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Review

Comparison of laparoscopic versus open procedure in the treatment of recurrent inguinal hernia: a meta-analysis of the results

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Open procedure;
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Meta-analysis

Abstract

BACKGROUND: The aim of this meta-analysis was to compare the effectiveness and complications of the laparoscopic procedure and open techniques in the treatment of recurrent inguinal hernias.

METHODS: The electronic databases MEDLINE, Embase, PubMed, and Cochrane Library were used to search for randomized controlled trials and comparative trials about laparoscopic and open procedures on recurrent inguinal hernia repair from January 1999 to September 2012.

RESULTS: A total of 1,311 patients enrolled into 6 randomized controlled trials and 5 comparative studies were included in this meta-analysis. Our pooled data showed that the laparoscopic procedure was associated with a lower incidence of wound infection and a shorter sick leave. However, there were no differences in other complication rates or the operation time between the 2 methods.

CONCLUSIONS: The laparoscopic technique in the treatment of recurrent inguinal hernia was associated with less wound infection rates and a faster recovery to normal activity, whereas other complication rates, including the re-recurrence rate, were comparable between these 2 methods. Laparoscopic and open procedures could be performed with equal operation time.

Inguinal hernia is one of the most frequently performed operations in general surgery. The surgical techniques used to manage inguinal hernias are primary open repair, open tension-free repair with mesh, and laparoscopic repair with mesh. Despite the achievement in the field of treating hernias, the main concern for patients and surgeons is preventing recurrence. Recurrent rates of 1.1% to 33% have been reported depending on the technique and the type and size of the mesh used to repair the original hernia.[1–4] Reoperations account for 8% to 17% of all inguinal hernia repairs.[2,3,5] Recurrent inguinal hernia repair is a demanding procedure; this type of repair does not always have successful results, and higher recurrence and complication rates have been reported. The risk of re-recurrence for recurrent inguinal hernias is higher than the risk of recurrence after primary inguinal hernia repair; a recurrence rate of 8.3% was reported even in specialized centers,[6] and a recurrence rate as high as 40% has also been reported.[7]

The repair of recurrent inguinal hernia is frequently associated with increased technical difficulty, high morbidity, and a greater risk for further recurrence. However, although there is no doubt that recurrent inguinal hernia should be repaired using mesh,[8] the questions concerning the

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most appropriate treatment for this condition have not yet been answered. Some surgeons recommend laparoscopic repair, whereas others prefer open tension-free repair.[9,10] The open tension-free methods have the disadvantages of reoperating through scar tissue with the risk of testicular and nerve damage, whereas the main advantages are lower cost and a shorter learning curve.[11] The theoretical advantage of the laparoscopic technique is the avoidance of scarred tissue of the primary operation, permitting relative uncomplicated dissection for mesh placement, whereas the main drawbacks are the need for general anesthesia and the increased cost of the operating room and the disposable supplies used. Early reports indicated that the laparoscopic technique could have advantages over the open technique in terms of postoperative pain and the time to full recovery.[12]

However, these results are controversial because few studies have compared the different surgical techniques used to treat recurrent inguinal hernias, and some of the studies are small. Because of the obvious difficulties in recruiting patients, large randomized trials of recurrent hernia repairs do not exist; thus, meta-analysis studies on this topic would be essential for evaluating the results.

The objective of article was to use meta-analysis as a tool to compare the outcome of laparoscopic versus open mesh repair in recurrent inguinal hernia repair. The primary objectives of this meta-analysis were to determine whether the 2 different approaches produce any difference in postoperative complications and recovery with respect to postoperative acute and chronic pain, wound infection, hematomas/seromas, testicular and urinary complications, recurrence, and reoperation rate due to abdominal injuries and bleeding.

Methods

By conducting an intensive search of literature in the major database (PubMed, Embase, Springer, and Cochrane Library), we identified all randomized controlled trials (RCTs) and comparative trials published from January 1999 to and including September 2012 that compared laparoscopic and open mesh procedures for recurrent inguinal hernia repair. The term "recurrent inguinal hernia" was used in combination with the medical subject headings "laparoscopic," "open," and "repair." Reference list and relevant articles referenced in these primary studies were downloaded from databases. The related article function also was used to widen the search results. All abstracts, comparative studies, nonrandomized trials, and citations scanned were searched comprehensively. At last, the data from 11 publications (6 RCTs) including 1,311 patients were summarized in a formal meta-analysis. We first excluded 251 trials by using the keyword "laparoscopic." Furthermore, experimental trials, emergency trials, and reports other than inguinal hernias were excluded for analysis. Techniques other than transabdominal preperitoneal (TAPP) and total extraperitoneal procedure (TEP) were also excluded in the analysis (eg, intraperitoneal only mesh repair [IPOM], expanded polytetrafluoroethylene [ePTFE], and Shouldice techniques [n = 3]). Trials with incomplete

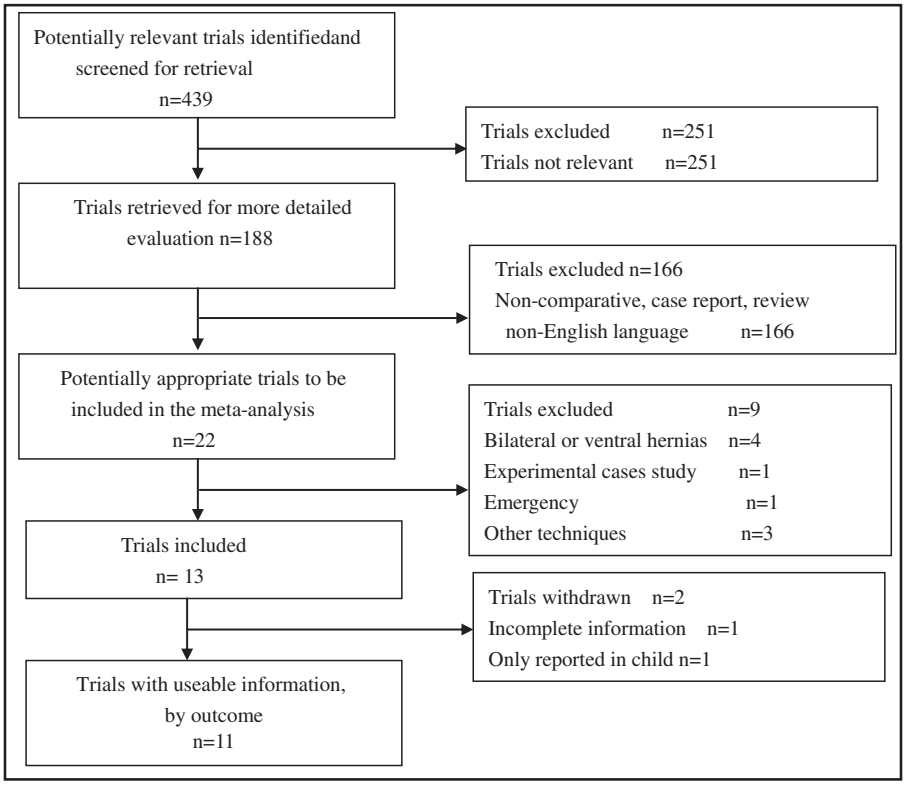

Figure 1 A flow diagram of the selection of trials.

information (eg, quality of life) that were not suitable for comparison were also excluded. A flowchart of the literature is shown in Fig. 1. Only published data were used in the analysis. The laparoscopic TAPP and TEP techniques were summarized in 1 group.

The quality of trials was assessed with the Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.1[13] and a quantitative analysis was performed to compare the following parameters: operating time, intra- and postoperative total morbidity, intestinal and bladder lesions, lesions of major vessels, wound infections, hematomas/seromas, urinary retention, time to return to normal work, testicular problems, acute pain and long-term complications such as chronic pain, and hernia recurrence. Each article was critically reviewed by 2 independent researchers for eligibility in the meta-analysis, and data were extracted separately by the 2 researchers. Disagreements were resolved by consensus.

Each included trial was assessed independently to ascertain the following methodological qualities: sequence generation, allocation concealment, blinding of participants, personnel and outcome assessors, incomplete outcome data, selective outcome reporting, and other sources of bias. No sponsors were involved in the study design, data collection, analysis and interpretation, or the writing and submitting of the report for publication. All authors had access to the raw data.

Pooled estimates of outcomes were calculated using a fixed effects model, but a random effects model was used according to heterogeneity. Tests for heterogeneity and overall effects were provided for each total or subtotal. We used the chi-square statistic to assess heterogeneity between trials, and the I^2 statistic to assess the extent of inconsistency. For dichotomous data, results for each trial were expressed as an odds ratio (OR) or risk difference (RD) with 95% confidence intervals (CIs).

Forest plots were used for the graphic display of results from the meta-analysis. Statistical analysis were performed using Review Manager (RevMan version 5.0), the Cochrane Collaboration's software for preparing and maintaining Cochrane systematic reviews.

Bias was studied using sensitivity analysis by removing individual studies from the data set and analyzing the overall effects size and weighted regression test described by Egger et al.[14] Publication bias was tested using the Egger test.

Results

Eleven trials[15–25] on laparoscopic versus open tension-free repair of recurrent inguinal hernia repair encompassing 1,311 patients were retrieved from electronic databases. Fig. 1 shows the flowchart of studies from the initial results of publication searches to the final inclusion or exclusion. Basic information and the methodological quality of the included trials are provided in Table 1.

Recurrence

There were 11 trials included in the present study that compared postoperative recurrence with long-term follow-ups.[15–25] There was no significant heterogeneity among 11 trials ($P = .32$, $I^2 = 13\%$); therefore, the fixed-effect model was appropriate. There was no significant difference in the recurrence rate between the laparoscopic and open groups (RD = −.01; 95% CI, −.04 to .01; Fig. 2A). In both the fixed and random effects model, the result was the same. To test the sensitivity of this results, we reanalyzed the recurrence rate in only RCT trials, and there was still no significant recurrence in the 2 groups (OR = −.01; 95% CI, −.06 to .03; Fig. 2B). Furthermore, this result was recalculated with relative risk and OR; the same conclusion was obtained. We

Table 1 Basic information and quality of the included studies

Author, year (reference)	Sample size	Comparison of techniques	Parameters compared	Type of publication	Follow-up time (mo)	Baseline comparable
Demetrashvili, 2011[15]	52	TAPP/LI	1, 2, 4, 5, 7, 8, 9	RCT	62.4	NA
Kouhia, 2009[17]	96	TEP/LI	1, 2, 4, 5, 8, 9, 10	RCT	63.6	NA
Eklund, 2007[18]	146	TAPP/LI	1, 2, 3, 4, 5, 6, 7	RCT	86.4	NA
Dedemadi, 2006[19]	82	TAPP/TEP/LI	1, 2, 3, 5, 6, 7, 8, 9	RCT	36	NA
Beets, 1999[22]	108	TAPP/GPRVS	1, 2, 4, 5, 6, 7, 8, 9, 10	RCT	24	NA
Neumayer, 2004[23]	159	TAPP/TEP/LI	1	RCT	24	NA
Shah, 2011[16]	172	TAPP & TEP/LI, MG, BA, ST	1, 2, 4, 5, 7	RE	144	$P > .05$
Feliu, 2004[20]	207	TEP/LI	1, 2, 3, 5, 6, 7, 8	PR	36	$P > .05$
Kumar, 1999[21]	50	TEP/LI	1, 2, 6, 7	PR	44	$P > .05$
Alani, 2006[25]	99	TEP/ST	1, 2, 4, 5, 6	PR & RE	120	$P > .05$
Richards, 2004[24]	140	TEP/LI	1, 5	RE	120	$P > .05$

The parameters compared are as follows: 1, recurrence; 2, hematomas/seromas; 3, acute pain; 4, chronic pain; 5, wound infection; 6, testicular problem; 7, urinary complication; 8, operating time; 9, recovery; 10, reoperation for bleeding or other reasons.

BA = bassini; F/U = follow-up; GPRVS = giant prosthetic reinforcement of the visceral sac; LI = Lichtenstein repair; MG = mesh plug; NA = not associated; PR = prospective; RCT = randomized controlled trial; RE = retrospective; ST = Stoppa repair; TAPP = transabdominal preperitoneal procedure; TEP = total extraperitoneal procedure.

further investigated the recurrence rate within these 2 groups during the early postoperative stage (<2 years) and late stage (>2 years). Our results showed no difference in the recurrence rate in the early period (RD = −.00; 95% CI, −.03 to .02) or late period (RD = −.01; 95% CI, −.04 to .01; Fig. 2C). Publication bias was also tested with the Egger test; no publication bias was detected among the present included articles (data not shown).

Pain

Eight[15–20,22,25] of the 11 trials reported postoperative pain. We analyzed acute pain and chronic pain (>3 months) separately. The fixed effects model was used in the acute pain analysis because of the heterogeneity (P = .74, I^2 = 0%), and the random effects model was used in the chronic pain group analysis because of the heterogeneity (P = .03, I^2 = 61%). Result showed there was no significant difference in acute and chronic pain between the laparoscopic and open groups (OR = .48; 95% CI, .14 to 1.69 and RD = −.04; 95% CI, −.10 to .02, respectively; Fig. 3A,B).

Wound infection

Nine studies[15–20,22,24,25] reported wound infection after operation. The main meta-analysis with the fixed effects

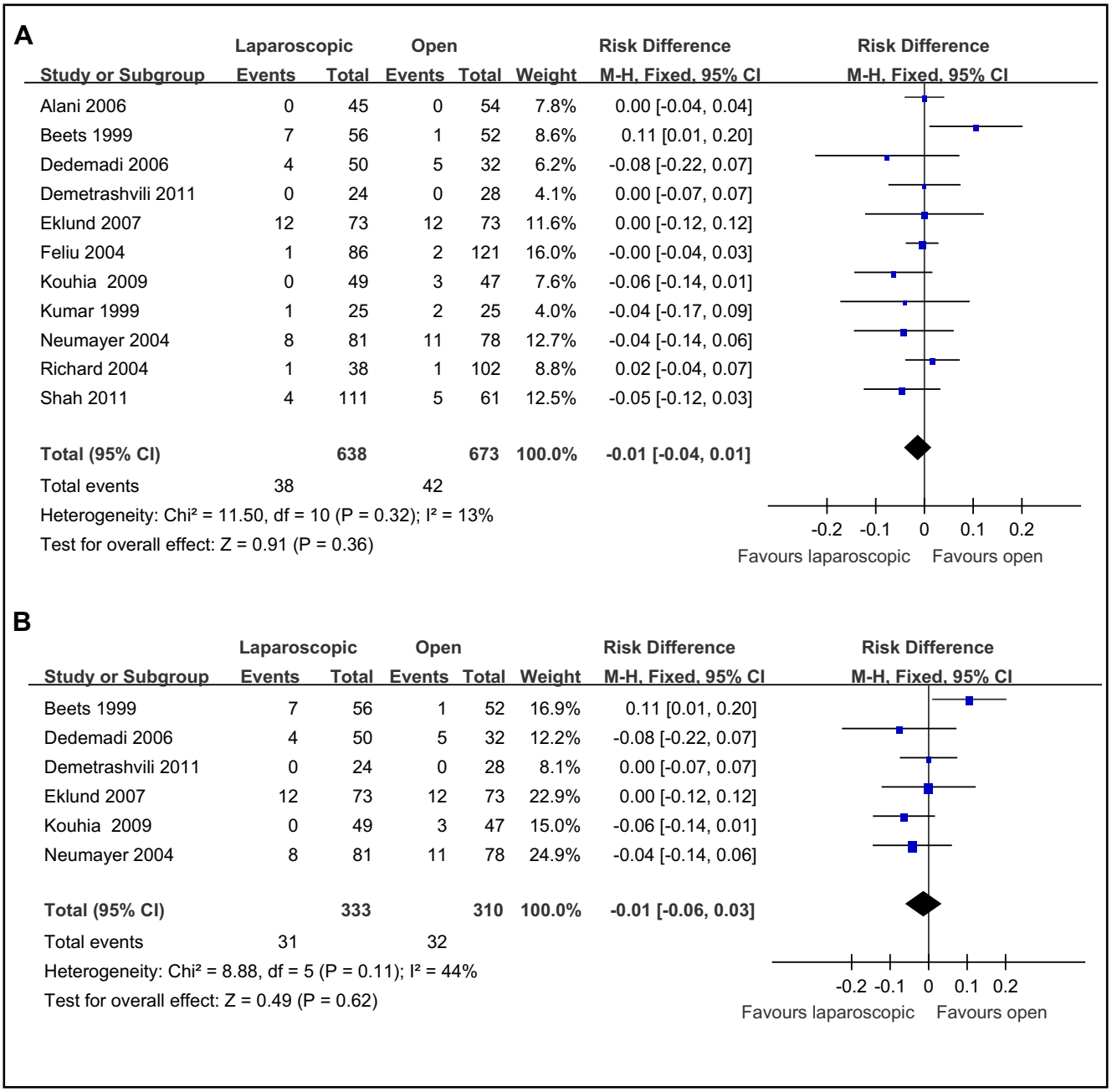

Figure 2 (A) Postoperative inguinal hernia recurrences. (B) Postoperative recurrence with only RCT trials. (C) Postoperative inguinal hernia recurrence in the early and late groups.

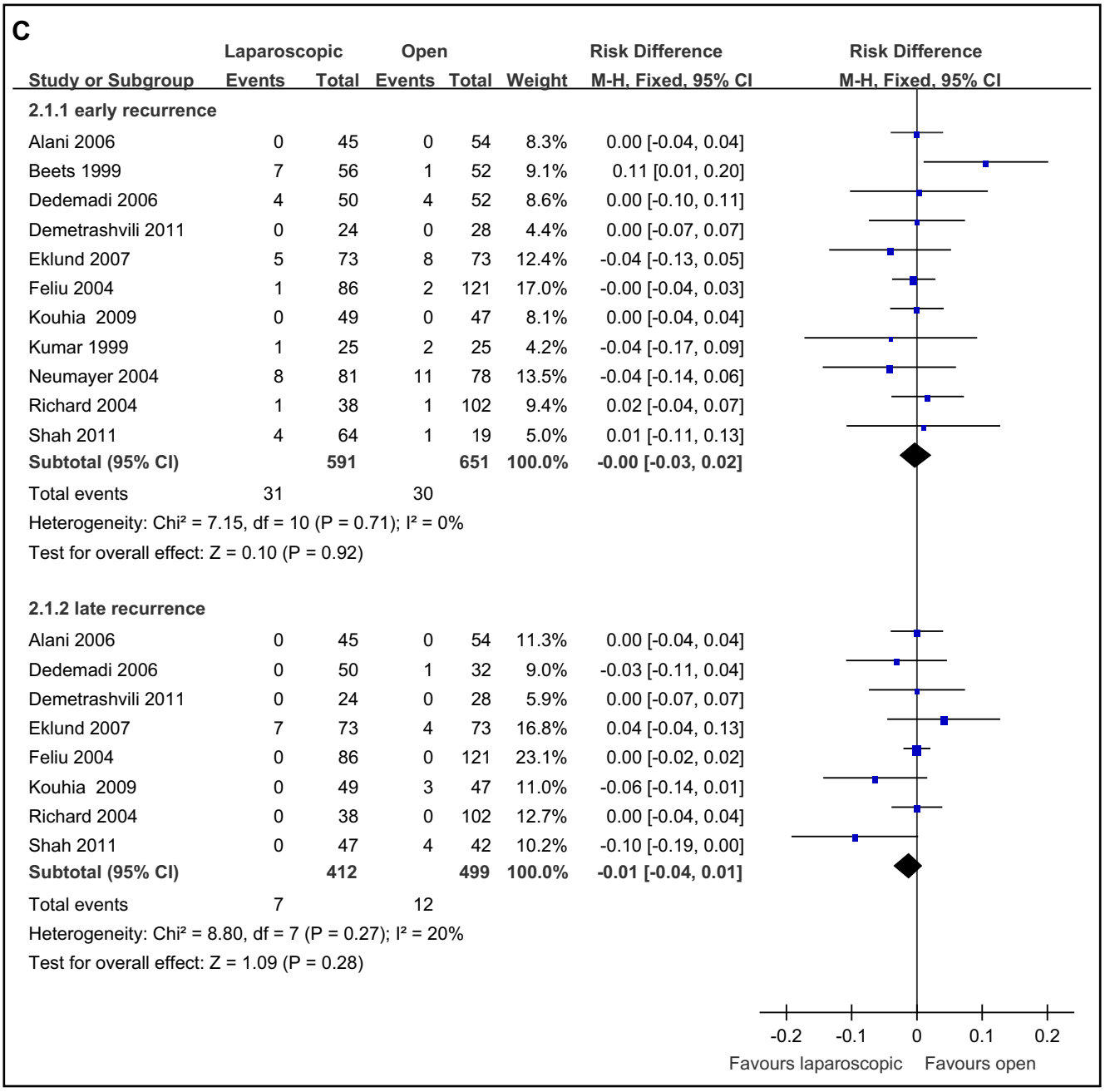

Figure 2 *(Continued)*

model showed statistically less wound infection in the laparoscopic group than the open group (RD = −.02; 95% CI, −.04 to −.00). The heterogeneity was not significant (P = .57, I^2 = 0%) (Fig. 4A). Sensitivity analysis was made to test the results in only RCT trials, and the same conclusion was obtained (OR = .23; 95% CI, .07 to .76; Fig. 4B).

Hematomas and seromas

Fig. 5 shows the incidence of hematomas/seromas after laparoscopic and open surgeries; 9 studies were included.[15–22,25] The random-effects model was used because of the heterogeneity (P = .009, I^2 = 59%). The results showed that there was no significant difference of hematomas/seromas between the laparoscopic and open repair groups (OR = .68; 95% CI, .36 to 1.30; Fig. 5).

Testicular problems

Six studies[18–22,25] reported postoperative testicular problems (including orchitis and pain). There was no heterogeneity among the trials (P = .17, I^2 = 36%), and therefore, the fixed effects model was used; the results showed no significant difference of testicular problems between the 2 groups (RD = −.02; 95% CI, −.04 to .01).

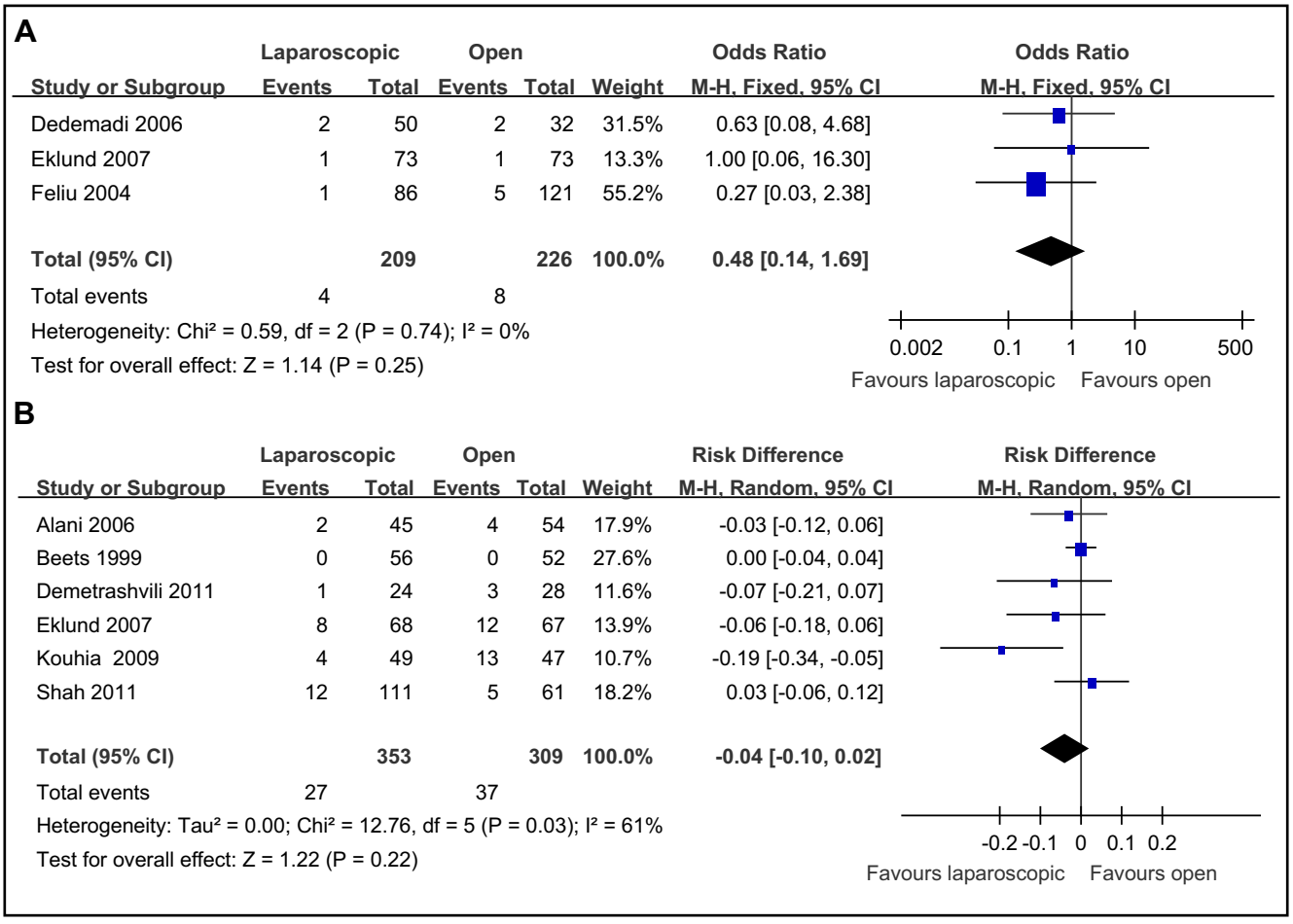

Figure 3 (A) Postoperative acute pain. (B) Postoperative chronic pain.

Urinary problems

Seven studies[15,16,18–22] reported the urinary retention and infection after hernia repair. The fixed effects model was used because of the heterogeneity ($P = .46$, $I^2 = 0\%$). The results showed that there was no significant difference of urinary problems between the 2 groups (OR = .82; 95% CI, .38 to 1.79).

Operation time

Five trials compared the operation time between the 2 groups.[15–17,19,20] One trial reported the results in 3 groups[19]; thus, we presented the results in 2 subgroup analysis (subgroups 1 and 2). There were significant heterogeneities in both subgroups ($P < .00001$, $I^2 = 92\%$ and $P < .00001$, $I^2 = 94\%$, respectively), and the random effects model was used in both subgroups. The results showed no difference in the operation time in the results of both subgroups ($P = .4$ in both subgroups) (Fig. 6).

Time to return to work

Four RCT trials reported the time to return to work or normal activity (sick leave) after laparoscopic and open repair.[15,17,19,22] Again, the results of 2 subgroups were presented because 1 trial reported results in 3 groups.[19] The random effects model was used because of heterogeneity ($P = .02$, $I^2 = 69\%$ and $P = .01$, $I^2 = 72\%$, respectively). The results showed a significantly shorter convalescence period after laparoscopic repair ($P < .00001$) in both subgroups (Fig. 7).

Reoperation rate

Only 2 trials[17,22] contributed to the combined analysis of reoperation rates; the reason for reoperation was either bleeding or ileus. There was no significant heterogeneity among trials ($P = .26$, $I^2 = 22\%$). There was no significant difference in the reoperation rate accordingly (OR = 1.34; 95% CI, .26 to 6.89).

Comments

The repair of recurrent inguinal hernia is a problematic issue; it is far more complex than the treatment of primary hernias. There is no doubt that recurrent inguinal hernia should be repaired with the application of meshes.[8] Several methods are proposed to solve this problem, including both open and laparoscopic methods; however, there are still

conflicting views regarding the indications of the application of these methods. Some surgeons recommend laparoscopic repairs,[5,17,26] whereas others prefer the open procedures.[27]

The laparoscopic procedure has the advantage of reducing the hernia sac through virgin tissues and covering the entire myopectineal orifice with a mesh. Furthermore, the laparoscopic method was shown to have the superiority of reduced postoperative pain, a shorter recovery period and earlier return to work, and accessibility to different potential hernia defects.[28,29] However, the laparoscopic procedure was reported to be more often associated with serious intraoperative complications than the open repair although such complications are infrequent.[30] Furthermore, the laparoscopic technique requires general anesthesia.[31] However, the main drawback with open tension-free recurrent inguinal hernia repair is dissection through the scarred tissue, which increases the risk of cord and testicular vessels injury or nerve injury, causing potential damage to the inguinal ligament.[11]

Only a few randomized trials have compared the results of laparoscopic and open procedures for recurrent inguinal hernias, and because of obvious difficulties in recruiting patients, large randomized trials of recurrent hernia repairs do not exist. Thus, a meta-analysis on this issue would be essential to evaluate the results. The aim of our trial was to perform a combined analysis of the immediate- and long-term results of the 2 different surgical approaches, the open tension-free procedures and the laparoscopic methods. In the present article, we combined TAPP and TEP repair in 1 group because a Cochrane database systemic review showed no obvious difference between TAPP and TEP concerning hematoma, vascular injuries, deep mesh infection, and recurrence, and further subgroup analysis would only hinder the statistical evaluation.[32]

From the patient's point of view, recurrence is the major concern after hernia repair.[5] It has been shown that the risk of recurrence is greater after surgery for a recurrent versus a primary hernia.[33] In the Swedish registry,[5] the reoperation

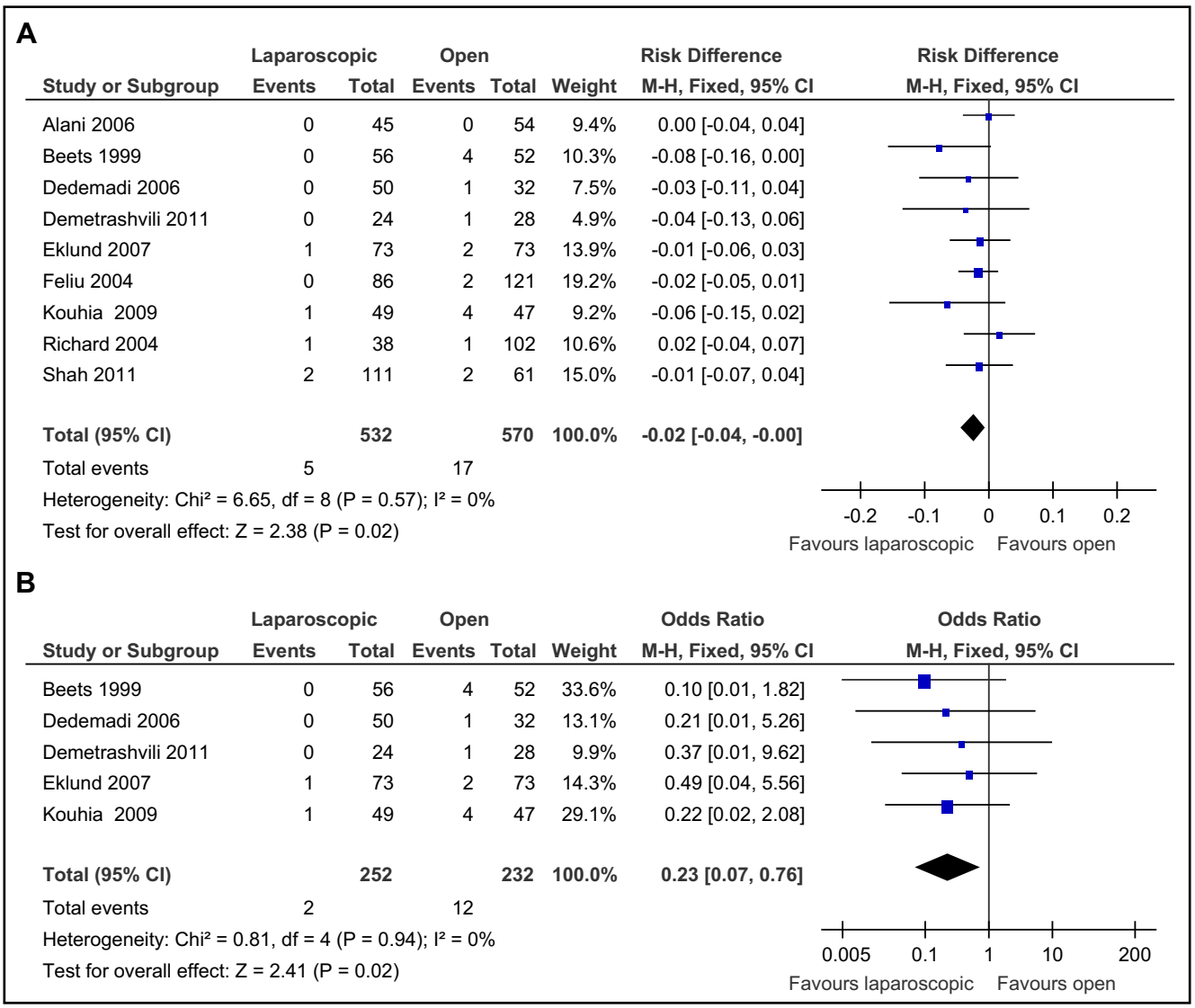

Figure 4 (A) Postoperative wound infection. (B) Postoperative wound infection analyzed in RCT trials.

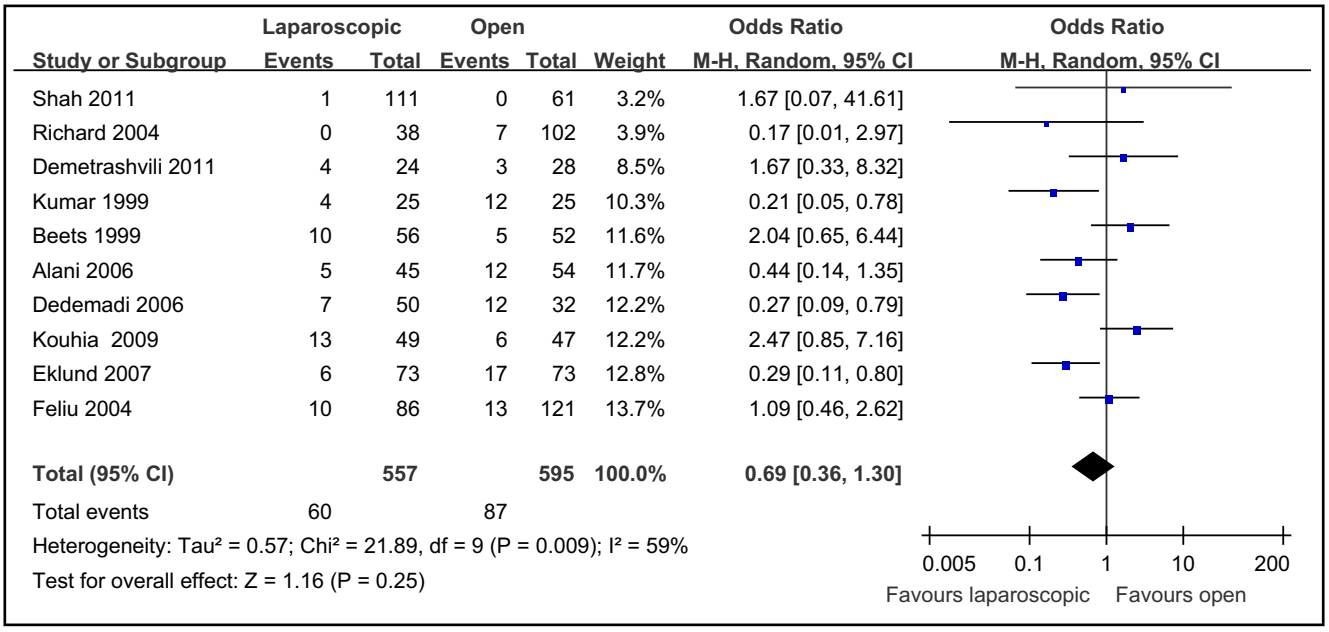

Figure 5 Postoperative hematomas and seromas.

rates were 4.6% after recurrent hernia repair versus 1.7% after primary hernia repair at the 24-month follow-up. In particular, the recurrence rate after recurrent hernia repair could be as high as 39% after conventional open surgery,[34,35] justifying the use of prosthesis for the management of recurrent hernias. There were conflicting results regarding the recurrence rate after laparoscopic and open procedure after recurrent inguinal hernia repair.[17,22,23] In the present pooled analysis, we found no significant difference in the recurrence rates between

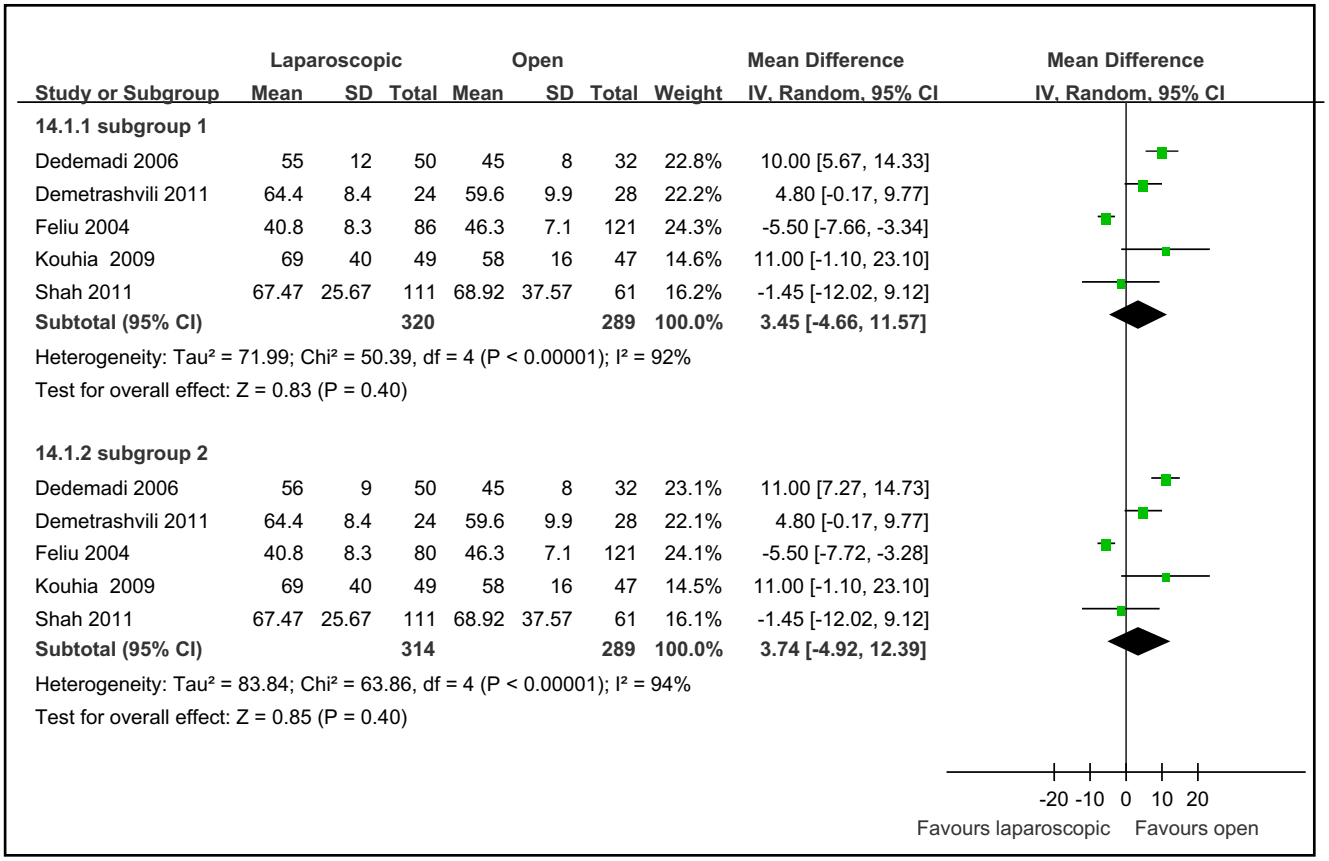

Figure 6 The operation time between the 2 groups.

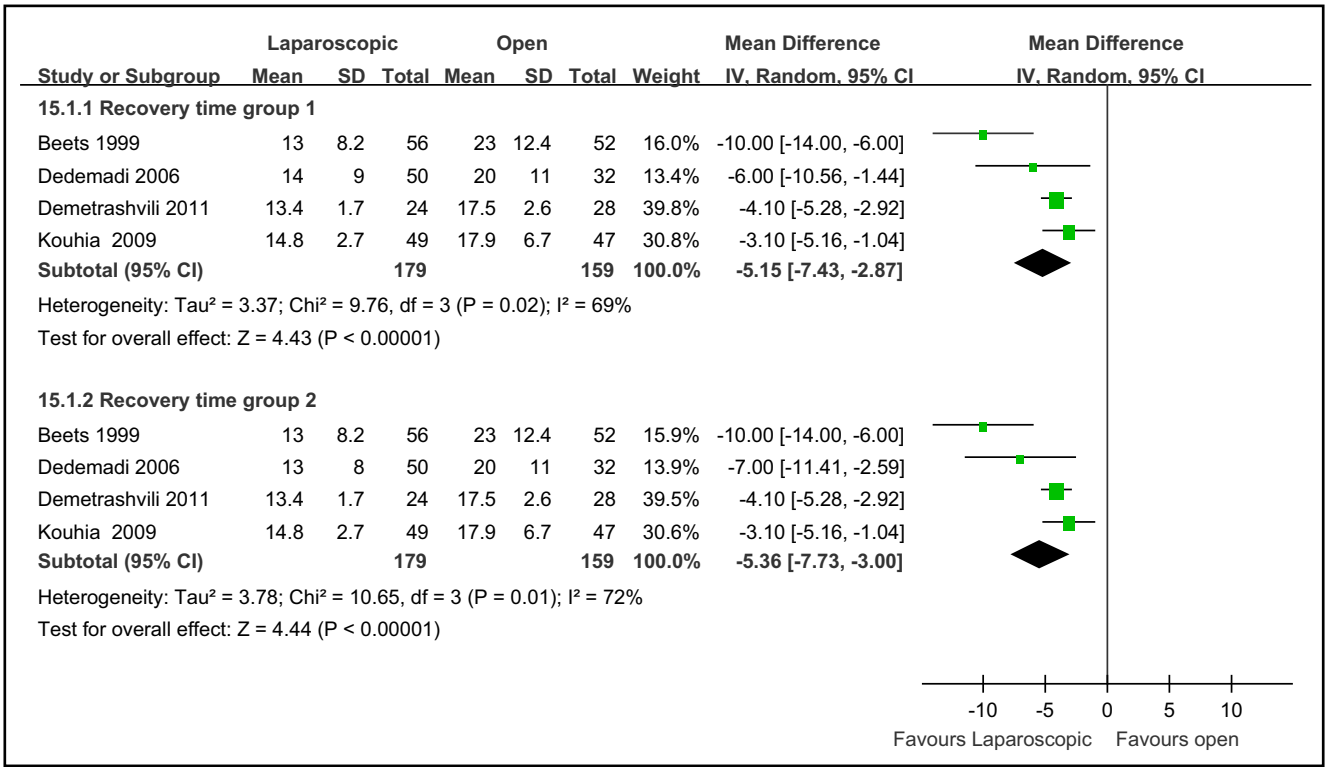

Figure 7 The time to return to work (sick leave) after repair between the 2 groups.

laparoscopic and open repair of recurrent inguinal hernia. In this study, sensitivity analysis was performed within the RCT trials, and publication bias was tested with the Egger test, showing no publication bias, which justified our comparisons.

Recently, Shah et al[16] reported that the laparoscopic technique had a significantly lower re-recurrence rate than the open technique during long-term follow-up (>1.5 years) in our meta-analysis. Therefore, we performed subgroup analysis for earlier (<2 years) and late recurrence (>2 years); contrary to Shah's study, we did not detected the different recurrence rates between the early and late periods.

A study by Arvidsson et al[36] showed a correlation between a low surgical performance score and the recurrence rate, which indicated that the recurrence rate is influenced by technical difficulties. It is argued that "poor results" of laparoscopic hernioplasty should be blamed on a lack of expertise and not the laparoscopic approaches per se.[37] Therefore, it was suggested that laparoscopic repair for recurrence should be restricted to highly experienced laparoscopic surgeons[38] and highly specialized laparoscopic centers.[23,39]

Pain after inguinal hernia repair was frequent. A study in England showed that chronic groin pain after hernia repair is 1 of the 2 most common causes of litigation.[40] Chronic pain was reported to be 18% to 30% after mixed open techniques at 3 years postoperatively.[41,42] An equal rate of chronic pain with significant effects on daily activities was reported for 12% of patients after both open and laparoscopic repair.[43] Others reported a higher prevalence of chronic pain after open hernia repair compared with a laparoscopic approach and attributed the reason for the difficulty to identifying nerve structures when operating through scar tissues formed after the previous surgical intervention. However, contrary results were also reported.[44] Furthermore, Grant et al[45] showed that the incidence of pain at 1 year was greater in the open group compared with the laparoscopic group, but at the 5-year follow-up, the incidence of pain in both groups was equal. In our present combined analysis, the incidences of both acute pain and chronic pain (>3 months) were analyzed, and both results proved to be similar between the open and laparoscopic groups.

Another severe complication after inguinal hernia repair is testicular atrophy, which was reported for 30% of patients after ischemic orchitis[46,47] and occurs for .09% to .5% of patients after primary hernia repair and 3% to 5% after recurrent hernia repair.[46,48] Our present study revealed similar testicular problem rates in both laparoscopic and open recurrent hernia repair.

We did not compare the hospital stay in this study because some hernias were repaired as a day surgery and others were not. With no surprise, we confirmed that the time to return to work and normal activity was significantly less in the laparoscopic group.

Previously, pooled analysis reported a significantly increased operating time in the laparoscopic repair group[49]; however, in our study, no significant difference in the operating time was noted between the open and laparoscopic

procedures. Contrary to another meta-analysis from Dedemadi et al,[50] which found all the compared outcomes were equivalent between laparoscopic and open procedure in recurrent hernia repair, we concluded in the present study that laparoscopic recurrent inguinal hernia repair was associated with less wound infection, a faster return to postoperative normal work and activity, and an equal duration of the operating time.

We also acknowledge the weak points in this meta-analysis. There were both RCTs and comparative studies in our analysis; although the baseline in each trial was comparable (>.05), it would be more apposite to only compare the RCTs.

In summary, our current study findings showed that the laparoscopic and open procedures are equally quick to perform with similar recurrence rates and postoperative acute and chronic pain. However, the laparoscopic procedures have the advantages of fewer postoperative wound infection rates and a quick return to normal work compared with open techniques.

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