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REVIEW

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Transabdominal pre-peritoneal (TAPP) versus totally extraperitoneal (TEP) laparoscopic techniques for inguinal hernia repair: a systematic review

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Abstract Background: The choice of approach to the laparoscopic repair of inguinal hernia is controversial. There is a scarcity of data comparing the laparoscopic transabdominal preperitoneal (TAPP) approach with the laparoscopic totally extraperitoneal (TEP) approach, and questions remain about their relative merits and risks. Methods: Electronic databases were searched to identify reports of trials comparing laparoscopic TAPP with laparoscopic TEP. In addition, selected conference proceedings were hand-searched, websites consulted, reference lists of all included papers were scanned, and experts contacted for other potentially eligible reports. All published and unpublished randomised controlled trials and quasi-randomised controlled trials comparing laparoscopic TAPP with laparoscopic TEP for inguinal hernia repair were eligible for inclusion. Large non-randomised prospective studies were also eligible for inclusion to provide further comparative evidence of complications and serious adverse events. Two reviewers independently extracted data and assessed study quality. Statistical analyses were performed using the fixed effects model and the results expressed as relative risk (RR) for dichotomous outcomes and weighted mean difference (WMD) for continuous outcomes with 95% confidence intervals (CI). Results: The search identified one RCT which reported no statistically significant difference between TAPP and TEP when considering duration of operation, haematoma, length of stay, time to return to usual activities, and recurrence. The eight non-randomised studies suggest that TAPP is associated with higher rates of port-site hernias and visceral injuries whilst there appear to be more conversions with TEP. Vascular injuries and deep/mesh infections were rare and there was no obvious difference between the groups. No studies reporting economic evidence were identified. Conclusions: There is insufficient data to allow conclusions to be drawn about the relative effectiveness of TEP compared with TAPP. Efforts should be made to start and complete adequately-powered randomised controlled trials (RCTs), which compare the different methods of laparoscopic repair.

Keywords Inguinal hernia · Laparoscopic surgery · Systematic review · Randomised controlled trial · Synthetic mesh

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Introduction

The most commonly used laparoscopic techniques for inguinal hernia repair are transabdominal preperitoneal (TAPP) repair and totally extraperitoneal (TEP) repair. TAPP requires access to the peritoneal cavity with placement of a mesh through a peritoneal incision. This mesh is placed in the preperitoneal space covering all potential hernia sites in the inguinal region. The peritoneum is then closed above the mesh, leaving it between the preperitoneal tissues and the abdominal wall where it becomes incorporated by fibrous tissue. TEP repair was first reported in 1993 [1]. TEP is different in that the peritoneal cavity is not entered and mesh is used to seal the hernia from outside the peritoneum. This approach is considered to be more difficult than TAPP but may lessen the risks of damage to the internal organs and of adhesion formation leading to intestinal obstruction, which has been linked to TAPP.

Laparoscopic repair is technically more difficult than open repair and there is evidence of a ''learning curve''

in its performance [2]. It is likely that some of the higher rates of potentially serious complications reported for laparoscopic repair are associated with learning effects, particularly for the more complex TEP repair.

Large randomised controlled trials such as those conducted by the MRC Laparoscopic Groin Hernia Group and Neumayer and colleagues, both of which compared a predominantly TEP arm with open repair, suggested that TEP has a higher risk of recurrence than open mesh repair. However, a systematic review found no statistically significant differences in recurrence rates between TAPP and open mesh repair [3]. While any conclusions drawn on such indirect comparisons should be treated with caution, they do raise questions that can only be satisfactory addressed by well-designed studies and systematic reviews that directly compare TAPP and TEP.

In light of this, this systematic review aimed to compare TAPP and TEP directly in order to determine which method is associated with better outcomes; in particular, serious adverse events and subsequent potential consequences such as persisting pain.

Materials and methods

Studies were eligible for inclusion if they were randomised or quasi-randomised trials comparing laparoscopic transabdominal preperitoneal (TAPP) with laparoscopic totally extraperitoneal (TEP) inguinal hernia repair. Trials were included irrespective of the language in which they were reported. The trials included patients with a clinical diagnosis of groin hernia for whom surgical management was judged appropriate; in addition to primary inguinal hernia, this could include patients with recurrent and bilateral hernias. Non-randomised prospective studies with concurrent comparators, prospective comparative studies with non-concurrent comparators including more than 500 participants, and large prospective case series with greater than 1000 participants were also eligible for inclusion to provide further comparative evidence of complications and serious adverse events.

Selecting studies

Since the first reported use of a prosthetic mesh in laparoscopic repair was in 1991, and TEP was not reported until 1992, electronic literature searches were limited to works published from 1990 to the present. A search strategy incorporating index and text word terms for inguinal hernia repair including TAPP and TEP procedures was developed and run on the following databases without language restrictions: Medline (1990 to Week 1, June 2003), Medline Extra (13th June 2003), Embase (1990 to Week 23, 2003), Biosis (1990 to 18th June 2003), Science Citation Index (1991 to 21st June 2003), Cochrane Central Register of Controlled Trials (Issue 2, 2003), the electronic version of the journal Surgical Endoscopy (1996 to June 2003) and Journals@Ovid Full Text (25th July 2003) restricted to the surgical journals: Annals of Surgery 1996 to July 2003, Archives of Surgery 1995 to June 2003, British Journal of Surgery and Supplements 1995 to June 2003 and Surgical Laparoscopy 1996 to June 2003.

Systematic reviews and other evidence-based reports were also identified. In addition, selected conference proceedings were hand-searched, websites consulted, reference lists of all included papers were scanned, and experts contacted for other potentially eligible reports.

Data collection and analysis

All abstracts identified by the above search strategies were assessed for subject relevance by two researchers. The full publications of all possibly relevant abstracts were obtained and formally assessed for inclusion. A data abstraction form was developed to record details of study design, participants, setting and timing, interventions, patient characteristics, and outcomes. Data abstraction was performed independently by two reviewers. Where a difference of opinion existed, the two reviewers consulted an arbiter. All studies that met the selection criteria were assessed for methodological quality. The system for classifying methodological quality of RCTs was based on an assessment of the four principal potential sources of bias. These were: selection bias from inadequate concealment of allocation of treatments; attrition bias from losses to follow-up without appropriate intention-to-treat analysis, particularly if related to one or other surgical approaches; detection bias from biased ascertainment of outcome where knowledge of the allocation might have influenced the measurement of outcome; and selection bias in analysis. Studies reporting health service resource use and economic measures of quality of life outcomes may be subject to additional biases. Therefore, it was planned that the methodological quality of these studies were to be additionally assessed using the Drummond checklist for economic evaluations [4].

We aimed to do a formal quantitative meta-analysis of data from comparable trials using the methods described by Yusuf and colleagues [5]. In the event, only one randomised controlled trial was available and a narrative review was undertaken. For this reason, studies using other designs were identified in order to provide further comparative evidence of complications and serious adverse events. Attention was focussed on vascular injuries, visceral injuries, deep/mesh infections, port-site hernia, and conversions (a conversion was defined as a procedure initiated as a laparoscopic but

Table 1 Characteristics of included non-randomised studies

Literature reference	Country of study	Study design	Data collection	Number of repairs	Patient characteristics: TAPP	Patient characteristics: TEP
[14]	Germany	Case series	Retrospective	2500 TAPP	92% maleaverage age: 59 (range 19–88)32% direct, 37% indirect, 2% femoral, 12% combined, 17% recurrent, 22% bilateralmean follow-up: 39 months (range 4 weeks to 7 yrs)87% patients included in analysis	not applicable
[7]	Brazil	Concurrent comparison?	Prospective	108 TAPP100 TEP	100% malemean age: 35 (range 21–73), overall only28% unilateral, 38% bilateral, 33% recurrent	100% malemean age: 35 (range 21–73), overall only9% unilateral, 49% bilateral, 42% recurrent
[8]	USA	Concurrent comparison	Retrospective	733 TAPP382 TEP	87% malemean age: 49 (range 12–89)median follow-up: 24 months (TAPP) and 9 months (TEP)60% indirect, 23.6% direct, 15.3% pantaloon, 1% femoral	
[9]	Canada	Concurrent comparison	Prospective	60 TAPP60 TEP	91% maleAge range: 20–7667% indirect, 28% direct, 3% femoral, 2% combined	Used a distension balloon93% male Age range: 20–7368% indirect, 27% direct, 2% femoral, 3% combined
[15]	Germany	Case series	Retrospective	5707 TAPP	not reported	not applicable
[10]	France	Concurrent Comparison	Retrospective	1290 TAPP682 TEP	87% male overall63% unilateral, 37% bilateral, 9% recurrent	87% male overall74% unilateral, 36% bilateral, 8% recurrent
[13]	Germany	Case series	Retrospective	5203 TEP	not applicable	91% malemedian age: 53 (range: 15–89) 32% direct, 57% indirect, 8% combined, 3% femoral, 13% recurrent, 35% bilateral
[11]	Belgium	Concurrent comparison?	Prospective	37 TAPP69 TEP	100% malemean age: 58 (range: 20–79)78% unilateral, 22% bilateral, 43% direct, 54% direct, 3% combined, 5% recurrent	97% malemean age: 59 (range: 21–84)68% unilateral, 32% bilateral, 29% direct, 59% indirect, 12% combined, 10% recurrent
[12]	Germany	Non-concurrent comparison	Retrospective	1216 TAPP1547 TEP	not reported	not reported

converted to an open repair) because these were deemed to be the more serious complications.

Results

Number and type of studies included

Only one randomised controlled trial [6] was identified. It reported data on the following outcomes: operation time, intra-operative and postoperative complications, length of hospital stay, time to return to work, time to return to usual activities, and hernia recurrence. The concealment of allocation was by sealed envelope and there were no losses to follow-up. However, it was unclear if the outcome assessor was blinded or if analysis was by intention-to-treat. The mean duration of follow-up was three months, hernia diagnosis was confirmed by clinical examination and the operation was reported to have been performed by an ''experienced'' surgeon.

Nine additional non-randomised, observational studies met the eligibility criteria: five studies with concurrent comparators [7, 8, 9, 10, 11]; one with a non-concurrent comparator [12]; and three studies were case series (TEP, 5203 hernia repairs [13] and TAPP, 2500 [14] and 5203 [15] hernia repairs respectively). The characteristics of these studies are described in Table 1.

No study was identified that reported an economic evaluation or information on cost.

Randomised controlled trials

The results from the single randomised trial are tabulated in Table 2. The operating time was slightly longer in TEP than TAPP, although the difference was not statistically significant (WMD −6.30 min, 95% CI −12.82 to 0.22; $p = 0.06$). There was only one haematoma recorded in the study and this was in the TAPP group. Length of stay was shorter in the TEP group (WMD −0.70 days, 95% CI −1.33 to −0.07; $p = 0.03$). An overall figure for time to return to usual activities was not given in the paper, although several separate activities (such as return to work) were listed, with none showing a statistically significant difference between the TAPP and TEP groups. Hernia recurrence was only assessed up to three months. Within this time there was one recurrence in the TAPP group.

Complications/serious adverse events from non-randomised observational studies

The results for non-randomised studies are tabulated in Table 3. Seven studies reported vascular injuries [8, 9, 10, 11, 13, 14, 15], including three large case series. In the comparative studies, three reported no vascular injuries [8, 10, 11], whilst one—a small study of 120 patients—reported a higher rate (3% versus 0%) in TEP. In the three case series, one reported no vascular injuries in TAPP while the rates from the other two case series showed similar rates for TAPP (0.5%, based on 5707 cases) and TEP (0.47% based on 5203 cases) [13].

Seven studies reported visceral injuries [7, 8, 9, 11, 13, 14, 15], including the three large case series. In the comparative studies, two reported no visceral injuries [9, 11] whilst two reported a higher rate (0.9% versus 0% and 0.4% versus 0%) in TAPP than in TEP [7, 8]. The combined number of cases in these studies was 1323. In the three case series, the two TAPP series [14, 15] reported similar rates of 0.64% and 0.60% with a combined number of cases of 8207, whilst the one TEP series reported a lower rate of 0.23% based on 5203 cases [13].

Deep infections, primarily mesh infections, are potentially more serious than superficial infections and can result in removal of the mesh. These were reported in seven studies [8, 9, 11, 12, 13, 14, 15]. In the comparative studies, three reported no deep infections [8, 9, 11], whilst one reported rates of 0.2% and 0% for TAPP and TEP respectively [12]. Reported rates were also low for the case series and did not indicate a difference between TAPP and TEP. The two TAPP case series [14, 15] had rates of 0% and 0.1%, while the corresponding rate for the TEP case series was 0.02% [13].

Eight of the nine studies reported port-site hernia [7, 8, 9, 11, 12, 13, 14, 15]. The comparative studies showed rates of 0% to 3.7% [7, 8, 9, 11, 12]. In all four studies

Table 2 Results from study comparing effectiveness of TAPP with TEPP

Outcomes	TAPP ($n = 28$)	TEP ($n = 24$)
Operation time (mean/SD)	46.0 (9.2)	52.3 (13.9)
Intraoperative complications	None	None
Haematoma	1/28	0/24
Time to return to usual activities (days) (mean/SEM):		
Walking	8.6 (1.4)	8.5 (1.3)
Driving a car	10.1 (1.4)	12.4 (1.7)
Sexual intercourse	17.7 (2.7)	18.9 (2.6)
Sports	35.5 (4.9)	35.2 (4.6)
Time to return to work (weeks) (mean/SEM)	4.9 (0.7)	4.6 (0.6)
Length of hospital stay (mean/SD)	3.7 (1.4)	4.4 (0.9)*
Recurrence at three months	1/28	0/24

* Statistically significant result; SEM = standard error of the mean; SD = standard deviation

Table 3 Potentially serious adverse events reported in non-randomised studies of TAPP and TEP

Literature reference	Vascular injury		Visceral injury		Deep/mesh infection		Port-site hernia		Conversions	
	TAPP % (n/N)	TEP % (n/N)	TAPP % (n/N)	TEP % (n/N)	TAPP % (n/N)	TEP % (n/N)	TAPP % (n/N)	TEP % (n/N)	TAPP % (n/N)	TEP % (n/N)
Comparative studies										
[7]	NR	NR	0.9% (1/108)	0% (0/100)	NR	NR	3.7% (4/108)	0% (0/100)	0% (0/108)	4% (4/100)
[8]	0% (0/733)	0% (0/382)	0.4% (3/733)	0% (0/382)	0% (0/733)	0% (0/382)	0.8% (6/733)	0% (0/733)	0% (0/382)	1.8% (7/382)
[9]	0% (0/60)	3% (2/60)	0% (0/60)	0% (0/60)	0% (0/60)	0% (0/60)	1.7% (1/60)	0% (0/60)	0% (0/60)	0%
[10]	0% (0/1290)	0% (0/682)	NR	NR	NR	NR	NR	NR	NR	NR
[11]	0% (0/33)	0% (0/58)	0% (0/33)	0% 0/58)	0% (0/33)	0% (0/58)	0% (0/33)	0% (0/58)	5% (2/33)	7% (4/58)
[12]	NR	NR	NR	NR	0.2% (2/1216)	0% (0/1547)	0.3% (4/1216)	0.1% (2/1547)	NR	NR
Case series										
[14]	0% (0/2500)	NA	0.64% (16/2500)	NA	0% (0/2500)	NA	0.24% (6/2500)	NA	0.24% (6/2500)	NA
[15]	0.5% (29/5707)	NA	0.6% (34/5707)	NA	0.1% (6/5707)	NA	0.35% (20/5707)	NA	NR	NA
[13]	NA	0.47% (24/5203)	NA	0.23% (12/5203)	NA	0.02% (1/5203)	NA	0% (0/5203)	NA	0.23% (12/5203)

NA = not applicable; NR = not reported

where cases of port-site hernia were reported, TAPP was associated with a higher rate than TEP [7, 8, 9, 12]. In three studies there were no cases of port-site hernia reported in the TEP groups, compared to 3.7% [7], 0.8% [8] and 1.7% [9] in the TAPP groups. This trend was also seen in the case series, where there were no reported cases of port-site hernia amongst 5203 TEP repairs [13], compared to 0.24% [14] and 0.35% [15] amongst 8207 TAPP repairs.

The conversion rate was reported in six of the studies [7, 8, 9, 11, 13, 14]. In three of the four comparative studies the rate was higher in the TEP group, with rates of 0% versus 4% [7], 0% versus 1.8% [8], and 5% versus 7% [11]. The fourth comparative study was small, with only 120 procedures, and had no conversions [9]. However, in the large case series the conversion rates between TAPP and TEP were very similar at 0.24% [14] and 0.23% [13] respectively.

Discussion

Despite extensive literature searching, only one small randomised trial met the inclusion criteria [6]. There appeared to be no differences between TAPP and TEP in terms of length of operation, haematomas, time to return to usual activities and hernia recurrence, but confidence intervals were all very wide. In other words, the estimates are all imprecise and do not rule out clinically important differences.

The data about complications from the additional non-randomised studies of TAPP and TEP suggest that an increased number of port-site hernias and visceral injuries are associated with TAPP rather than TEP, whilst there appear to be more conversions with TEP. These results appear to be broadly consistent regardless of the evidence source. Vascular injuries and deep/mesh infections were very rare and there was no obvious difference between the groups, the numbers being too small to draw any conclusions. These data should be interpreted cautiously, however. As they are based on observational data the comparisons may be biased by underlying differences in the groups of patients studied.

There is now very extensive evidence about the relative performance of laparoscopic and open hernia repair including data from over 12,000 randomised patients [3, 16, 17, 18]. In contrast, only a single small randomised trial has compared TAPP with TEP. Questions about the relative merits of TAPP and TEP can only be reliably addressed by well-designed, adequately-powered randomised comparisons.

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bodies. A more detailed version of this review will be published and updated in the Cochrane Database of Systematic Reviews.

References

1. Ferzli G, Masaad A, Albert P et al. (1993) Endoscopic extraperitoneal herniorrhaphy versus conventional hernia repair. A comparative study. Curr Surg 50:291–294
2. Wright D, O'Dwyer PJ (1998) The learning curve for laparoscopic hernia repair. Semin Laparosc Surg 5:227–232
3. McCormack K, Wake B, Perez J et al. (2004) Systematic review of the clinical effectiveness and cost-effectiveness of laparoscopic surgery for inguinal hernia repair. Health Technol Assess (in press)
4. Drummond M, O'Brien B, Stoddart G, Torrance G (1997) Methods for the economic evaluation of healthcare programmes, 2nd edn. Oxford University Press, Oxford
5. Yusuf S, Peto R, Lewis J et al. (1985) Beta blockade during and after myocardial infarction: an overview of randomized controlled trials. Prog Cardiovasc Dis XXVII:335–371
6. Schrenk P, Woisetschlager R, Rieger R et al. (1996) Prospective randomised trial comparing postoperative pain and return to physical activity after transabdominal preperitoneal, total preperitoneal or Shouldice technique for inguinal hernia repair. Brit J Surg 83:1563–1566
7. Cohen RV, Alvarez G, Roll S et al. (1998) Transabdominal or totally extraperitoneal laparoscopic hernia repair? Surg Laparosc Endosc 8:264–268
8. Felix EL, Michas CA, Gonzalez MH Jr (1995) Laparoscopic hernioplasty. TAPP vs TEP. Surg Endosc 9:984–989
9. Khoury N (1995) A comparative study of laparoscopic extraperitoneal and transabdominal preperitoneal herniorrhaphy. J Laparoendosc Surg 5:349–355
10. Lepere M, Benchetrit S, Debaert M et al. (2000) A multicentric comparison of transabdominal versus totally extraperitoneal laparoscopic hernia repair using PARIETEX meshes. J Soc Laparoendosc Surg 4:147–153
11. Van Hee R, Goverde P, Hendrickx L et al. (1998) Laparoscopic transperitoneal versus extraperitoneal inguinal hernia repair: a prospective clinical trial. Acta Chir Belg 98:132–135
12. Weiser HF, Klinge B (2000) Endoscopic hernia repair—Experiences and characteristic features. Viszeralchirurgie 35:316–320
13. Tamme C, Scheidbach H, Hampe C et al. (2003) Totally extraperitoneal endsocopic inguinal hernia repair (TEP). Surg Endosc 17:190–195
14. Baca I, Schultz C, Gotzen V et al. (2000) Laparoscopic inguinal hernia repair. A review of 2500 cases. In: Lomanto D, Kum CK, So JBY, Goh PMY (eds) Proceedings of the 7th World Congress of Endoscopic Surgery, Singapore, 1–4 June 2000. Monduzzi Editore, Bologna, Italy, pp 425–430
15. Leibl BJ, Schmedt CG, Kraft K et al. (2000) Laparoscopic transperitoneal hernioplasty (TAPP)—efficiency and dangers. Chir Gastroenterol 16:106–109
16. The EU Hernia Trialists Collaboration (2002) Laparoscopic versus open groin hernia repair: meta-analysis of randomised trials based on individual patient data. Hernia 6:2–10
17. The EU Hernia Trialists Collaboration (2002) Open mesh versus non-mesh repair of groin hernia: meta-analysis of randomised trials based on individual patient data. Hernia 6:130–136
18. McCormack K, Scott NW, Go PMNYH et al. (2003) Laparoscopic techniques versus open techniques for inguinal hernia repair. In: The Cochrane Collaboration (2003) The Cochrane Library, Issue 1. Update Software, Oxford