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REVIEW

Interventions to optimize recovery after laparoscopic appendectomy: a scoping review

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Abstract
Background No enhanced recovery after surgery protocol has been published for laparoscopic appendectomy. This was a review of evidence-based interventions that could optimize recovery after appendectomy.
Methods Interventions for the review Clinical pathway, fast-track or enhanced recovery protocols; needlescopic approach; single incision laparoscopic (SIL) approach; natural orifice transluminal endoscopic surgery (NOTES); regional nerve blocks; intraperitoneal local anaesthetic (IPLA); drains. *Data sources* MEDLINE, EMBASE, the Cochrane Library, and the Web of Science Core Collection. *Study eligibility criteria* Randomized controlled trial (RCT); prospective evaluation with historical controls for studies assessing clinical pathways/protocols. *Participants* People undergoing laparoscopic appendectomy for acute appendicitis. *Study appraisal and synthesis methods* Meta-analysis, random effects model.
Results Clinical pathways for laparoscopic appendectomy were safe in selected patients, but may be associated with a higher readmission rate. Needlescopic surgery offered no recovery advantage over traditional laparoscopic appendectomy. SIL afforded no recovery advantage over conventional laparoscopic surgery, but may increase operative time in children. The search found no RCT on NOTES appendectomy. Transversus abdominis plane blocks did not significantly reduce pain after laparoscopic appendectomy. IPLA should be considered in laparoscopic appendectomy; studies in paediatric surgery are needed. The search found no RCT on the use of drains in appendectomy.
Conclusions This review identified gaps in the literature on optimizing recovery after laparoscopic appendectomy and found the need for more randomized controlled trials on regional anaesthesia and intraperitoneal local anaesthesia in children.

Keywords Analgesia · Appendectomy · Laparoscopy · Length of stay · Postoperative pain

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Enhanced recovery after surgery (ERAS) pathways began in the 1990s when surgeons saw the need for a more evidenced-based approach to perioperative care. Surgeons found they could 'fast track' recovery by using a protocolized, multimodal approach [1]. Interventions within ERAS protocols include preoperative education and nutrition, minimally invasive surgery, intraoperative regional anaesthesia, avoidance of drains or nasogastric tubes, early postoperative feeding and early mobilization. The ERAS approach reduces care time and complications [2]. ERAS protocols have been devized for diverse procedures including colorectal surgery, pancreaticoduodenectomy and gastrectomy.

Appendicitis affects one in seven individuals at some point during their lifetime, and usually in late childhood or early adulthood. The laparoscopic approach to appendectomy was first described in the 1980 [3]. Laparoscopic appendectomy has replaced the open approach at many centres after showing reduced hospital stay and wound complications [4]. Other 'minimally invasive' variants include needlescopic surgery (port diameter $\leq$3 mm), single incision laparoscopic (SIL) surgery, and natural orifice transluminal endoscopic surgery (NOTES). Although minimally invasive, laparoscopic appendectomy still causes considerable postoperative pain. Patients may rest 1–2 days in hospital, 3–7 days after perforated or complicated appendicitis, and lose 1–3 weeks' work or school.

Short stay appendectomy is now a reality in many surgical units. In a recent clinical trial from our unit, one quarter of children returned home within 18 h of surgery [5]. An optimized recovery pathway could facilitate same day discharge and help reduce inconvenience, cost, and pressure on hospital beds. Caveats to day-case appendectomy include excellent safety, patient satisfaction, and a low readmission rate. Optimized recovery pathways could benefit patients and their families by reducing time away from home, school and sport, and potentially benefit society by reducing hospital expenditure and lost productivity. However, no ERAS protocol has been published for laparoscopic appendectomy to date, to our knowledge.

Therefore, the purpose of this review was to survey the breadth of research on optimized recovery after laparoscopic appendectomy, to review the literature on clinical pathways and intraoperative interventions that could influence postoperative recovery.

Review questions

1. Should laparoscopic appendectomy care follow an optimized recovery pathway?
2. Do special minimally invasive approaches improve recovery?
3. Should patients receive a regional nerve block?
4. Should patients receive intraperitoneal local anaesthetic?
5. Should surgeons insert a drain?

Materials and methods

The review protocol was registered on the International Prospective Register of Systematic Reviews, PROSPERO, registration number CRD42016029901. This paper complies with the reporting items of the PRISMA statement [6, 7].

Eligibility criteria

- *Participants* people undergoing laparoscopic appendectomy for acute appendicitis, without age restriction.
- *Interventions* (1) clinical pathway, fast-track or enhanced recovery protocols; (2) surgical approach; (2a) needlescopic approach; (2b) SIL approach; (2c) NOTES approach; (3) regional nerve block techniques; (4) intraperitoneal local anaesthetic (IPLA); (5) drains.
- *Control* no intervention or placebo.
- *Type of study* randomized controlled trial (RCT); prospective evaluation with historical controls for studies assessing clinical pathways/protocols.

Exclusion criteria

- *Intervention* open surgery.
- *Control* no control, or comparisons of variations of the same intervention.
- *Type of study* retrospective studies, non-randomized trials (except for pathway studies), and trial protocols that could not be tracked to a publication of the results.

Information sources

Searches were applied to the electronic databases MEDLINE (1966 to present), EMBASE (1980 to present), the Cochrane Library, Web of Science Core Collection (1945 to present) for citation tracking, OpenGrey for grey literature (www.opengrey.eu), Google Scholar, and the following trial registries: the International Standard Registered Clinical/soDial Study Number registry (www.isrctn.com), ClinicalTrials.gov (http://clinicaltrials.gov), and the Australian and New Zealand Clinical Trials Register (http://anzctr.org.au). Specialist society websites were also searched, including the ERAS Society (http://erassociety.org) and the PROSPECT site (www.postoppain.org).

Search

The search strategy combined terms for laparoscopic appendectomy—appendectomy or appendicectomy or appendicitis, appendectom* or appendicectom*, minimally invasive surgical procedures or laparoscopy, laparoscop* or coeliosco* or celiosco* or minimal* invasive—with the Cochrane highly sensitive search for RCTs, and terms pertaining to the review questions: ERAS, surgical approach, regional nerve blocks, intraperitoneal local anaesthesia, and the use of drains. No language or publication status restrictions were imposed. The last search was

performed on March 10, 2016 (Tables S1–S5 in the online supplement).

Study selection

The study selection process began with a search of electronic databases, screening of titles and abstracts, and full-text review of selected studies, followed by citation tracking electronically and by hand from studies and systematic reviews obtained by searching the Cochrane Library, and searches for grey literature, in an iterative process.

Data collection

The data were entered into a previously piloted, customized data collection form. Data items included participant age, intervention, comparison, outcomes, sources of funding, and authors' conclusions.

Outcomes Primary outcomes were length of hospital stay, readmissions, complications, operative time, pain scores, and opioid use.

Risk of bias in individual studies

To estimate the risk of bias, the reviewer assessed each included outcome in each paper for sequence generation, allocation concealment, blinding of participants, personnel and outcome assessors, incomplete outcome data, selective outcome reporting, loss to follow-up, and intention-to-treat. Risk of bias assessment did not lead to study exclusion.

Summary measures and synthesis of results

Summary measures were the odds ratio or mean difference. The standardized mean difference was used for opioid dose where drugs and dose measurements (e.g., divided by body weight) were variably reported. Synthesis was by meta-analysis of summary measures pooled from included studies. Interpretation of the quality of evidence and strength of recommendation for each study question was by GRADE (Grading of Recommendations, Assessment, Development, and Evaluations) methodology [8].

Subgroup analysis

Topics with sufficient study numbers underwent subgroup analysis of children. Sensitivity analysis entailed excluding trials viewed as outliers on a funnel plot (meaning possible bias) and only analysing those trials judged at low risk of bias in randomization and allocation concealment.

Statistical analysis

Review Manager 5.3 [9] generated analyses and plots using a random effects model throughout. The package, meta [10] within the statistical programme, R [11] was used for the linear regression test of funnel plot asymmetry (Egger test [12]). Data reported only as the median and range/interquartile range were converted to the mean and standard deviation using the method described by Wan et al. [13]. Review Manager calculated heterogeneity between studies by using the Cochran χ^2 test [14], $p \leq 0.1$ was interpreted as 'significant'; and inconsistency was assessed using the I^2 test [15, 16], $I^2 < 30$ %, 30–60, and >60 % signifying 'low', 'moderate', and 'high' inconsistency, respectively.

Results

Study selection, study characteristics, and risk of bias within studies

Database searches found 378 references comprising 65 on pathways/protocols, 208 on surgical approaches, 28 on regional nerve blocks, 46 on IPLA, and 31 on use of drains. Other searches found seven further papers, two theses, and six clinical trial protocols for unpublished studies. Full-text screening left 30 papers related to 27 studies, including five on clinical pathways, 16 on surgical access, 2 on regional nerve blocks, 4 on IPLA, and zero on drainage (Fig. 1). The study characteristics of each trial are shown in Table 1. The risk of bias assessment for each study is

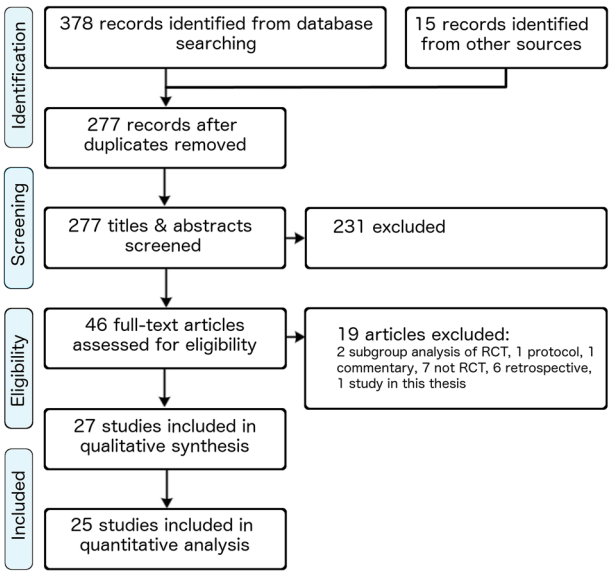

Fig. 1 Flow diagram of the study selection process

Table 1 Characteristics of studies included in this review

Clinical pathways versus standard care[a]						Outcomes		
First author	Year	Place	Age	*n*	*N*	Compl	Readm	LOS
Putnam [19]	2014	USA	Child	478	794	⊖	⊖	⊕
Warner [20]	1998	USA	Child	120	240	↔	–	⊕
Warner [21]	2002	USA	Child	718	893	–	–	⊕
Cash [17]	2012	USA	Adult	116	235	↔	↔	⊕
Lefrancois [18]	2015	France	Adult	184	652	↔	↔	⊕
Single incision laparoscopy versus 3-port laparoscopic appendectomy						Pain	Analgesia	LOS
Perez [32]	2013	USA	Child	25	50	↔	↔	↔
St Peter [34]	2011	USA	Child	180	360	–	⊖	↔
Wu [37]	2015	China	Child	30	60	–	–	↔
Amos [25]	2012	China	Adultb	27	44	–	–	↔
Carter [26]	2014	USA	Adult	37	75	⊖	⊖	↔
Frutos [27]	2013	Spain	Adultb	91	184	⊖	⊖	↔
Kye [28]	2013	Korea	Adult	51	102	⊕	↔	↔
Lee [29]	2013	Korea	Adult	114	230	↔	↔	↔
Mori [30]	2014	Spain	Adult	60	120	⊕	↔	↔
Park [31]	2010	Korea	Adult	20	40	⊖	↔	↔
Scarless group [24]	2015	UK	Adult	39	77	↔	⊕	↔
Sozutek [33]	2013	Turkey	Adult	25	50	–	–	↔
Teoh [35]	2012	Hong Kong	Adult	98	195	⊖	⊖	↔
Vidal [36]	2010	Spain	Adult	15	30	↔	–	↔
Needlescopic versus 3-port laparoscopic appendectomy						Pain	Analgesia	LOS
Huang [22]	2001	Taiwan	Adult[b]	26	75	–	⊕	↔
Lau [23]	2005	Hong Kong	Adult	174	363	–	–	↔
Transversus abdominis plane block versus control						Pain	Analgesia	LOS
Sandeman [38]	2011	Australia	Child	46	93	↔	↔	↔
Tanggaard [39]	2015	Denmark	Adult	27	52	⊕	↔	–
Cunniffe [40]	1998	Ireland	Adult	3	7	↔	–	–
Kang [41]	2010	Korea	Adult	30	63	⊕	⊕	↔
Kim [42]	2011	Korea	Adult	25	68	⊕	⊕	↔
Thanapal [43]	2014	Malaysia	Adult	68	100	↔	⊕	–

Compl., complication rate; *n*, sample size of intervention group; *N*, total sample siz; Readm, readmission rate; ⊕, favours intervention; ⊖, favours control; ↔, not significant; –, no data

[a] Prospective protocol versus historical controls

[b] Included younger adolescents

shown in Fig. S1 and Fig. S2 in the online supplement. The GRADE evidence profile is shown in Table 2.

Clinical pathways

Studies The search found no RCT on clinical pathways for laparoscopic appendectomy, but did find five prospective evaluations compared with retrospective controls [17–21], as shown in Table 1. Interventions generally consisted of standardizing the preoperative workup, early diet, early mobilization, and criteria-based discharge. All studies were scored to have a high risk of bias (Fig. S1).

Synthesis Clinical pathways resulted in a significantly higher proportion of patients discharged on day one, 57.8 %, compared to standard care, 29.3 % (Fig. S3), and a trend towards more readmissions, 4.7 % in pathway patients compared to 3.4 % with standard care (Fig. S4). Imprecision was high. Clinical pathways did not influence the complication rate on pooled analysis (Table 2 and Fig. S5).

Summary Clinical pathways for laparoscopic appendectomy appear to be safe in selected patients, but may be associated with a higher readmission rate—quality of evidence ⊕ O O O (very low).

Recommendation Surgeons could consider a clinical pathway for laparoscopic appendectomy—strength of recommendation weak.

Needlescopic surgery

Studies The search found two RCTs on needlescopic appendectomy [22, 23], as shown in Table 1. Huang et al. randomized 26 patients to needlescopic appendectomy and 23 patients to conventional laparoscopic appendectomy. They found no statistically significant differences in operative time, number of doses of pethidine given, length of hospital stay, or complications [22]. Lau et al. randomized 174 patients to needlescopic appendectomy and 189 to conventional laparoscopic appendectomy. They found a significantly longer operative time and a higher conversion rate in the needlescopic group, but no differences in pain scores, length of hospital stay, or complication rates [23]. It was not possible to blind the operators. Studies scored at high or uncertain risk of bias (Fig. S1).

Synthesis Needlescopic surgery did not alter the number of days spent in hospital (Fig. S6). The time taken to perform the operation with needlescopic instruments trended to 5 min longer than for standard surgery, but this was not statistically significant (Fig. S7). Needlescopic surgery did not alter the complication rate (Fig. S8).

Summary Needlescopic surgery offered no recovery advantage over traditional laparoscopic appendectomy—level of evidence ⊕ ⊕ ⊕ O (moderate).

Recommendation Instrument size can be determined by surgeon preference—strength of recommendation strong.

Single incision laparoscopic surgery

Studies The search found 14 RCTs comparing SIL with three-port appendectomy [24–37], as shown in Table 1. It was not possible to blind the operators to the intervention, so all studies scored as having a high risk of bias in at least one domain. Two studies blinded the outcome assessors [32, 35] (Fig. S1).

Synthesis Pooled analysis showed a trend of increased operative time and decreased time spent in hospital with SIL appendectomy (Fig. S9 and Fig. S10). SIL had no effect on the complication rate (Fig. S11).

Risk of bias across studies A funnel plot of the difference in hospital stay (left side of the graph indicating less time in hospital) against the standard error revealed outliers on the left side of the graph, indicating possible bias (Fig. S12). Linear regression showed that the asymmetry of the funnel plot was significant, $t = -2.26$, $p = 0.04$.

Subgroup analysis SIL appendectomy for children was associated with a longer operative time and no difference in hospital stay (Fig. S9 and Fig. S10).

Sensitivity analysis Exclusion of the four outliers shown on the funnel plot [29, 30, 36, 37] removed the overall trend towards reduced time in hospital, although the trend remained for adult studies (Fig. S13). The heterogeneity between adult and paediatric studies became significant and high at $I^2 = 66$ %. Inclusion of only studies at low risk of bias in randomization and allocation concealment removed the effect on hospital stay in adult studies and reduced heterogeneity between adults and children to $I^2 = 0$ % (Fig. S14).

Summary SILS afforded no recovery advantage over conventional laparoscopic surgery, but may increase operative time in children—level of evidence ⊕ ⊕ ⊕ O (moderate).

Recommendation Surgeons should consider the technical challenges and possible disadvantages when considering SIL appendectomy—strength of recommendation strong.

Natural orifice surgery

The search found no RCT on NOTES appendectomy.

Regional nerve blocks

Studies The search found two RCTs on bilateral transversus abdominis plane (TAP) blocks in laparoscopic appendectomy, one in children [38] and one in adults [39], as shown in Table 1, and one RCT on a rectus sheath nerve block in children [5].

Synthesis Analysis of the TAP block RCTs showed a trend towards reduced opioid requirements, but no difference in pain scores (Fig. S15 and Fig. S16). The rectus sheath block RCT showed reduced pain scores but no difference in opioid requirements.

Summary TAP blocks did not significantly reduce pain after laparoscopic appendectomy—level of evidence ⊕ ⊕ ⊕ O (moderate).

Recommendation Further research investigating other forms of regional anaesthesia in laparoscopic appendectomy is justified—strength of recommendation strong.

Intraperitoneal local anaesthetic

Studies The search found four RCTs on IPLA in appendectomy [40–43]. All studies were in adults, as shown in

Table 2 GRADE evidence profile. Interventions to optimize recovery after laparoscopic appendectomy

Quality assessment							Summary of findings				
N studies	ROB (design)	Incons		Indir	Impr	Pub bias	*N*		Difference	(95 % CI)	Quality
		I^2	*p*				E	C			
Clinical pathway							*Day one discharge, odds ratio*				
3	High (not RCT)	96 %	<0.01	☺	☺	?	466	903	4.54	[1.21 to 17.13]	⊕ OOO very low
Clinical pathway							*Readmission rate, odds ratio*				
3	High (not RCT)	39 %	0.19	☺	☹	?	632	903	1.85	[0.76 to 4.46]	⊕ OOO very low
Needlescopic laparoscopic appendectomy							*Days in hospital, mean difference*				
2	Moderate (RCT)	8 %	0.3	☺	☺	?	200	212	−0.09	[−0.42 to 0.24]	⊕ ⊕ ⊕ O moderate
Needlescopic laparoscopic appendectomy							*Minutes to perform operation, mean difference*				
2	Moderate (RCT)	6 %	0.30	☺	☺	?	200	212	4.44	[−1.18 to 10.06]	⊕ ⊕ ⊕ O moderate
Single incision laparoscopic appendectomy							*Days in hospital, mean difference*				
2	Moderate (RCT)	13 %	0.31	☺	☺	☹	812	805	−0.07	[−0.16, 0.02]	⊕ ⊕ ⊕ O moderate
Single incision laparoscopic appendectomy							*Minutes to perform operation, mean difference*				
14	Moderate (RCT)	96 %	<0.01	☺	☺	☹	775	767	2.78	[−1.78 to 7.34]	⊕ ⊕ ⊕ O moderate
Transversus abdominis plane block							*Pain score, mean difference*				
13	Moderate (RCT)	0 %	0.38	☺	☺	?	69	70	0.14	[−0.55 to 0.82]	⊕ ⊕ ⊕ O moderate
Transversus abdominis plane block							*Opioid use, standardized mean difference*				
3	Moderate (RCT)	0 %	0.96	☺	☺	?	69	70	−0.26	[−0.59 to 0.08]	⊕ ⊕ ⊕ O moderate
Intraperitoneal local anaesthetic							*Pain score, mean difference*				
2	Moderate (RCT)	31 %	0.23	☺	☺	?	55	54	−0.94	[−1.47 to −0.40]	⊕ ⊕ ⊕ O moderate
Intraperitoneal local anaesthetic							*Opioid use, standardized mean difference*				
4	Moderate (RCT)	53 %	0.09	☺	☺	?	98	90	−1.31	[−1.83 to −0.80]	⊕ ⊕ ⊕ O moderate

☺, No serious concerns; ☹, serious concern; ?, little evidence; ⊕ quality of evidence

CI confidence interval, *C* control group, *E* experimental group, *Impr* imprecision, *Incons* inconsistency, *Indir* indirectness, *N* number, *Pub* publication, *ROB* risk of bias

Table 1. The risk of bias was high for two studies (Cunniffe et al. [40] and Thanapal et al. [43]; Fig. S1).

Synthesis Opioid consumption was standardized for pooled analysis to adjust for the variable reporting of total dose of morphine [40, 43], total fentanyl dose [41], or fentanyl dose per kg [42]. IPLA significantly reduced pain scores, shoulder tip pain, and opioid requirements on the first day after surgery (Fig. S17, Fig. S18 and Fig. S19). Heterogeneity for opioid use was moderate.

Summary IPLA reduced early postoperative pain and opioid use in adults—level of evidence ⊕ ⊕ ⊕ O (moderate).

Recommendation IPLA should be considered in laparoscopic appendectomy; studies in paediatric surgery are needed—strength of recommendation strong.

Drains

The search found no RCT on the use of drains in appendectomy.

Discussion

Summary of evidence

This scoping review surveyed the literature on optimized recovery after laparoscopic appendectomy. The minimally invasive SIL and needlescopic approaches did not improve recovery, nor did the regional anaesthetic TAP block

technique reduce postoperative pain; however, IPLA was beneficial in adult laparoscopic appendectomy. These results will assist surgeons who wish to develop an enhanced recovery after surgery protocol for appendectomy. This review showed that the protocolized approach to appendectomy has not yet been studied in a randomized controlled trial.

One function of a scoping review is to 'map' the literature. By topic, studies on new surgical approaches predominated, specifically SIL appendectomy. In contrast, RCTs on optimized recovery pathways were absent and studies on regional or intraperitoneal anaesthetic techniques were few. By time period, 85 % of studies appeared within the past decade, indicating a relatively recent body of the literature. By patient population, one quarter of papers were in children; excluding the non-randomized studies on pathways and the SIL appendectomy trials, only one RCT, a TAP block study, had been published in children [38]. The scoping review therefore revealed 'lacunae' in the literature on local anaesthetic techniques to improve recovery in children, as well as in clinical pathways.

Since ERAS is by definition evidence-based, we need evidence for laparoscopic appendectomy before devising a recovery pathway. The present review refutes the need for further studies in SIL, given the number of trials and plethora of systematic reviews on the subject in recent years [44–52]. Perhaps the desire of some surgeons for a technical challenge or the lure of new 'high-tech' equipment explains the abundance of SIL studies.

Needlescopic surgery is similar to traditional laparoscopy, differing only in port diameters being $\leq$3 mm. Sajid et al. [53] previously combined two needlescopic RCTs on laparoscopic appendectomy in meta-analysis and recommended 'a major multicentre randomized controlled trial'. A Cochrane review of needlescopic cholecystectomy found reduced pain scores on the first postoperative day, reduced opioid use, improved cosmetic appearance, longer operative time, and no difference in complications [54].

In the quest for 'scar-less' surgery, surgeons have looked to access the peritoneal cavity via the stomach, vagina, or colon. Special instrumentation facilitates these approaches. One non-randomized study of trans-vaginal versus conventional laparoscopic appendectomy found no difference in sexual function between the two groups [55].

The two RCTs on TAP blocks provided reasonable evidence for the inefficacy of this form of regional anaesthesia in laparoscopic appendectomy [38, 39]. One large RCT on a rectus sheath block for children showed reduced pain scores soon after surgery but no effect on opioid requirements or length of hospital stay [5]. This suggests the need for more trials on rectus sheath blocks to confirm the published results, to investigate the technique in adults, and to develop ways to prolong the duration of the block.

Randomized clinical trials in laparoscopic gynaecology [56], cholecystectomy [57, 58], gastric procedures [59], and in open surgery [60] showed that IPLA reduced postoperative pain. The present review confirms these findings in laparoscopic appendectomy for adults. Between the completion of the present study and its publication, a trial on IPLA in laparoscopic appendectomy in children appeared, showing no benefit in this patient population [61]. Given the strength of evidence, surgeons should consider using IPLA in adult laparoscopic appendectomy.

Drainage is recognized as being unnecessary in most elective surgical settings [62]. ERAS protocols specify avoidance because drains probably hinder mobilization [63]. Some surgeons place drains after appendectomy for complicated appendicitis when pus is present. A Cochrane review of open appendectomy found very low quality evidence for drainage and suggested drains may delay discharge from hospital [64]. Conversely, investigators have infused local anaesthetic through peritoneal catheters to provide sustained pain relief after open operations [65]. Therefore, a well-controlled study in laparoscopic appendectomy could clarify the role of peritoneal catheters in recovery and their potential to deliver local anaesthetic to the peritoneum.

Investigators in clinical pathway management of appendicitis recognized the need for appropriate patient selection for ambulatory surgery. Lefrancois et al. recently described the 'Saint-Antoine Score', which is based on five factors independently associated with early discharge: body mass index $<$28 kg/m^2, white cell count $<$15,000/μL, *C*-reactive protein $<$30 mg/L, no radiological signs of perforation, and appendix diameter $\leq$10 mm on imaging. Using the scoring system, 71 % patients with 4 criteria and 92 % with 5 criteria returned home on the day of surgery [18].

Limitations As a scoping review, the present study lacked some of the rigour of a full systematic review. Search, study selection, quality assessment, and data extraction by the author were not independently duplicated. GRADE assessments were by the author, not developed in a consensus setting. Some scoping reviews map all evidence on a topic, while the present review confined its scope to five interventions for laparoscopic appendectomy. Meta-analysis as performed in the present study is not normally a component of a scoping review.

Conclusions

Gaps exist in the literature on optimizing recovery after laparoscopic appendectomy. RCTs on clinical pathways and use of drains in laparoscopic appendectomy were absent. This scoping review identified the need for randomized controlled trials on regional anaesthesia and intraperitoneal local anaesthesia in children.

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Compliance with ethical standards

Disclosures Dr. James K. Hamill, Dr. Jamie-Lee Rahiri, Mr. Gamage Gunaratna, and Andrew G. Hill have no conflicts of interest or financial ties to disclose.

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