the 2 techniques, which was undertaken by the Cochrane Collaboration in 2005, has shown a higher incidence of visceral injuries and an increased risk for port-site hernias after TAPP repair.16 However, the power of this analysis was limited by the low quality of the included studies, and the authors emphasized the need for randomized trials in order to compare the outcome between endoscopic and laparoscopic hernia repair.

In view of the wide dissemination of minimally invasive techniques for inguinal hernia repair and the high prevalence of this surgical disease, evaluation of currently available high-quality comparative evidence of current modalities is essential. A systematic review and meta-analysis of randomized studies comparing the transabdominal peritoneal (TAPP) and totally extraperitoneal (TEP) repair modalities is essential. A systematic review and meta-analysis of randomized studies comparing the transabdominal peritoneal approach for inguinal hernia repair was undertaken, with the objective to evaluate the outcomes of the 2 techniques, as expressed by the incidence of recurrence, operative morbidity, length of surgery, chronic pain, and the time to resume to normal activities.

Materials and Methods

Eligibility criteria and study selection

An ad hoc protocol was established in order to predetermine the inclusion criteria and analytic methods. Randomized controlled trials (RCTs) comparing TAPP with TEP repair were considered for inclusion. No restrictions were applied with regard to the number of defects (unilateral/bilateral disease), site of defect (inguinal/scrotal/femoral hernia), type of hernia (direct/indirect/combined hernia), prior hernia repair (primary/recurrent hernia), hernia status (reducible/strangulated/incarcerated hernia), type of intervention (elective/urgent surgery), size of study population, demographic data (sex, age, and health status), follow-up time, and examined measures of outcome. The relative risk of recurrence was the primary outcome measure of the treatment effect in the present meta-analysis, whereas secondary outcome measures included in-hospital morbidity, long-term pain or sensory deficits, operative time, early postoperative pain (within 24 to 48 hours after surgery), length of hospitalization, and recovery time.

Search strategy

The electronic databases of the National Library of Medicine (Medline; provider Ovid, from 1966 to July 2011), Excerpta Medica (EMBASE; provider Elsevier, from 1980 to July 2011), and the Cochrane Central Register of Controlled Trials were searched in order to identify relevant articles. No language restrictions were applied, and abstracts of articles in other than the English language were translated. The Medical Subject Headings “laparoscopy” and “inguinal hernia” and the terms “TAPP,” “preperitoneal,” “properitoneal,” “TEP,” “totally extraperitoneal,” and “total extraperitoneal” were used in combination with the Boolean operators AND or OR (Appendix 1). A second-level manual search included the bibliography of the retrieved articles. The last search was run on July 30, 2011, and an update of the literature search was performed on August 12, 2012. Eligibility assessment was performed independently in an unblinded standardized manner by 2 reviewers. Disagreements between reviewers were resolved by consensus. The literature review conformed to Preferred Reported Items for Systematic Reviews and Meta-analyses (PRISMA) statement standards.17

Data collection and analysis

An electronic data extraction sheet was developed and refined accordingly. One review author extracted the data from the included studies, and a second author checked the extracted data. The latter included the following: year of publication; study design (single blinded/double-blinded/nonblinded RCT); number of participating institutions (single-center/multicenter RCT); number of participating patients; number of patients having completed the follow-up period; duration of follow-up time; type of follow-up evaluation (physical examination or telephone interview); demographic data of participants (age, sex, and concomitant diseases); inclusion and exclusion criteria; pain scoring system; disease characteristics of the examined patient populations including the number of defects (unilateral/bilateral hernia), site of defect (inguinal/scrotal/femoral hernia), type of hernia (direct/indirect/combined hernia), prior hernia repair (primary/recurrent hernia), hernia status (reducible/strangulated/incarcerated hernia), prosthetic material used, and method of mesh fixation; and study outcome measures including operative time, amount of blood loss, intraoperative complications, postoperative complications, pain score within 24 to 48 hours, length of hospitalization, time to resume to normal activities, and number of patients suffering from long-term pain or sensory deficits. Outcome data were collected upon completion of the follow-up period in all studies. The authors of
studies fulfilling the inclusion criteria were formally contacted by electronic mail; they were informed about the purpose of the study and were asked to provide missing data and/or follow-up results of their study. In order to assess the methodologic quality of eligible RCTs, respective data from each study protocol were extracted, and the Jadad score was calculated. Study-specific estimates were combined using random-effects or fixed-effects models as appropriate. Weighted mean differences (WMDs) with 95% confidence intervals (CI) were calculated to assess the size of the effect of each type of procedure on continuous variables. Pooled odds ratios (ORs) with 95% CIs were calculated to measure the effect of each type of procedure on categorical variables. Heterogeneity among the trials was assessed using the $I^2$ statistic. Publication bias was assessed using the Egger regression intercept. Statistical analysis was performed using Comprehensive Meta Analysis Version 2.0 (Biostat, Englewood, NJ). Statistical expertise was provided by 1 of the study authors (G.A.A.).

Results

Search results and study selection

A total of 248 records were identified through the electronic search of the databases. The second-level manual search of the included articles identified 1 additional randomized trial. Based on the abstract, 220 articles were discarded as nonrandomized studies and another 23 as non-relevant RCTs. No duplicate studies were identified in the searched electronic databases. The primary literature search identified 6 eligible RCTs, and the updated literature search identified a further eligible RCT. A total of 7 articles fulfilled the eligibility criteria and were included in the meta-analysis.

Study characteristics

The selected studies were published in English. The year of publication ranged between 1996 and 2012; 5 studies have been published within the past 5 years. One study was single blinded, and another was double blinded. The remaining studies failed to report on whether a blinded approach was applied. All but 1 were single-center studies. Four of the 7 included articles reached a Jadad score of 1 or 2. The follow-up period ranged between 3 months and 3 years, with a mean duration of 23.4 months. The type of follow-up examination for the diagnosis of recurrence was specified in 5 articles (ie, physical examination), whereas additional ultrasound examination was performed by 1 author team if hernia recurrence was clinically suspected. The visual analog score in a 10-point scaling system was used to assess postoperative pain in 4 studies. One study used a modified 5-point scaling system, and another did not measure postoperative pain. Only 1 author team responded to our query on data not provided in the published article; however, follow-up data of this trial were not available at the time the present study was written. Regarding the inclusion criteria, most authors considered patients with primary unilateral inguinal hernia, whereas 1 study exclusively enrolled patients with recurrent hernia. Irreducible or incarcerated hernia was commonly considered as an exclusion criterion. The study characteristics are summarized in Table 1.

A total of 516 participants with 538 hernia defects were enrolled. The size of the study cohorts ranged between 44 and 119 patients. Ninety-six percent (462/477) of the patients were men, and the mean age was 48.1 years. Details on demographic and disease characteristics of the study populations are presented in Table 2. Two patients with bilateral disease were included in 1 study. However, the expressed outcome (percentage values) was presented for unilateral disease; therefore, it was assumed that only 1 side was operated on. Analytic data were provided by a second study, which enrolled 22 patients with bilateral disease. Polypropylene mesh was used by all authors providing relevant data; however, the prosthetic material was not specified in 1 study. Fixation of the mesh was performed with a conventional stapler in 1 study and with a conventional tacker in another; another author team did not fixate the preshaped mesh on the abdominal wall or the pubic tubercle, whereas the remaining studies did not specify whether the mesh was fixated or not.

Synthesis of results and outcome

A summary of outcome data of the included studies is presented in Table 3.

Hernia recurrence. The incidence of hernia recurrence was 3.1% for laparoscopic repair and 2.4% for endoscopic repair (OR = 1.03; 95% CI, 0.36 to 2.94; $P = .96$). There was no evidence of study heterogeneity ($I^2 = 0\%)$, and the evidence of publication bias was low ($P = .15$) (Fig. 1).

Operative morbidity. The morbidity rate was 24.8% for laparoscopic repair and 11.9% for endoscopic repair (OR = 2.15; 95% CI, 1.29 to 3.61; $P = .004$). No significant heterogeneity among studies was identified ($I^2 = 0\%)$, and the likelihood of publication bias was low ($P = .75$) (Fig. 2).

Sensitivity analysis, which excluded a study that considered analgesic consumption as a complication and another study that enrolled only patients with recurrent hernias, showed marginal results in favor of the TEP approach (OR = 1.85; 95% CI, .96 to 3.56; $P = .07$). Heterogeneity was minimal ($I^2 = 3\%)$ with low evidence of publication bias ($P = .82$).

Long-term pain or sensory deficits. The incidence of long-term pain or sensory deficits was 5.7% for the laparoscopic group and 8.7% for the endoscopic group (OR = .63; 95% CI, .74 to 1.99; $P = .37$). Heterogeneity was significant among studies ($I^2 = 96\%)$, whereas publication bias was low ($P = .79$) (Fig. 3).
Table 1  Summary of characteristics of RCTs comparing TAPP versus TEP

<table>
<thead>
<tr>
<th>Study</th>
<th>Year of publication</th>
<th>Study design</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
<th>Duration of follow-up</th>
<th>Type of follow-up</th>
<th>Jadad score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schrenk et al</td>
<td>1996</td>
<td>Single-center RCT</td>
<td>Elective surgery, unilateral inguinal hernia</td>
<td>Recurrent or incarcerated inguinal hernia</td>
<td>3 months</td>
<td>Physical examination</td>
<td>2</td>
</tr>
<tr>
<td>Dedemadi et al</td>
<td>2006</td>
<td>Single-center RCT</td>
<td>Recurrent inguinal hernia</td>
<td>ASA III or IV, coagulation disorders, previous abdominal or pelvic surgery, irreducible hernia, ascites, previous TAPP</td>
<td>3 years</td>
<td>Physical examination</td>
<td>3</td>
</tr>
<tr>
<td>Butler et al</td>
<td>2007</td>
<td>Single-center, double-blinded RCT</td>
<td>Primary unilateral inguinal hernia</td>
<td></td>
<td>NR</td>
<td>Physical examination at 7-day intervals until patients returned to work</td>
<td>4</td>
</tr>
<tr>
<td>Pokorny et al</td>
<td>2008</td>
<td>Multicenter RCT</td>
<td>Age 19–85 years, primary unilateral inguinal hernia</td>
<td>unfit for general anesthesia, incarcerated, recurrent, bilateral or femoral hernia recurrent, irreducible or obstructed inguinal hernia, previous surgery of the lower abdomen, coagulopathy, COPD, constipation, obstructive uropathy</td>
<td>3 years</td>
<td>Physical examination</td>
<td>2</td>
</tr>
<tr>
<td>Gong et al</td>
<td>2011</td>
<td>Single-center RCT</td>
<td>Male gender, age 30–70 years, ASA 1/2, primary unilateral inguinal hernia</td>
<td>Urgent surgery, previous surgery of the lower abdomen, irreducible, giant, bilateral or recurrent hernia</td>
<td>15.6 months*</td>
<td>Physical examination at 1 week and 1 month then phone interview</td>
<td>1</td>
</tr>
<tr>
<td>Krishna et al</td>
<td>2012</td>
<td>Single-center RCT</td>
<td>Primary inguinal hernia</td>
<td>Previous surgery of the lower abdomen, irreducible, strangulated or recurrent hernia, coagulopathy, poor surgical candidates, diabetes, hypertension</td>
<td>29.5 months*</td>
<td>Physical examination</td>
<td>3</td>
</tr>
</tbody>
</table>

ASA = American Society of Anesthesiologists classification system; COPD = chronic obstructive pulmonary disease; NR = not reported; RCT = randomized controlled trial; TAPP = transabdominal preperitoneal; TEP = totally extraperitoneal repair.

*Mean value.
Hospital stay. Five studies reported on the length of hospital stay, and 3 provided the respective P values or CIs. The mean length of hospitalization was 3.3 days for the laparoscopic group and 2.7 days for the endoscopic group (WMD = 0.60 minutes for the laparoscopic group and 66.0 minutes for the endoscopic group). Operative time. The mean length of surgical time was 82%), whereas the likelihood of publication bias was low (P = .11).

Operative time. The mean length of surgical time was 60.0 minutes for the laparoscopic group and 66.0 minutes for the endoscopic group (WMD = −.13; 95% CI, −.64 to −.39; P = .63). Significant evidence of heterogeneity among the studies existed (I² = 82%), whereas the likelihood of publication bias was low (P = .41).

Recovery time. The mean time to resume to normal activities was 8.5 days for the laparoscopic group and 8.0 days for the endoscopic group (WMD = −.29; 95% CI, −.71 to −.07; P = .02). There was no evidence of between-study heterogeneity (I² = 0%) and a low evidence of publication bias (P = .87).

Table 2 Demographic and disease characteristics of the included study populations

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of patients</th>
<th>Mean age (y)</th>
<th>Male/female (n)</th>
<th>Type of hernia defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schrenk et al 19</td>
<td>52</td>
<td>40.6</td>
<td>46/6</td>
<td>Direct, n = 15; indirect, n = 37</td>
</tr>
<tr>
<td>Dedemadi et al 20</td>
<td>49</td>
<td>NR</td>
<td>NR</td>
<td>Nyhus II, n = 30; Nyhus IIIa, n = 15;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nyhus IIIc, n = 5; bilateral, n = 2</td>
</tr>
<tr>
<td>Butler et al 21</td>
<td>44</td>
<td>NR</td>
<td>44/0</td>
<td>Direct, n = 20; indirect/scrotal, n = 72;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>combined, n = 10</td>
</tr>
<tr>
<td>Pokorny et al 22</td>
<td>119</td>
<td>48.7</td>
<td>121/8</td>
<td>Direct, n = 44; indirect, n = 78;</td>
</tr>
<tr>
<td>Hamza et al 23</td>
<td>50</td>
<td>35.8</td>
<td>50/0</td>
<td>Direct, n = 20; bilateral, n = 22</td>
</tr>
<tr>
<td>Gong et al 24</td>
<td>102</td>
<td>56.5</td>
<td>102/0</td>
<td></td>
</tr>
<tr>
<td>Krishna et al 25</td>
<td>100</td>
<td>49</td>
<td>99/1</td>
<td></td>
</tr>
</tbody>
</table>

NR = not reported.

Comments

Surgical treatment of inguinal hernia intends to restore the anatomic components of the inguinal canal and provide long-term relief from associated symptoms. Less invasive approaches have gained wide popularity, providing lower long-term relief from associated symptoms. Less invasive inguinal hernia repair is associated with late rather than early recurrence. Randomized studies with longer-term follow-up periods are justified.

Furthermore, the incidence of surgical perioperative complications was significantly higher for the preperitoneal approach. This outcome is more pronounced by the low level of between-study heterogeneity and the consistency of results in favor of the transabdominal approach. However, when interpreting this parameter, it should be taken into account that the high morbidity rates (ie, 11.9% for endoscopic repair and 24.8% for laparoscopic repair) may be mainly attributed to the results of 2 single studies. Pokorny et al 22 considered analgesic consumption as a postoperative complication in 8.4% of their patient population, whereas Dedemadi et al 20 observed a high incidence of local complications in their series of recurrent hernia repair. If we exclude these studies from the calculated operative morbidity, the incidence of surgical complications for the laparoscopic and the endoscopic repair are 8.7% and 7.9%, respectively. Nevertheless, sensitivity analysis could show a trend toward higher operative morbidity for the TEP repair although the difference in pooled relative risks was marginal.

Current evidence suggests significantly longer duration of surgery for endoscopic approaches in comparison with open repair. The present analysis did not show a significant difference between the TAPP and the TEP repair with regard to operative time (57.6 vs 67.1 minutes, respectively), whereas significant heterogeneity existed among studies. The lack of standardized techniques for minimally invasive inguinal hernia repair is a pragmatic issue and is reflected by the wide variety of technical details presented in the contemporary literature. Modification and standardization of the operative steps, such as the method of entrance into the preperitoneal space and the creation of the operative space, the extent of dissection, the size and type of mesh, and the fixation of the mesh, may result in a reduction of operative times in TEP repair. Similarly, the location of the peritoneal incision, the extent of preperitoneal...
dissection, the management of the hernia sac, the fixation of the mesh, and the type of peritoneal closure are subjects for further evaluation with regard to their clinical effect on patient-oriented outcomes and the length of surgery in the context of laparoscopic hernia repair.

The posterior approach of minimally invasive techniques seems to result in improved pain scores, a lower incidence of sensory deficits, a shorter hospital stay, and a reduced recovery time after inguinal hernia repair in comparison to open mesh techniques. In these terms, no significant differences were found between the 2 treatment arms although the mean time to resume to normal activities was slightly shorter for the endoscopic group (8.5 vs 8.0 days). Nevertheless, further evaluation of controversial operative trends, including the need for mesh fixation, the use of lightweight prosthetics, and the extent of dissection, may further reduce the incidence of long-term pain and sensory complications and the length of hospitalization.

Although similar outcomes were shown for endoscopic and laparoscopic inguinal hernia repair in the present analysis, clinical interpretation of these results must be performed with caution. It is noteworthy that several institutions routinely use either the endoscopic or the laparoscopic technique, which provides a greater amount of experience and probably improved outcomes with a specific procedure. Furthermore, if we consider the high learning curves of endoscopic hernia repairs, transition to another technique is not justified for the present. However, the role of laparoscopic exploration in patients with risk factors for bilateral disease is strongly supported in the literature.

Furthermore, these results have to be interpreted with caution, considering the significant limitations of the cumulative analysis of the examined outcome measures. Follow-up periods varied significantly among studies, and long-term follow-up was performed by telephone interview by 1 author team. Although recurrent hernia was a criterion for exclusion in most studies, 1 article considered only patients with recurrent hernia for analysis and excluded those with primary hernia. Technical details were either not defined or inconsistently reported by participating studies. Furthermore, only 2 of the included studies were of excellent methodologic quality. A further limitation to this analysis may be introduced by the potential of publication bias. Although the incidence of hernia recurrence and operative morbidity have been addressed by all reports, the outcome variables of long-term pain and operative time were reported by only a few studies, hereby limiting the power to assess publication bias.

Current evidence suggests similar results for laparoscopic and endoscopic inguinal hernia repair with regard to the incidence of neuralgia and sensory deficits, operative time, and hospital stay. There is a trend toward higher operative morbidity for the preperitoneal approach. Randomized trials with a longer-term follow-up period are needed to further assess the relative effectiveness of the 2 procedures in the prevention of hernia recurrence.
Figure 1  Forest plot showing differences in the incidence of hernia recurrence for TAPP and TEP.

Figure 2  Forest plot showing differences in terms of operative morbidity for TAPP and TEP.

Figure 3  Forest plot showing differences in the incidence of long-term pain or sensory deficit after TAPP and TEP.
References

## Appendix 1  Search Strategy

<table>
<thead>
<tr>
<th>No.</th>
<th>Search term</th>
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<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>hernia, inguinal (abstract or text)</td>
</tr>
<tr>
<td>3</td>
<td>TAPP (abstract or text)</td>
</tr>
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<td>TEP (abstract or text)</td>
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<td>totally AND extraperitoneal (abstract or text)</td>
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<td>8</td>
<td>total AND extraperitoneal (abstract or text)</td>
</tr>
<tr>
<td>9</td>
<td>3 OR 4 OR 5</td>
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<tr>
<td>10</td>
<td>6 OR 7 OR 8</td>
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<tr>
<td>11</td>
<td>1 AND 2 AND 9 AND 10</td>
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