Systematic review

Meta-analysis of patient-reported outcomes after laparoscopic *versus* open inguinal hernia repair

T. J. Patterson, J. Beck, P. J. Currie, R. A. J. Spence and G. Spence

Department of General Surgery, Ulster Hospital, Dundonald, BT16 1RH, UK
Correspondence to: Mr T. J. Patterson (e-mail: tpatterson02@qub.ac.uk)

Background: **Inguinal hernia repair is a common low-risk intervention. Patient-reported outcomes (PROs) are being used increasingly as primary outcomes in clinical trials. The aim of this study was to review and meta-analyse the PROs in RCTs comparing laparoscopic *versus* open inguinal hernia repair techniques in adult patients.**

Methods: **A systematic review and meta-analysis was carried out in accordance with PRISMA guidelines. Only RCTs in peer-reviewed journals were considered. PubMed, Ovid Embase, Scopus and the Cochrane Library were searched. In addition, four trial registries were searched. The search interval was between 1 January 1998 and 1 May 2018. Identified publications were reviewed independently by two authors. The review was registered in the PROSPERO database (CRD42018099552). Bias was assessed using the Cochrane Collaboration risk-of-bias tool.**

Results: **Some 7192 records were identified, from which 58 unique RCTs were selected. Laparoscopic hernia repair was associated with significantly less postoperative pain in three intervals: from 2 weeks to within 6 months after surgery (risk ratio (RR) 0·74, 95 per cent c.i. 0·62 to 0·88), 6 months to 1 year (RR 0·74, 0·59 to 0·93) and 1 year onwards (RR 0·62, 0·47 to 0·82). Paraesthesia (RR 0·27, 0·18 to 0·40) and patient-reported satisfaction (RR 0·91, 0·85 to 0·98) were also significantly better in the laparoscopic repair group.**

Conclusion: **The data and analysis reported in this study reflect the most up-to-date evidence available for the surgeon to counsel patients. It was constrained by heterogeneity of reporting for several outcomes.**

Paper accepted 22 January 2019
Published online 20 March 2019 in Wiley Online Library (www.bjs.co.uk). **DOI:** 10.1002/bjs.11139

Introduction

Inguinal hernia is a common surgical condition, with a lifetime risk in the UK of 27 per cent for men and 3 per cent for women. Hernia repair is one of the most common low-risk general surgical interventions in Europe and North America[1].

When assessing the efficacy of common low-risk procedures, traditional outcome measures may be less appropriate. Traditional quality measurements include: duration of surgery, length of hospital stay and mortality. Although important and easy to capture using routinely recorded data, they do not depict patients' postoperative recovery after low-risk procedures. Understanding patient experience, viewpoint and functional outcome after hernia surgery is crucial in evaluating different procedures, to provide informed patient-centred care and encourage standards to improve[2].

Patient-reported outcomes (PROs) may include any aspect of health or function which is patient-reported rather than observer-reported. The outcomes themselves may be either individual outcomes (such as symptoms, satisfaction ratings, time until return to specific activities) or summative outcomes produced from multiple information points (such as Short Form (SF) 12 and EuroQol Five Dimensions questionnaires). Patient-reported outcome measures (PROMs) are a common way for health-related quality of life to be reported[2].

However, their quality of reporting varies in the literature. In 2013 the PRO CONSORT guideline extension[3] was published. This extension of the pre-existing CONSORT guidelines provides a framework for the improved reporting of PROs in RCTs and their subsequent interpretation by clinicians.

To date, there has been no systematic review or meta-analysis of outcomes after inguinal hernia surgery

from the patient's perspective. The aim of this study was to summarize PROs from RCTs of laparoscopic *versus* open inguinal hernia repair.

Methods

This systematic review was conducted in accordance with the PRISMA statement[4]. A review protocol was registered with the PROSPERO systematic review database (CRD42018099552).

Study eligibility criteria

Adults diagnosed with an inguinal hernia (primary or recurrent) who were aged 18 years or more at time of intervention were included. Operative interventions were either laparoscopic or open repair, irrespective of type of repair, presentation (elective or emergency) or hospital setting (inpatient or outpatient).

The primary outcome was PROs, presented as both crude rates and, after meta-analysis, risk ratio (RR) or weighted mean difference (MD). Only RCTs were included. Only papers published in an indexed medical journal were included, with English as the language of publication; conference abstracts were excluded. Age of publication was restricted to the past two decades (1 January 1998 to 1 May 2018) and there were no geographical limitations. Only studies investigating surgical technique (rather than anaesthetic or analgesic) were analysed. Both unilateral and bilateral, primary and recurrent hernias were included.

Information sources and search

Four databases were searched: PubMed, Ovid Embase, Scopus and the Cochrane Library. The search strategy was 'Inguinal hernia' AND 'RCT'. Additionally, the ISRCTN register, ClinicalTrials.gov, ICTR Platform and EU Clinical Trials Register were searched with the phrase 'Hernia'.

For PubMed, the search was conducted using both Medical Subject Heading (MeSH) terms and the advanced search option. The MeSH terms ('Hernia, Inguinal') AND ('Randomised Controlled Trial') were used. An advanced search was conducted using the terms 'Hernia' AND 'Randomised controlled trial'. Ovid Embase and Scopus were searched with the same terms. The Cochrane Library and trial registries were searched using the term 'Hernia'.

Study selection and data collection process

Two independent reviewers reviewed all titles, placing any screened citations into an Excel® database (Microsoft, Redmond, Washington, USA). Duplicates were eliminated and, if possible, a decision was made on inclusion of each article based on the abstract. The full text was then assessed; disagreements between reviewers were resolved by consensus, or arbitration by a senior author, if necessary. If an RCT had been reported in more than one publication, the most recent publication that reported the trial was used as the reference article in this review. Once each author had completed data extraction, the data files were compared electronically, and discrepancies in data entry were investigated and resolved.

Data items

The following variables were recorded in an Excel® spreadsheet: basic information – first author, publication year and country of origin; demographic information – total number of patients, number of men and women in each group, number of hernias repaired in each group, minimum age, maximum age and median age; treatment information – type of open or laparoscopic repair used; and follow-up information – mean and median follow-up, planned follow-up interval and number of study participants who completed follow-up.

For each PRO, the data recording method, score and crude rate, and time after surgery when data were collected was recorded. If values were recorded at multiple time points during follow-up for each variable, the value recorded at the last time point was reported. Pain, which was expected to be the most common PRO, was subdivided into: postoperative (0–2 weeks), acute (from 2 weeks to within 6 months), early chronic (6 months up to 1 year) and later chronic (after 1 year). For studies that reported pain as visual analogue scale (VAS) data, the only patients included in the present analysis were those who experienced moderate or severe pain, represented by a VAS score of over 4 on a scale from 1 to 10. Outcome values for all other PROs were grouped. Mean duration of follow-up was presented for each outcome.

Risk of bias in individual studies and across studies

Two authors assessed the potential bias independently using the Cochrane Collaboration risk-of-bias tool[5].

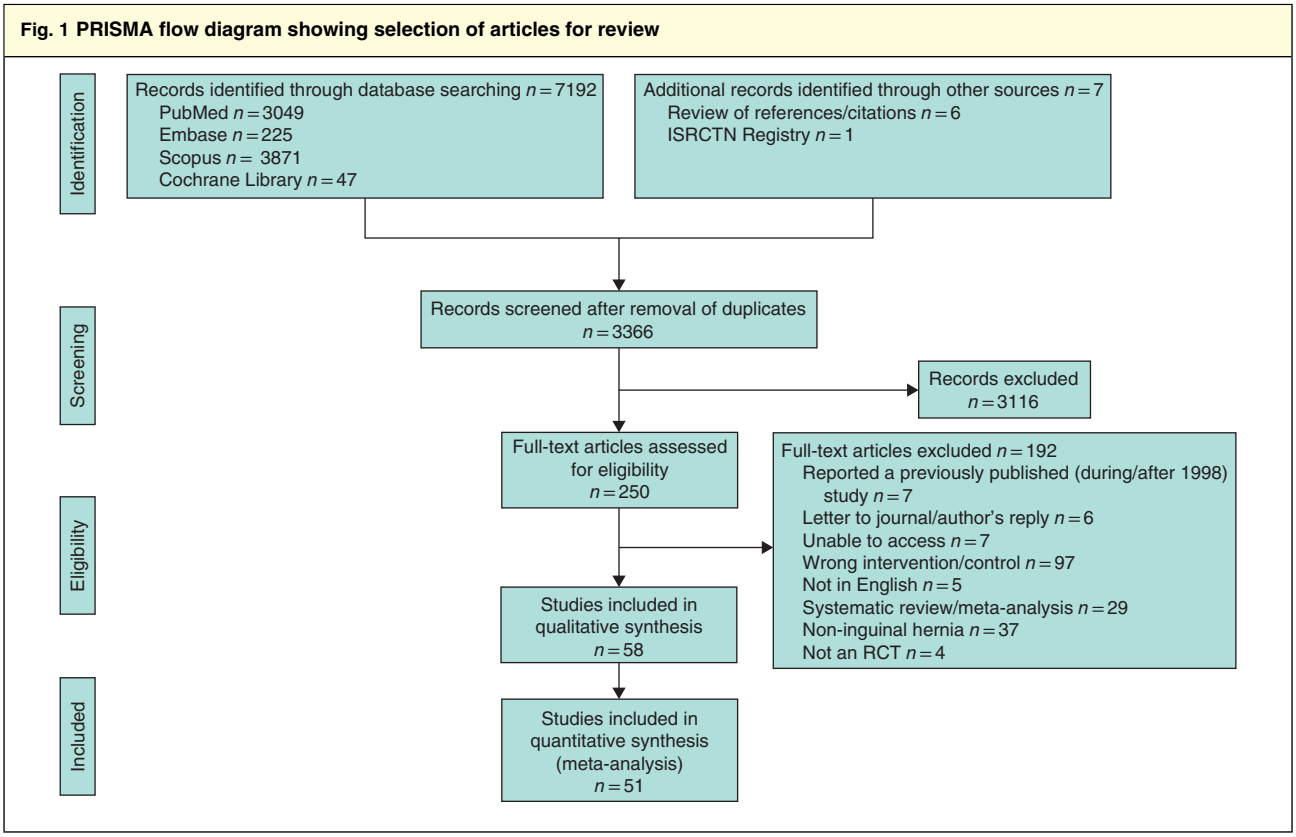
Summary measures and synthesis of results

PROs are shown as crude rates and, if appropriate, mean scores.

Meta-analysis

Meta-analysis was undertaken for each distinct outcome if there were two or more RCTs that examined the same

Fig. 1 PRISMA flow diagram showing selection of articles for review



outcome. The outcome groups were divided into open and laparoscopic, with subdivision into specific techniques if there were sufficient data (2 or more homologous studies).

Review Manager 5 software (The Nordic Cochrane Centre, Copenhagen, Denmark) was used for results synthesis[6]. If the outcome data were presented in the form of dichotomous categorical variables, RRs were reported with corresponding 95 per cent confidence intervals. Statistical heterogeneity between studies was checked and reported using the I^2 measure of study heterogeneity. If low heterogeneity between studies was reported (I^2 below 50 per cent), a fixed-effect model was used[7]. If higher heterogeneity was evident, a random-effects model was used. If a meta-analysis had a heterogeneity of more than 75 per cent, it was excluded from the results. The MD was calculated for outcome data presented in the form of continuous data[8].

The primary summary measure of the meta-analysis was RR, with 95 per cent confidence intervals. If the total number of a specific event was zero for any given study, the study was still entered into the overall data pool. A sensitivity analysis was also undertaken. Only studies in which the majority of areas of potential bias (4 or more) were low risk were analysed.

Results

Study characteristics

Sixty-seven studies met the inclusion criteria. Nine studies had the same participants with different durations of follow-up, resulting in 58 RCTs[9–66] with unique populations (*Fig. 1*).

A total of 17 510 randomly assigned patients were included in this analysis; 8475 patients underwent laparoscopic hernia repair and 9035 had open hernia repair. There were 18 431 inguinal hernia repairs included in the analysis. The studies used different open techniques, Lichtenstein repair being the most common (38 studies), followed by Shouldice (14), Stoppa (5), Bassini (4), narrowing on the internal inguinal ring (2), plication with darn (2), properitoneal repair (1), Jean Rives repair (1), Nyhus repair (1), mesh plug (1) and Kugel repair (1). Two laparoscopic techniques, totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP) repair, were encountered, in

27 and 31 studies respectively. Details of the studies are described in *Table S1* (supporting information).

Patient characteristics

Patient characteristics were heterogeneous regarding both sex and age. Of 48 studies that reported the sex of the population, 23 included men only. Across the 48 studies, 97·6 per cent of the population were men in the laparoscopic group, and 97·8 per cent in the open group. The mean or median age of study participants was reported in 51 studies, and ranged from 23·6 to 65·4 years. Study-specific patient characteristics are summarized in *Table S2* (supporting information).

Risk of bias within studies

An individual risk-of-bias analysis for each study is presented in *Table S3* (supporting information).

Crude rates and results of meta-analysis

Results of comparisons of laparoscopic *versus* open procedures are described in the text. Technique subgroup analyses are shown in *Table 1*. Pain was the most commonly reported PRO, with 57 of 58 studies reporting this as an outcome.

Postoperative pain

Thirty studies[10,11,13,15–17,19,23–25,27,35–37,39,44–48,52,53,55–58,61,63,65,66] (52 per cent) reported pain within the first 2 weeks after surgery, with 4616 patients randomized in the open repair group and 4585 in the laparoscopic repair group.

Nine studies reported this as a dichotomous variable (pain *versus* no pain). The crude rate of pain at last follow-up during this interval was 4·3 (range 0–8·9) per cent in the open group and 4·4 (1·4–18·2) per cent in the laparoscopic group, after a mean(s.d.) of 7·4(4·3) (range 2–14) days. Meta-analysis demonstrated no significant difference between the open and laparoscopic groups (RR 0·86, 95 per cent c.i. 0·63 to 1·16) (*Fig. 2*). All trials included in this group were rated as having a low risk of bias, so a sensitivity analysis was not carried out.

Twenty-one studies reported pain as a mean VAS score. The crude mean VAS score, on a scale from 1 to 10, at last follow-up during this interval was 2·98 (range 0·6–5·2) in the open repair group and 2·27 (0–4·2) in the laparoscopic group, after a mean of 7·1(5·1) (range 0·5–14) days. Eleven studies also reported s.d. values along with mean scores, which allowed meta-analysis. This demonstrated that the laparoscopic group had significantly lower pain scores (MD −0·69, 95 per cent c.i. −0·78 to −0·61). After exclusion of trials at high risk of bias, the laparoscopic group still showed better clinical results (MD −0·31, −0·40 to −0·21).

Acute pain

Thirteen studies[15,16,23,26,27,31,42,47,50,57,62,63,65] (22 per cent) reported pain as an outcome more than 2 weeks and less than 6 months after surgery; 2115 patients were randomized to open hernia repair and 1988 to laparoscopic repair.

Ten studies reported this as a dichotomous variable. The crude rate of pain at last follow-up during this interval was 11·5 (range 0–16·4) per cent in the open repair group and 8·4 (0–22·7) per cent in the laparoscopic group, after a mean(s.d.) of 2·2(0·9) (range 1–3) months. Meta-analysis showed that there was significantly less pain reported in the laparoscopic group (RR 0·74, 95 per cent c.i. 0·62 to 0·88) (*Fig. 3*). After exclusion of trials at high risk of bias, the laparoscopic group still had better clinical results (RR 0·68, 0·54 to 0·86).

Three studies reported pain as a mean VAS score. The crude mean VAS score (scale from 1 to 10) at last follow-up during this interval was 2·3 (range 0·5–3·3) in the open repair group and 1·5 (0–2·5) in the laparoscopic group, after a mean(s.d.) of 2·0(0·9) (range 1·5–3) months. Two studies also reported s.d. values along with mean scores, which allowed meta-analysis; this showed that the laparoscopic group had significantly lower pain scores (MD −0·88, 95 per cent c.i. −1·39 to −0·36).

Early chronic pain

Twenty studies[9,12,13,16,18,20,26,29–31,33,38,40,43,48–50,55,57,66] (34 per cent) reported pain between 6 months and up to 1 year, with 3133 patients randomized to open hernia repair and 2999 to laparoscopic hernia repair.

All studies reported this as a dichotomous variable. The crude rate of pain at last follow-up during this interval was 13·4 (range 0–34·9) per cent in the open repair group and 10·3 (0–27·7) per cent in the laparoscopic group, after a mean(s.d.) of 9·7(3·0) (range 6–12) months. Meta-analysis showed that significantly less pain was reported in the laparoscopic group (RR 0·74, 95 per cent c.i. 0·59 to 0·93) (*Fig. 4*). After exclusion of trials at high risk of bias, the laparoscopic group still had less chronic pain at this stage (RR 0·75, 0·60 to 0·95).

Later chronic pain

Twenty-one studies[12,14,16,18,22,23,28,29,34,37,41,42,45,48,51,57,59,60,62–64] (36 per cent) reported pain as an outcome after 1 year, with 4481 patients randomized in the open repair group and 4290 in the laparoscopic repair group.

Table 1 Subgroup analysis of included studies

Patient-reported outcome	Outcome categories	Subgroups	Result	Effect size
Postoperative pain	Pain *versus* no pain	TAPP *versus* Lichtenstein[15,39,47]	Favoured neither	RR 0·55 (0·28, 1·07)
		TEP *versus* Lichtenstein[16,23,46]	Favoured neither	RR 0·76 (0·43, 1·34)
	Mean VAS scores (0–10)	TAPP *versus* Lichtenstein[19,27,45,52,66]	Favoured laparoscopic	MD −1·59 (−1·74, −1·44)
		TEP *versus* Lichtenstein[23,61]	Favoured laparoscopic	MD −0·54 (−0·75, −0·33)
		TEP *versus* Stoppa[10,58]	Favoured laparoscopic	MD −1·8 (−2·41, −1·19)
Acute pain	Pain *versus* no pain	TAPP *versus* Lichtenstein[15,38,47,62]	Favoured neither	RR 0·65 (0·29, 1·45)
		TAPP *versus* Shouldice[26,57]	Favoured neither	RR 0·82 (0·55, 1·21)
		TEP *versus* Lichtenstein[16,23,31,50,63]	Favoured laparoscopic	RR 0·62 (0·48, 0·82)
Early chronic pain	Pain *versus* no pain	TAPP *versus* Lichtenstein[9,12,38,66]	Favoured neither	RR 0·48 (0·17, 1·34)
		TAPP *versus* Shouldice[26,57]	Favoured neither	RR 1·02 (0·53, 1·96)
		TEP *versus* Lichtenstein[16,18,20,29,31,33,49,50,55,66]	Favoured laparoscopic	RR 0·71 (0·56, 0·89)
Later chronic pain	Pain *versus* no pain	TAPP *versus* Lichtenstein[12,45,62,64]	Favoured neither	RR 0·36 (0·06, 2·06)
		TAPP *versus* Shouldice[34,42,51,57]	Favoured neither	RR 0·60 (0·21, 1·73)
		TEP *versus* Lichtenstein[14,16,18,23,29,63]	Favoured laparoscopic	RR 0·58 (0·39, 0·86)
Paraesthesia	Paraesthesia *versus* no paraesthesia	TAPP *versus* Lichtenstein[11,38,39,47,64]	Favoured neither	RR 0·31 (0·10. 1·02)
		TEP *versus* Lichtenstein[14,16,18,20,23,31,50,55,63]	Favoured laparoscopic	RR 0·22 (0·12, 0·41)
		TEP *versus* Shouldice[17,48]	Excluded owing to extreme heterogeneity ($I^2 = 83\%$)	–
Satisfaction	Satisfied *versus* not satisfied	TAPP *versus* Lichtenstein[47,62,64]	Excluded owing to extreme heterogeneity ($I^2 = 80\%$)	–
		TAPP *versus* Shouldice[34,64]	Favoured neither	RR 0·92 (0·80, 1·05)
		TEP *versus* Lichtenstein[23,61,65]	Favoured neither	RR 0·91 (0·68, 1·22)
Period of disability	Length of time (days)	TAPP *versus* Shouldice[42,51]	Excluded owing to extreme heterogeneity ($I^2 = 97\%$)	–
		TEP *versus* Lichtenstein[55,66]	Favoured laparoscopic	MD −4·51 (−6·21, −2·81)
Time until return to work	Length of time (days)	TAPP *versus* Lichtenstein[11,12,66]	Favoured laparoscopic	MD −3·55 (−6·46, −0·63)
		TEP *versus* Lichtenstein[11,20,29,33,50,61,66]	Favoured laparoscopic	MD −3·66 (−5·23, −2·09)
Recurrence	No. of recurrences in laparoscopic *versus* open	TAPP *versus* Lichtenstein[9,11,15,25,27,38,45,47,52,62,64,66]	Favoured neither	RR 0·79 (0·52, 1·21)
		TAPP *versus* Shouldice[21,25,26,34,35,42,51,57]	Favoured neither	RR 0·96 (0·69, 1·33)
		TEP *versus* Lichtenstein[11,14,16,20,23,29,33,45,49,50,55,61,63,66]	Favoured neither	RR 1·05 (0·58, 1·91)
		TEP *versus* Shouldice[17,48]	Favoured neither	RR 1·73 (0·07, 40·38)

TAPP, transabdominal preperitoneal; RR, risk ratio; TEP, totally extraperitoneal; MD, mean difference.

All studies reported this as a dichotomous variable. The crude rate of pain at last follow-up during this interval was 9·4 (range 0–27·9) per cent in the open repair group and 6·6 (0–18·1) per cent in the laparoscopic group, after a mean(s.d.) of 53·9(28·6) (range 16–120) months. In meta-analysis, there was significantly less pain reported in the laparoscopic group (RR 0·62, 95 per cent c.i. 0·47 to 0·82) (*Fig. 5*). After exclusion of trials at high risk of bias, the laparoscopic group still had less chronic pain (RR 0·62, 0·48 to 0·82).

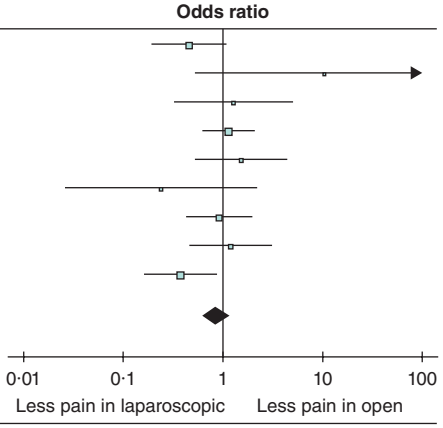
Paraesthesia

Twenty-two studies[11,13–15,17,18,20,22–24,31,38–40,43,47,48,50,55,57,63,64] (38 per cent) reported paraesthesia, with 3446 patients randomized to open hernia repair and 3237 to laparoscopic repair.

Fig. 2 Meta-analysis of postoperative pain up to 2 weeks after laparoscopic *versus* open hernia repair

Reference	Proportion reporting pain: Laparoscopic	Open	Weight (%)	Odds ratio
Wellwood *et al.*[47]	8 of 188	17 of 192	18·0	0·46 (0·19, 1·09)
Heikkinen *et al.*[23]	4 of 23	0 of 22	0·5	10·38 (0·53, 205·27)
Picchio *et al.*[39]	5 of 52	4 of 52	4·0	1·28 (0·32, 5·05)
Johansson *et al.*[25]	18 of 200	32 of 400	21·6	1·14 (0·62, 2·08)
Wennström *et al.*[48]	9 of 131	6 of 130	6·3	1·52 (0·53, 4·41)
Eklund *et al.*[15]	1 of 73	4 of 73	4·4	0·24 (0·03, 2·20)
Berndsen *et al.*[57]	13 of 524	14 of 518	15·3	0·92 (0·43, 1·97)
Eklund *et al.*[16]	9 of 665	8 of 706	8·5	1·20 (0·46, 3·12)
Waris *et al.*[46]	8 of 200	20 of 200	21·4	0·38 (0·16, 0·87)
Total	75 of 2056	105 of 2293	100·0	0·86 (0·63, 1·16)

Heterogeneity: $\chi^2 = 12{\cdot}44$, 8 d.f., $P = 0{\cdot}13$; $I^2 = 36\%$
Test for overall effect: $Z = 0{\cdot}99$, $P = 0{\cdot}32$

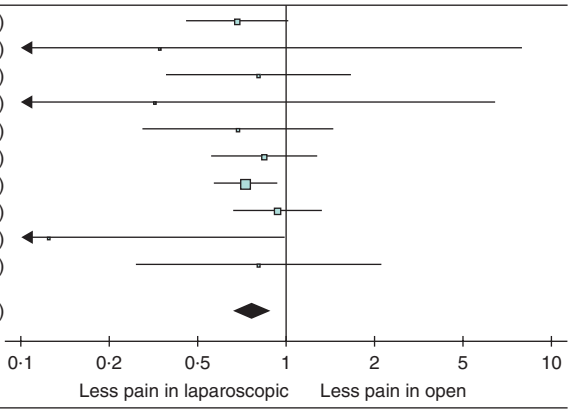


Risk ratios are shown with 95 per cent confidence intervals. A Mantel–Haenszel fixed-effect model was used for meta-analysis.

Fig. 3 Meta-analysis of acute pain from 2 weeks to within 6 months after laparoscopic *versus* open hernia repair

Reference	Proportion reporting pain: Laparoscopic	Open	Weight (%)	Risk ratio
Wellwood *et al.*[47]	27 of 182	40 of 176	15·0	0·65 (0·42, 1·02)
Heikkinen *et al.*[23]	0 of 20	1 of 20	0·3	0·33 (0·01, 7·72)
Juul and Christensen[26]	10 of 138	12 of 130	4·5	0·79 (0·35, 1·75)
Bringman *et al.*[63]	0 of 92	3 of 207	0·3	0·32 (0·02, 6·12)
Eklund *et al.*[15]	8 of 68	12 of 67	4·3	0·66 (0·29, 1·50)
Berndsen *et al.*[57]	31 of 518	38 of 524	14·0	0·83 (0·52, 1·31)
Langeveld *et al.*[31]	64 of 282	87 of 269	38·5	0·70 (0·53, 0·92)
Eklund *et al.*[16]	45 of 589	51 of 618	19·8	0·93 (0·63, 1·36)
Bignell *et al.*[62]	1 of 59	8 of 60	0·7	0·13 (0·02, 0·99)
Yen *et al.*[50]	5 of 40	7 of 44	2·6	0·79 (0·27, 2·28)
Total	191 of 1988	259 of 2115	100·0	0·74 (0·62, 0·88)

Heterogeneity: $\tau^2 = 0{\cdot}00$; $\chi^2 = 5{\cdot}49$, 9 d.f., $P = 0{\cdot}79$; $I^2 = 0\%$
Test for overall effect: $Z = 3{\cdot}42$, $P < 0{\cdot}001$



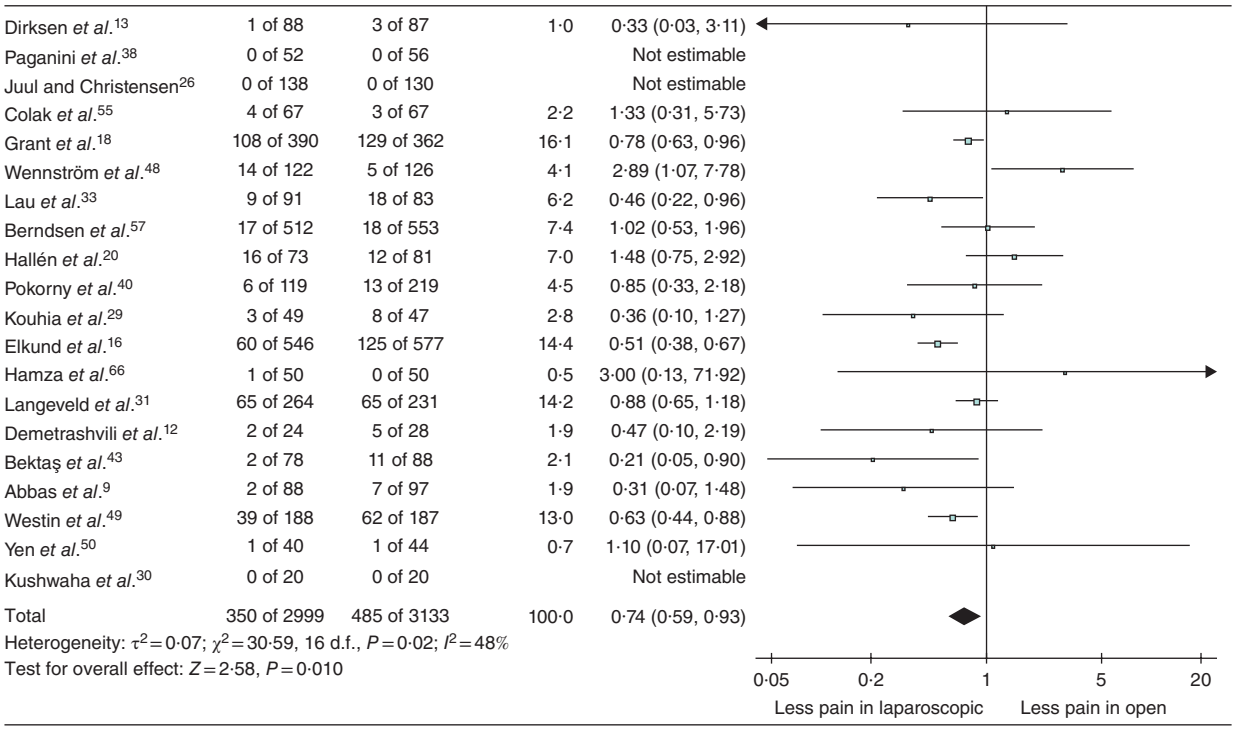
Risk ratios are shown with 95 per cent confidence intervals. A Mantel–Haenszel random-effects model was used for meta-analysis.

All studies reported this as a dichotomous variable. The crude rate of paraesthesia was 15·5 (range 0–80·9) per cent after open repair and 4·8 (0–18·1) per cent after laparoscopic repair, a mean(s.d.) of 18·4(21·6) (range 1–60) months following surgery. Meta-analysis showed that there was significantly less numbness reported in the laparoscopic group (RR 0·27, 95 per cent c.i. 0·18 to 0·40). After exclusion of trials at high risk of bias, the laparoscopic group still had less paraesthesia (RR 0·27, 0·15 to 0·49).

Other patient-reported symptoms

One study[57] reported that 1·5 per cent of patients in the laparoscopic (TAPP) group had postoperative nausea and/or abdominal discomfort at 7 days. The same study[57] also documented stiffness associated with the procedure, with one patient in each subgroup (open 1·7 per cent; laparoscopic 1·6 per cent) reporting this as an adverse effect. Another study[22] reported groin tension after 5 years, affecting 1·7 per cent in the laparoscopic (mixed

Fig. 4 Meta-analysis of early chronic pain from 6 months up to 1 year after laparoscopic *versus* open hernia repair



Risk ratios are shown with 95 per cent confidence intervals. A Mantel–Haenszel random-effects model was used for meta-analysis.

TAPP/TEP) group and 5·1 per cent in the open (Lichtenstein) repair group.

One study[57] asked the patients at 3-month follow-up if they were experiencing any problems with sexual intercourse related to the procedure. Overall, 0·6 per cent of patients in the open (Shouldice) group and 0·4 per cent of patients in the laparoscopic (TAPP) group experienced this as an adverse effect[57].

One study[64] reported a VAS score for overall discomfort and/or pain. After 52 months, this was ongoing in 6·6 per cent of those in the TAPP group, 1·2 per cent in the Lichtenstein group and 6·8 per cent in the Shouldice group.

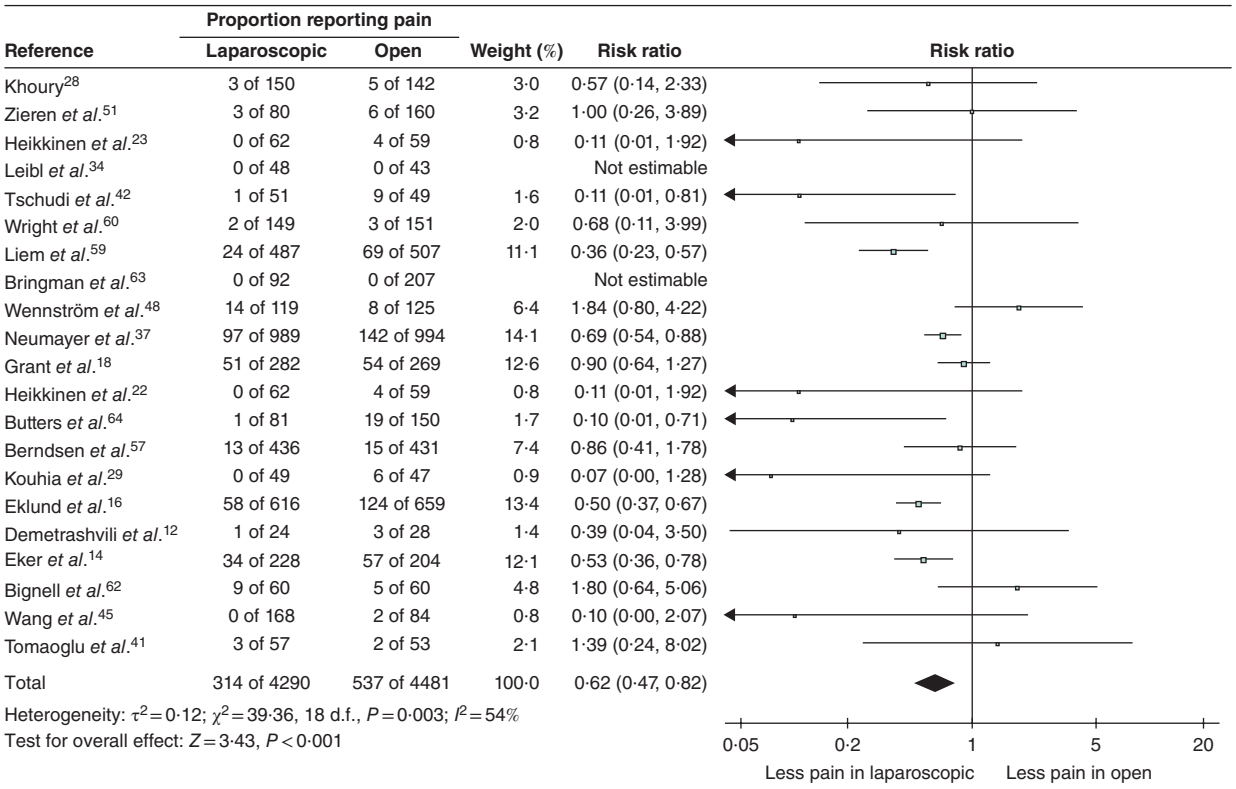
Satisfaction and patient-reported cosmesis

Fourteen studies[14,20,22–24,32,34,36,42,43,47,62,64,65] reported patient satisfaction as a PRO. In total, 1654 patients were randomized in the laparoscopic repair group and 1750 in the open repair group. The crude rate of satisfaction at last follow-up was 79·3 (range 56–100) per cent in the open repair group and 88·7 (77–98·8) per cent in the laparoscopic group, after a mean(s.d.) follow-up of 21·9(24·6) (range 3–72) months. Meta-analysis demonstrated significantly more patient-reported satisfaction after laparoscopic repair (RR 0·91, 95 per cent c.i. 0·85 to 0·98). After exclusion of trials at high risk of bias, the laparoscopic group still had a higher level of patient satisfaction (RR 0·89, 0·80 to 0·99).

The two studies[14,20] (both TEP *versus* Lichtenstein) that did not report satisfaction as dichotomous data instead reported satisfaction ratings at 12 months (median 98 of 100 points after Lichtenstein *versus* 100 of 100 after TEP repair) and 60 months (mean 8 of 10 points after Lichtenstein *versus* 8·5 of 10 after TEP repair).

In total, three studies[14,36,61] reported data on scar cosmesis. In the two studies[36,61] that presented dichotomous data, the laparoscopic groups reported 100 per cent patient satisfaction with the cosmetic outcome at a mean of 13 months, and 28 per cent in both open groups. The remaining study[14] presented a mean satisfaction rating at 60 months: 8·4 of 10 in the TEP repair group and 8·8 of 10 in the Lichtenstein group.

Fig. 5 Meta-analysis of later chronic pain from 1 year onwards after laparoscopic *versus* open hernia repair



Risk ratios are shown with 95 per cent confidence intervals. A Mantel–Haenszel random-effects model was used for meta-analysis.

Patient-reported outcome measures

In total, seven studies[9,30,37,44,47,62,65] (12 per cent) reported PROMs; 1423 patients were randomized in the laparoscopic repair group and 1437 in the open group. Six studies[9,30,37,44,47,65] presented scores on SF-36 version 1 or 2; of these, five reported no significant difference between scores at 3, 6 and 24 months. One study[9] reported statistically significant results, with better physical health component and overall SF-36 (version 1) scores in the laparoscopic group at the end of follow-up. Only one study[62] presented data for the SF-12 PROM, and reported no significant difference between the groups.

One study[62] obtained scores on the Pain Impact Questionnaire 6, and reported no significant difference between groups. The Carolinas Comfort Scale was the only hernia-specific scale used. In the one study[44] that used it, although discomfort levels increased after surgery, they never differed significantly, and after 15 days had returned to baseline.

Time until return to work

Twenty-nine studies[11–16,20,23,25,28,29,31–33,35–39,41,47,50,51,56,57,61–63,66] (50 per cent) reported time taken to return to work; 5543 patients were randomized in the open repair group and 5118 in the laparoscopic repair group. The crude mean time to return to work was 10·9 (range 2–27) days after laparoscopic repair and 16·8 (5–27) days after open repair.

Thirteen of these studies reported a measure of dispersion (s.d.) along with mean values, allowing meta-analysis. This meta-analysis produced an I^2 value of 81 per cent, showing extreme heterogeneity in study results, so was excluded from the analysis. This heterogeneity was also demonstrated after exclusion of trials judged to be at high risk of bias ($I^2 = 87$ per cent).

Period of disability and time until full recovery

Thirteen studies[13,23,26,31,34,42,43,47,49,51,54,55,66] (22 per cent) documented patient-reported disability after surgery, defined as time to return to normal activities of daily

living. There were 1449 patients randomized in the open repair group and 1365 in the laparoscopic repair group. The crude mean period of self-reported disability was 14·8 (range 2–39) days after laparoscopic repair and 17·1 (3–40) days after open hernia repair. Seven of these studies presented mean(s.d.) values, allowing meta-analysis. This had an I^2 value of 98 per cent demonstrating extreme heterogeneity in study results, so was excluded from the analysis. Considerable heterogeneity was still evident after the exclusion of trials judged to be at high risk of bias (I^2 = 79 per cent). Subgroup analysis of TAPP *versus* Shouldice (2 studies) also demonstrated extreme heterogeneity (I^2 = 97 per cent).

In total, six studies[17,25,47,49,51,63] reported patient-assessed time until full recovery, including 865 patients randomized to open repair and 874 to laparoscopic hernia repair. The crude mean time was 22·5 (range 14–18·4) days after laparoscopic repair and 24·9 (21–28·5) days after open hernia repair.

Hernia recurrence

Forty-six studies[9–11,13–17,20,21,23,25–30,32–38,40–43,45,47–55,57,59–64,66] (79 per cent) reported hernia recurrence as an outcome. There were 7991 hernias randomized to open repair and 7614 to laparoscopic hernia repair. The crude mean rate of recurrence was 3·9 (range 0–21·4) per cent in the open group and 4·4 (0–16·7) per cent in the laparoscopic group, after a mean(s.d.) follow-up of 35·4(29·3) (range 1–120) months. Meta-analysis showed no significant difference in recurrence rates across all time points (RR 0·94, 95 per cent c.i. 0·72 to 1·24). The result was similar when trials at high risk of bias were excluded (RR 1·13, 0·84 to 1·52).

Discussion

This systematic review and meta-analysis of PROs included 58 unique RCTs. Comparisons were made between laparoscopic and open groups, along with smaller subgroups comprising specific techniques. Several outcome comparisons were conducted between TAPP *versus* Lichtenstein, TEP *versus* Lichtenstein, TAPP *versus* Shouldice, TEP *versus* Shouldice and TEP *versus* Stoppa.

Laparoscopic hernia repair caused significantly less pain than open repair in the postoperative (0–2 weeks), acute (over 2 weeks and within 6 months), early chronic (6 months to 1 year) and later chronic (over 1 year) time intervals. Although the definition of chronic pain varies in the literature, this result correlates with findings of other meta-analyses comparing laparoscopic and open techniques[67,68].

Notably, most studies lacked assessment of preoperative pain, and only one[44] employed a hernia-specific pain measure to capture preoperative pain. In addition, anaesthetic and analgesic regimens were often poorly documented. These regimens have a large impact on a patient's initial experience of pain. Their low rate of documentation makes it difficult to draw conclusions in favour of either laparoscopic or open techniques in the postoperative phase.

Regarding postoperative pain, when VAS pain scores were compared, a significant advantage was found for the laparoscopic group. However, analysis of studies comparing dichotomous variables showed no significant difference. The subjectivity of a dichotomous response may be less effective in capturing a patient's experience than a continuous variable such as a VAS score. The presence of early postoperative pain is important clinically as, along with age and hernia recurrence, it is a risk factor for chronic inguinal pain after hernia repair[69,70].

Paraesthesia was also reported less frequently after laparoscopic repair, presumably owing to the proximity of an open approach to the ilioinguinal or genitofemoral nerves[71].

The rate of testicular swelling and sexual dysfunction was higher after open hernia repair. This may be due to the dissection around the spermatic cord which occurs during most procedures. However, when counselling a patient, it should be noted that inguinal hernia repair generally has a positive effect on sexual function[72].

Patient satisfaction, along with perceived cosmesis, was also better after laparoscopic hernia repair. This is in keeping with the trend demonstrated for other laparoscopic, minimally invasive procedures[73,74].

PROMS were generally well reported and in keeping with the PRO CONSORT statement[3]. However, only seven studies (12 per cent) reported these measures and meta-analysis was not possible owing to the variety of PROMs used and outcomes reported by the authors. Five of the six studies that used the SF-36 instrument reported no significant difference between the laparoscopic and open repair groups.

Return to work was quicker after laparoscopic hernia repair, concurring with the finding of a previous meta-analysis[67]. The authors grouped those in moderate and strenuous occupations together for this analysis; a smaller effect is likely for those in sedentary occupations. Extreme heterogeneity when analysing the duration of disability reported by patients prevented meta-analysis. Standardization of measurement of this variable should be introduced to allow accurate meta-analysis[67,75].

Meta-analysis showed no significant difference in hernia recurrence between laparoscopic and open repairs. These results are in keeping with the non-significant differences reported in a previous meta-analysis and large cohort studies[76–78]. Thirty-eight of the 46 studies that examined this outcome used clinical examination for diagnosing recurrence; the rest reported the use of a questionnaire or telephone interview. The signs of recurrence at clinical examination may lead to an increased number of asymptomatic hernias being reported. Only one study[13] documented whether the hernias were symptomatic at the time of diagnosis of recurrence. Only eight studies[13,15,16,21,34,38,41,43] reported on reoperation for recurrence. If reoperation alone was used as a marker of recurrence, the actual recurrence rate would be under-reported.

The present data may be used by the clinician who wishes to provide their patient with the most up-to-date outcome data following inguinal hernia repair. This study described PROs only, which in fact were little different from those of previous meta-analyses[67,75].

The authors adopted a broad definition of the disease in this study, with both primary and recurrent inguinal hernias being included. Likewise, all different procedures were included. The authors acknowledge that the subgrouping of open or laparoscopic repairs for comparison (for example into tension-free *versus* TAPP/TEP) may produce different results. Laparoscopic hernia repair may not have such a significant advantage over open hernia repair in certain situations. In addition, because the results are patient-subjective in nature, to complete a picture of how a patient's clinical state has improved, a knowledge of their baseline and any change from this is required. Nevertheless, this study suggests that laparoscopic inguinal hernia repair has patient-centred advantages over open inguinal hernia repair.

Disclosure

The authors declare no conflict of interest.

References

1 Fitzgibbons RJ Jr, Forse RA. Clinical practice. Groin hernias in adults. *N Engl J Med* 2015; **372**: 756–763.
2 Black N. Patient reported outcome measures could help transform healthcare. *BMJ* 2013; **346**: f167.
3 Calvert M, Blazeby J, Altman DG, Revicki DA, Moher D, Brundage MD; CONSORT PRO Group. Reporting of patient-reported outcomes in randomized trials: the CONSORT PRO extension. *JAMA* 2013; **309**: 814–822.
4 PRISMA. *PRISMA Statement and Checklist*; 2009. http://www.prisma-statement.org/ [accessed 4 November 2018].
5 Cochrane Collaboration. *Cochrane Risk of Bias Tool*. https://handbook-5-1.cochrane.org/chapter_8/8_assessing_risk_of_bias_in_included_studies.htm [accessed 4 November 2018].
6 Cochrane Collaboration. *Review Manager 5*. https://community.cochrane.org/help/tools-and-software/revman-5 [accessed 4 November 2018].
7 Huedo-Medina TB, Sánchez-Meca J, Marín-Martínez F, Botella J. Assessing heterogeneity in meta-analysis: Q statistic or I^2 index? *Psychol Methods* 2006; **11**: 193–206.
8 Demets DL. Methods for combining randomized clinical trials: strengths and limitations. *Stat Med* 1987; **6**: 341–350.
9 Abbas AE, Abd Ellatif ME, Noaman N, Negm A, El-Morsy G, Amin M *et al.* Patient-perspective quality of life after laparoscopic and open hernia repair: a controlled randomized trial. *Surg Endosc* 2012; **26**: 2465–2470.
10 Akgül N, Yaprak M, Doğru V, Balci N, Arici C, Mesci A. Quantitative assessment of the impacts of Stoppa repair and total extraperitoneal repair on the lower extremity muscular functions in cases of unilateral inguinal hernia: a randomized controlled study. *Hernia* 2017; **21**: 377–382.
11 Dedemadi G, Sgourakis G, Karaliotas C, Christofides T, Kouraklis G, Karaliotas C. Comparison of laparoscopic and open tension-free repair of recurrent inguinal hernias: a prospective randomized study. *Surg Endosc* 2006; **20**: 1099–1104.
12 Demetrashvili Z, Qerqadze V, Kamkamidze G, Topchishvili G, Lagvilava L, Chartholani T *et al.* Comparison of Lichtenstein and laparoscopic transabdominal preperitoneal repair of recurrent inguinal hernias. *Int Surg* 2011; **96**: 233–238.
13 Dirksen CD, Beets GL, Go PM, Geisler FE, Baeten CG, Kootstra G. Bassini repair compared with laparoscopic repair for primary inguinal hernia: a randomised controlled trial. *Eur J Surg* 1998; **164**: 439–447.
14 Eker HH, Langeveld HR, Klitsie PJ, van't Riet M, Stassen LP, Weidema WF *et al.* Randomized clinical trial of total extraperitoneal inguinal hernioplasty *vs* Lichtenstein repair: a long-term follow-up study. *Arch Surg* 2012; **147**: 256–260.
15 Eklund A, Rudberg C, Leijonmarck CE, Rasmussen I, Spangen L, Wickbom G *et al.* Recurrent inguinal hernia: randomized multicenter trial comparing laparoscopic and Lichtenstein repair. *Surg Endosc* 2007; **21**: 634–640.
16 Eklund A, Montgomery A, Bergkvist L, Rudberg C; Swedish Multicentre Trial of Inguinal Hernia Repair by Laparoscopy (SMIL) study group. Chronic pain 5 years after randomized comparison of laparoscopic and Lichtenstein inguinal hernia repair. *Br J Surg* 2010; **97**: 600–608.
17 Fleming WR, Elliott TB, Jones RM, Hardy KJ. Randomized clinical trial comparing totally extraperitoneal inguinal hernia repair with the Shouldice technique. *Br J Surg* 2001; **88**: 1183–1188.
18 Grant AM, Scott NW, O'Dwyer PJ; MRC Laparoscopic Groin Hernia Trial Group. Five-year follow-up of a randomized trial to assess pain and numbness after

laparoscopic or open repair of groin hernia. *Br J Surg* 2004; **91**: 1570–1574.
19 Günal O, Ozer S, Gürleyik E, Bahçebaşi T. Does the approach to the groin make a difference in hernia repair? *Hernia* 2007; **11**: 429–434.
20 Hallén M, Bergenfelz A, Westerdahl J. Laparoscopic extraperitoneal inguinal hernia repair *versus* open mesh repair: long-term follow-up of a randomized controlled trial. *Surgery* 2008; **143**: 313–317.
21 Arvidsson D, Berndsen FH, Larsson LG, Leijonmarck CE, Rimbäck G, Rudberg C *et al.* Randomized clinical trial comparing 5-year recurrence rate after laparoscopic *versus* Shouldice repair of primary inguinal hernia. *Br J Surg* 2005; **92**: 1085–1091.
22 Heikkinen T, Bringman S, Ohtonen P, Kunelius P, Haukipuro K, Hulkko A. Five-year outcome of laparoscopic and Lichtenstein hernioplasties. *Surg Endosc* 2004; **18**: 518–522.
23 Heikkinen TJ, Haukipuro K, Koivukangas P, Hulkko A. A prospective randomized outcome and cost comparison of totally extraperitoneal endoscopic hernioplasty *versus* Lichtenstein hernia operation among employed patients. *Surg Laparosc Endosc* 1998; **8**: 338–344.
24 Heikkinen TJ, Haukipuro K, Hulkko A. A cost and outcome comparison between laparoscopic and Lichtenstein hernia operations in a day-case unit. A randomized prospective study. *Surg Endosc* 1998; **12**: 1199–1203.
25 Johansson B, Hallerbäck B, Glise H, Anesten B, Smedberg S, Román J. Laparoscopic mesh *versus* open preperitoneal mesh *versus* conventional technique for inguinal hernia repair: a randomized multicenter trial (SCUR Hernia Repair Study). *Ann Surg* 1999; **230**: 225–231.
26 Juul P, Christensen K. Randomized clinical trial of laparoscopic *versus* open inguinal hernia repair. *Br J Surg* 1999; **86**: 316–319.
27 Khan N, Babar TS, Ahmad M, Ahmad Z, Shah LA. Outcome and cost comparison of laparoscopic transabdominal preperitoneal hernia repair *versus* open Lichtenstein technique. *J Postgrad Med Inst* 2013; **27**: 310–316.
28 Khoury N. A randomized prospective controlled trial of laparoscopic extraperitoneal hemia repair and mesh-plug hemioplasty: a study of 315 cases. *J Laparoendosc Adv Surg Tech A* 1998; **8**: 367–372.
29 Kouhia ST, Huttunen R, Silvasti SO, Heiskanen JT, Ahtola H, Uotila-Nieminen M *et al.* Lichtenstein hernioplasty *versus* totally extraperitoneal laparoscopic hernioplasty in treatment of recurrent inguinal hernia – a prospective randomized trial. *Ann Surg* 2009; **249**: 384–387.
30 Kushwaha JK, Enny LE, Anand A, Sonkar AA, Kumar A, Pahwa HS. A prospective randomized controlled trial comparing quality of life following endoscopic totally extraperitoneal (TEP) *versus* open Stoppa inguinal hernioplasty. *Surg Laparosc Endosc Percutan Tech* 2017; **27**: 257–261.
31 Langeveld HR, van't Riet M, Weidema WF, Stassen LP, Steyerberg EW, Lange J *et al.* Total extraperitoneal inguinal hernia repair compared with Lichtenstein (the LEVEL-Trial): a randomized controlled trial. *Ann Surg* 2010; **251**: 819–824.
32 Barkun JS, Keyser EJ, Wexler MJ, Fried GM, Hinchey EJ, Fernandez M *et al.* Short-term outcomes in open *vs*. laparoscopic herniorrhaphy: confounding impact of worker's compensation on convalescence. *J Gastrointest Surg* 1999; **3**: 575–582.
33 Lau H, Patil NG, Yuen WK. Day-case endoscopic totally extraperitoneal inguinal hernioplasty *versus* open Lichtenstein hernioplasty for unilateral primary inguinal hernia in males: a randomized trial. *Surg Endosc* 2006; **20**: 76–81.
34 Leibl BJ, Däubler P, Schmedt CG, Kraft K, Bittner R. Long-term results of a randomized clinical trial between laparoscopic hernioplasty and Shouldice repair. *Br J Surg* 2000; **87**: 780–783.
35 Lorenz D, Stark E, Oestreich K, Richter A. Laparoscopic hernioplasty *versus* conventional hernioplasty (Shouldice): results of a prospective randomized trial. *World J Surg* 2000; **24**: 739–345.
36 Laparoscopic *versus* open repair of groin hernia: a randomised comparison. The MRC Laparoscopic Groin Hernia Trial Group. *Lancet* 1999; **354**: 185–190.
37 Neumayer L, Giobbie-Hurder A, Jonasson O, Fitzgibbons R Jr, Dunlop D, Gibbs J *et al.*; Veterans Affairs Cooperative Studies Program 456 Investigators. Open mesh *versus* laparoscopic mesh repair of inguinal hernia. *N Engl J Med* 2004; **350**: 1819–1827.
38 Paganini AM, Lezoche E, Carle F, Carlei F, Favretti F, Feliciotti F *et al.* A randomized, controlled, clinical study of laparoscopic *vs* open tension-free inguinal hernia repair. *Surg Endosc* 1998; **12**: 979–986.
39 Picchio M, Lombardi A, Zolovkins A, Mihelsons M, La Torre G. Tension-free laparoscopic and open hernia repair: randomized controlled trial of early results. *World J Surg* 1999; **23**: 1004–1007.
40 Pokorny H, Klingler A, Schmid T, Fortelny R, Hollinsky C, Kawji R *et al.* Recurrence and complications after laparoscopic *versus* open inguinal hernia repair: results of a prospective randomized multicenter trial. *Hernia* 2008; **12**: 385–389.
41 Tomaoglu K, Sarı YS, Bektas H, Koc O, Gunes E, Uzum G *et al.* Prospective randomized clinical trial of Jean Rives technique *versus* laparoscopic TEP repair for primary inguinal hernia: 10-year follow-up. *Hernia* 2015; **19**: 383–387.
42 Tschudi JF, Wagner M, Klaiber C, Brugger JJ, Frei E, Krähenbühl L *et al.* Randomized controlled trial of laparoscopic transabdominal preperitoneal hernioplasty *vs* Shouldice repair. *Surg Endosc* 2001; **15**: 1263–1266.
43 Bektaş H, Bilsel Y, Ersöz F, Sarı S, Mutlu T, Arıkan S *et al.* Comparison of totally extraperitoneal technique and darn

plication of primary inguinal hernia. *J Laparoendosc Adv Surg Tech A* 2011; **21**: 583–588.
44 Utiyama EM, Damous SR, Tanaka EY, Yoo JH, de Miranda JS, Ushinohama AZ *et al.* Early assessment of bilateral inguinal hernia repair: a comparison between the laparoscopic total extraperitoneal and Stoppa approaches. *J Minim Access Surg* 2016; **12**: 271–277.
45 Wang WJ, Chen JZ, Fang Q, Li JF, Jin PF, Li ZT. Comparison of the effects of laparoscopic hernia repair and Lichtenstein tension-free hernia repair. *J Laparoendosc Adv Surg Tech A* 2013; **23**: 301–305.
46 Waris A, Abid KJ, Ishaque S, Saleem T, Anwer S, Ahmad A. Totally extra-peritoneal (TEP) *versus* tension free mesh repair for inguinal hernia. *Pak J Med Health Sci* 2016; **10**: 186–189.
47 Wellwood J, Sculpher MJ, Stoker D, Nicholls GJ, Geddes C, Whitehead A *et al.* Randomised controlled trial of laparoscopic *versus* open mesh repair for inguinal hernia: outcome and cost. *BMJ* 1998; **317**: 103–110.
48 Wennström I, Berggren P, Akerud L, Järhult J. Equal results with laparoscopic and Shouldice repairs of primary inguinal hernia in men. Report from a prospective randomised study. *Scand J Surg* 2004; **93**: 34–36.
49 Westin L, Wollert S, Ljungdahl M, Sandblom G, Gunnarsson U, Dahlstrand U. Less pain 1 year after total extra-peritoneal repair compared with Lichtenstein using local anesthesia: data from a randomized controlled clinical trial. *Ann Surg* 2016; **263**: 240–243.
50 Yen FV, Sani Mohamad I, Nizam Mohd Hashim M, Ramely R, Dzulkarnaen Zakaria A, Zainira Wan Zain W *et al.* Laparoscopic total extraperitoneal approach *versus* open Lichtenstein repair of primary unilateral uncomplicated inguinal hernia: a single centre experience in Malaysia. *Surg Chron* 2017; **22**: 54–58.
51 Zieren J, Zieren HU, Jacobi CA, Wenger FA, Müller JM. Prospective randomized study comparing laparoscopic and open tension-free inguinal hernia repair with Shouldice's operation. *Am J Surg* 1998; **175**: 330–333.
52 Anadol ZA, Ersoy E, Taneri F, Tekin E. Outcome and cost comparison of laparoscopic transabdominal preperitoneal hernia repair *versus* open Lichtenstein technique. *J Laparoendosc Adv Surg Tech A* 2004; **14**: 159–163.
53 Suter M, Martinet O, Spertini F. Reduced acute phase response after laparoscopic total extraperitoneal bilateral hernia repair compared to open repair with the Stoppa procedure. *Surg Endosc* 2002; **16**: 1214–1219.
54 Bender O, Balcı FL, Yüney E, Sağlam F, Ozdenkaya Y, Sarı YS. Systemic inflammatory response after Kugel *versus* laparoscopic groin hernia repair: a prospective randomized trial. *Surg Endosc* 2009; **23**: 2657–2661.
55 Colak T, Akca T, Kanik A, Aydin S. Randomized clinical trial comparing laparoscopic totally extraperitoneal approach with open mesh repair in inguinal hernia. *Surg Laparosc Endosc Percutan Tech* 2003; **13**: 191–195.
56 Jess P, Schultz K, Bendtzen K, Nielsen OH. Systemic inflammatory responses during laparoscopic and open inguinal hernia repair: a randomised prospective study. *Eur J Surg* 2000; **166**: 540–544.
57 Berndsen FH, Petersson U, Arvidsson D, Leijonmarck CE, Rudberg C, Smedberg S *et al.*; SMIL Study Group. Discomfort five years after laparoscopic and Shouldice inguinal hernia repair: a randomised trial with 867 patients. A report from the SMIL study group. *Hernia* 2007; **11**: 307–313.
58 Salma U, Ahmed I, Ishtiaq S. A comparison of post operative pain and hospital stay between Lichtenstein's repair and laparoscopic transabdominal preperitoneal (TAPP) repair of inguinal hernia: a randomized controlled trial. *Pak J Med Sci* 2015; **31**: 1062–1066.
59 Liem MS, van Duyn EB, van der Graaf Y, van Vroonhoven TJ; Coala Trial Group. Recurrences after conventional anterior and laparoscopic inguinal hernia repair: a randomized comparison. *Ann Surg* 2003; **237**: 136–141.
60 Wright D, Paterson C, Scott N, Hair A, O'Dwyer PJ. Five-year follow-up of patients undergoing laparoscopic or open groin hernia repair: a randomized controlled trial. *Ann Surg* 2002; **235**: 333–337.
61 Lal P, Kajla RK, Chander J, Saha R, Ramteke VK. Randomized controlled study of laparoscopic total extraperitoneal *versus* open Lichtenstein inguinal hernia repair. *Surg Endosc* 2003; **17**: 850–856.
62 Bignell M, Partridge G, Mahon D, Rhodes M. Prospective randomized trial of laparoscopic (transabdominal preperitoneal-TAPP) *versus* open (mesh) repair for bilateral and recurrent inguinal hernia: incidence of chronic groin pain and impact on quality of life: results of 10 year follow-up. *Hernia* 2012; **16**: 635–640.
63 Bringman S, Ramel S, Heikkinen TJ, Englund T, Westman B, Anderberg B. Tension-free inguinal hernia repair: TEP *versus* mesh-plug *versus* Lichtenstein: a prospective randomized controlled trial. *Ann Surg* 2003; **237**: 142–147.
64 Butters M, Redecke J, Köninger J. Long-term results of a randomized clinical trial of Shouldice, Lichtenstein and transabdominal preperitoneal hernia repairs. *Br J Surg* 2007; **94**: 562–565.
65 Dhankhar DS, Sharma N, Mishra T, Kaur N, Singh S, Gupta S. Totally extraperitoneal repair under general anesthesia *versus* Lichtenstein repair under local anesthesia for unilateral inguinal hernia: a prospective randomized controlled trial. *Surg Endosc* 2014; **28**: 996–1002.
66 Hamza Y, Gabr E, Hammadi H, Khalil R. Four-arm randomized trial comparing laparoscopic and open hernia repairs. *Int J Surg* 2010; **8**: 25–28.
67 Memon MA, Cooper NJ, Memon B, Memon MI, Abrams KR. Meta-analysis of randomized clinical trials comparing open and laparoscopic inguinal hernia repair. *Br J Surg* 2003; **90**: 1479–1492.
68 Scheuermann U, Niebisch S, Lyros O, Jansen-Winkeln B, Gockel I. Transabdominal preperitoneal (TAPP) *versus* Lichtenstein operation for primary inguinal hernia repair – a

systematic review and meta-analysis of randomized controlled trials. *BMC Surg* 2017; **17**: 55.
69 O'Dwyer PJ, Alani A, McConnachie A. Groin hernia repair: postherniorrhaphy pain. *World J Surg* 2005; **29**: 1062–1065.
70 Loos MJ, Roumen RM, Scheltinga MR. Classifying post-herniorrhaphy pain syndromes following elective inguinal hernia repair. *World J Surg* 2007; **31**: 1760–1765.
71 Hakeem A, Shanmugam V. Inguinodynia following Lichtenstein tension-free hernia repair: a review. *World J Gastroenterol* 2011; **17**: 1791–1796.
72 Sönmez MG, Sonbahar BÇ, Bora G, Özalp N, Kara C. Does inguinal hernia repair have an effect on sexual functions? *Cent European J Urol* 2016; **69**: 212–216.
73 Inoue S, Ikeda K, Kobayashi K, Kajiwara M, Teishima J, Matsubara A. Patient-reported satisfaction and cosmesis outcomes following laparoscopic adrenalectomy: laparoendoscopic single-site adrenalectomy *vs*. conventional laparoscopic adrenalectomy. *Can Urol Assoc J* 2014; **8**: E20–E25.
74 Allvin R, Rawal N, Johanzon E, Bäckström R. Open *versus* laparoscopic surgery: does the surgical technique influence pain outcome? Results from an international registry. *Pain Res Treat* 2016; **2016**: 4087325.
75 Schmedt CG, Sauerland S, Bittner R. Comparison of endoscopic procedures *vs* Lichtenstein and other open mesh techniques for inguinal hernia repair: a meta-analysis of randomized controlled trials. *Surg Endosc* 2005; **19**: 188–199.
76 Köckerling F, Bittner R, Kuthe A, Hukauf M, Mayer F, Fortelny R *et al.* TEP or TAPP for recurrent inguinal hernia repair – register-based comparison of the outcome. *Surg Endosc* 2017; **31**: 3872–3882.
77 Pisanu A, Podda M, Saba A, Porceddu G, Uccheddu A. Meta-analysis and review of prospective randomized trials comparing laparoscopic and Lichtenstein techniques in recurrent inguinal hernia repair. *Hernia* 2015; **19**: 355–366.
78 Arvidsson D, Smedberg S. Laparoscopic compared with open hernia surgery: complications, recurrences and current trends. *Eur J Surg Suppl* 2000; **165**: 40–47.

Supporting information

Additional supporting information can be found online in the Supporting Information section at the end of the article.

European Colorectal Congress

3 – 6 December 2023, St.Gallen, Switzerland

OVERVIEW
Sun, 3 Dec 2023

MASTERCLASS
PROCTOLOGY DAY
ROBOTIC COURSE
DAVOSCOURSE@ECC

SCIENTIFIC PROGRAMME
Mon, 4 Dec – Wed, 6 Dec 2023

DIVERTICULAR DISEASE

Gut microbiome and surgery
Phil Quirke, Leeds, UK

Diet in diverticular disease
Pamela Buchwald, Lund, SE

Decision making in the management of acute complicated Diverticulitis beyond the guidelines
Seraina Faes, Zurich, CH

Diverticular Abscess – Always drainage or who benefits from Surgery?
Johannes Schultz, Oslo, NO

Perforated Diverticulitis: Damage Control, Hartmann's Procedure, Primary Anastomosis, Diverting Loop
Reinhold Kafka-Ritsch, Innsbruck, AT

When to avoid protective stoma in colorectal surgery
Antonino Spinelli, Milano, IT

ENDOMETRIOSIS

Endometriosis – what is the role of the abdominal surgeon
Tuynman Juriaan, Amsterdam, NL

Challenges in Surgery of Endometriosis – always interdisciplinary?
Peter Oppelt, Linz, AT; Andreas Shamiyeh, Linz, AT

A gaze in the crystal ball: Where is the role of virtual reality and artificial Intelligence in colorectal surgery
Müller Beat, Basel, CH

MALIGNANT COLORECTAL DISEASE

Cytoreductive Surgery and Intraperitoneal Chemotherapy – facts and hopes
Michel Adamina, Winterthur, CH

Metastatic Colorectal Cancer – surgical approaches and limits
Jürgen Weitz, Dresden, DE

Extended lymph node dissection for rectal cancer, is it still under debate?
Miranda Kusters, Amsterdam, NL

Organ preservation functional outcome in rectal cancer treatment – in line with patient's needs? (Robot – laparoscopic – open surgery?)
Hans de Wilt, Nijmegen, NL

ROBOTICS

Advances in Robotic Surgery and what we learnt so far
Parvaiz Amjad, Portsmouth, UK

Challenging the market: Robotic (assistant) Devices and how to choose wisely (Da Vinci – Hugo Ras – Distalmotion ua)
Khan Jim, London, UK

TAMIS - Robotic Transanal Surgery, does it make it easier?
Knol Joep, Genk, BE

Live Surgery – Contonal Hospital of St.Gallen
Walter Brunner, St.Gallen, CH;
Salvadore Conde Morals, Sevilla, ES;
Friedrich Herbst, Vienna, AUT;
Amjad Parvaiz, Portsmouth, UK

Video Session

Lars Pahlmann Lecture
Markus Büchler, Lisboa, PRT

Honorary Lecture
Bill Heald, Lisboa, PRT

Information & Registration **www.colorectalsurgery.eu**