

# The role of the laparoendoscopic single site totally extraperitoneal approach to inguinal hernia repairs: a review and meta-analysis of the literature

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**Background:** Laparoendoscopic single site (LESS) surgery may have perceived benefits of reduced visible scarring compared to conventional laparoscopic (LAP) totally extraperitoneal (TEP) hernia repairs. We reviewed the literature to compare LESS TEP inguinal hernia repairs with LAP TEP repairs.

**Methods:** We searched electronic databases for research published between January 2008 and January 2012.

**Results:** A total of 13 studies reported on 325 patients. The duration of surgery was 40–98 minutes for unilateral hernia and 41–121 minutes for bilateral repairs. Three studies involving 287 patients compared LESS TEP ( $n = 128$ ) with LAP TEP ( $n = 159$ ). There were no significant differences in operative duration for unilateral hernias ( $p = 0.63$ ) or bilateral repairs ( $p = 0.29$ ), and there were no significant differences in hospital stay ( $p > 0.99$ ), intraoperative complications ( $p = 0.82$ ) or early recurrence rates ( $p = 0.82$ ). There was a trend toward earlier return to activity in the LESS TEP group ( $p = 0.07$ ).

**Conclusion:** Laparoendoscopic single site surgery TEP hernia repair is a relatively new technique and appears to be safe and effective. Advantages, such as less visible scarring, mean patients may opt for LESS TEP over LAP TEP. Further studies with clear definitions of outcome measures and robust follow-up to assess patient satisfaction, return to normal daily activities and recurrence are needed to strengthen the evidence.

**Contexte :** La chirurgie laparoendoscopique à orifice unique (LESS) a comme avantage perçu une réduction des cicatrices apparentes comparativement aux réparations laparoscopiques (LAP) classiques totalement extrapéritonéales (TEP) des hernies. Nous avons passé en revue la littérature afin de comparer les réparations des hernies inguinales par chirurgie LESS TEP et par LAP TEP.

**Méthodes :** Nous avons interrogé les bases de données électroniques pour y recenser la recherche publiée entre janvier 2008 et janvier 2012.

**Résultats :** En tout, 13 études ont porté sur 325 patients. La durée de la chirurgie a été de 40 à 98 minutes pour les réparations de hernies unilatérales et de 41 à 121 minutes pour les réparations de hernies bilatérales. Trois études regroupant 287 patients ont comparé la technique LESS TEP ( $n = 128$ ) à la technique LAP TEP ( $n = 159$ ). On n'a observé aucune différence significative quant à la durée de la chirurgie des réparations de hernies unilatérales ( $p = 0,63$ ) ou bilatérales ( $p = 0,29$ ) et aucune différence significative de durée des séjours hospitaliers ( $p > 0,99$ ), de complications peropératoires ( $p = 0,82$ ) ou de taux de récurrences précoces ( $p = 0,82$ ). On a noté une tendance à un retour plus rapide aux activités dans le groupe soumis à la technique LESS TEP ( $p = 0,07$ ).

**Conclusion :** La réparation de hernie par chirurgie TEP laparoendoscopique à un seul orifice est une technique relativement nouvelle et semble sécuritaire et efficace. Ses avantages, par exemple des cicatrices moins apparentes, pourraient pousser les patients à opter pour la technique LESS TEP plutôt que LAP TEP. Il faudra procéder à d'autres études fondées sur des définitions paramétriques claires et comportant un suivi robuste pour évaluer la satisfaction des patients, la reprise des activités quotidiennes normales et les taux de récurrences afin de consolider les preuves.

Inguinal hernias are a common problem and concern in the population with more than 80 000 new diagnoses<sup>1</sup> leading to more than 70 000 repairs between 2010 and 2011 in the UK;<sup>2</sup> 20 million repairs are performed worldwide every year.<sup>3,4</sup> Open inguinal hernia repairs are well-established procedures<sup>5</sup> with good postoperative outcomes. Since the early 1990s<sup>6,7</sup> laparoscopic techniques have become more popular. Some studies report an increase from 6% in 1992 to more than 40% in 2008 of hernias being repaired laparoscopically;<sup>8</sup> this rapid rise in use may be because of less pain, faster recovery and better long-term outcomes.<sup>9–11</sup> Furthermore, the minimally invasive procedures (typically the transperitoneal approach, but also the extraperitoneal approach if the midline raphe is crossed) offer the ability to examine the contralateral side,<sup>12</sup> which may reveal an incipient or obvious hernia in up to 20% of patients.<sup>13,14</sup> The proportion of laparoscopic repairs has increased markedly over the last 20 years.<sup>15</sup> The 2 recognized types of laparoscopic approaches are totally extraperitoneal preperitoneal (TEPP) or transabdominal preperitoneal (TAPP). Although both techniques are safe<sup>16</sup> and offer advantages, totally extraperitoneal (TEP) repairs may be associated with a lower incidence of port site hernias, bowel-related complications, less pain and greater patient satisfaction; conversely, TEP may be associated with an increased likelihood of conversion.<sup>17–19</sup>

Greater patient education and demand for better cosmesis after surgical procedures have led to increased interest in laparoendoscopic single site surgery (LESS). Initially there was reluctance to adopt the technique owing to lack of technical facilitation; however, new or innovative port types<sup>20</sup> and newer instruments have led to its application in a variety of surgical specialties.<sup>21</sup> Laparoendoscopic single site TEP may be performed using conventional instruments, although articulating or curved instruments are in use.<sup>22</sup> Although patients have good outcomes after conventional laparoscopic techniques, some authors suggest that there is a preference for LESS,<sup>23</sup> which may be because of less postoperative pain<sup>24,25</sup> or possible better cosmesis. Some have argued there is no advantage to single port surgery.<sup>26</sup> We hypothesized that LESS TEP may be superior to conventional laparoscopic TEP (LAP TEP) because of fewer incisions, which may lead to less pain, and because the single incision in the umbilicus may result in a hidden scar with a better cosmetic appearance.

We reviewed the literature examining the role of LESS TEP for inguinal hernias. We aimed to compare LESS TEP with LAP TEP. Our main summative outcome measures were duration of surgery, hospital stay, cosmesis and return to activity.

## METHODS

### *Searching and selection*

We identified all studies examining the role of LESS TEP for hernia repairs or comparing LESS TEP with LAP TEP

that were published between January 2008 and January 2012. We searched the Medline, Embase and CINAHL databases available through the National Health Service National Library of Health website, the Cochrane library and PubMed. A range of key words are available to describe LESS techniques, and we used these terms to search for relevant material.<sup>27</sup> The main key words “single port,” “single site surgery,” “laparoendoscopic single site,” “single port access,” “single incision,” “multiport” and “totally extraperitoneal hernia repair” were used in combination with the medical subject headings “hernia” and “inguinal hernia.” Articles, reviews and meta-analyses that we considered irrelevant based on the titles and abstracts were excluded. Relevant articles referenced in these publications were obtained, and we searched the references of identified studies to identify any further studies. No language restriction was applied.

### *Quality assessment*

Two authors (M.R.S.S. and M.K.) independently assessed the methodological quality of the trials included for meta-analysis using standardized reference tools.<sup>28–31</sup>

### *Data extraction*

Articles were included according to our review criteria (all noncomparative studies reporting on LESS TEP, all studies comparing LESS TEP with LAP TEP for groin hernias, all comparative or randomized studies, all elective cases, trials involving adults of any sex) and were reviewed by 2 researchers (M.R.S.S. and M.K.). This was performed independently, and if any conflict arose resolution was through discussion with the authors prior to analysis. Only papers examining the role of LESS TEP for hernias in adults and studies comparing LESS TEP with LAP TEP were included.

Our main outcome measures were duration of surgery for unilateral and bilateral hernias, hospital stay, complications, pain and concerns raised at follow up.

### *Statistical analysis*

Statistical analyses were performed using Review Manager 5.0.23 (RevMan; Cochrane Collaboration).<sup>32</sup> A value of  $p < 0.05$  was chosen as the significance level for outcome measures. For continuous data (duration of surgery, hospital stay, return to activity), the inverse variance method was used for the combination of standardized mean differences (SMD). Binary data (intraoperative complications and recurrence) were summarized as risk ratios (RR) and combined using the Mantel-Haenszel method.<sup>33</sup> Heterogeneity of the studies was assessed according to  $Q$  and  $I^2$  statistics. We used a random-effects method if the heterogeneity was significant; otherwise a fixed-effects method was used. In a sensitivity analysis, 1 was added to each cell frequency for trials in which

no event occurred, according to the method recommended by Deeks and colleagues.<sup>34</sup> When standard deviations were not reported, we estimated them either from ranges or *p* values. Forest plots were used for the graphical display.

**RESULTS**

A total of 136 articles were screened for relevance. On further scrutiny, 16 articles<sup>15,19,22,35-47</sup> were used in our literature review and 3 studies comparing LESS TEP with LAP TEP were found to have useful data for the summative outcome. One study commented on a previous report.<sup>37</sup> Three studies<sup>22,40,45</sup> compared LESS TEP with LAP TEP and were combined to produce a summative outcome. A flow chart of the literature search according to PRISMA guidelines<sup>48</sup> is shown in Figure 1. Characteristics of each article are given in Tables 1 and 2.

*Demographic characteristics of patients undergoing LESS TEP*

Thirteen studies<sup>15,19,35-39,41-44,46,47</sup> reported on 325 patients undergoing the LESS TEP procedure. The patient age

range was 18–85 years,<sup>15,19,35,37-39,41-44,46</sup> and 90% of patients were men.<sup>15,19,35,37-39,41-43,46</sup>

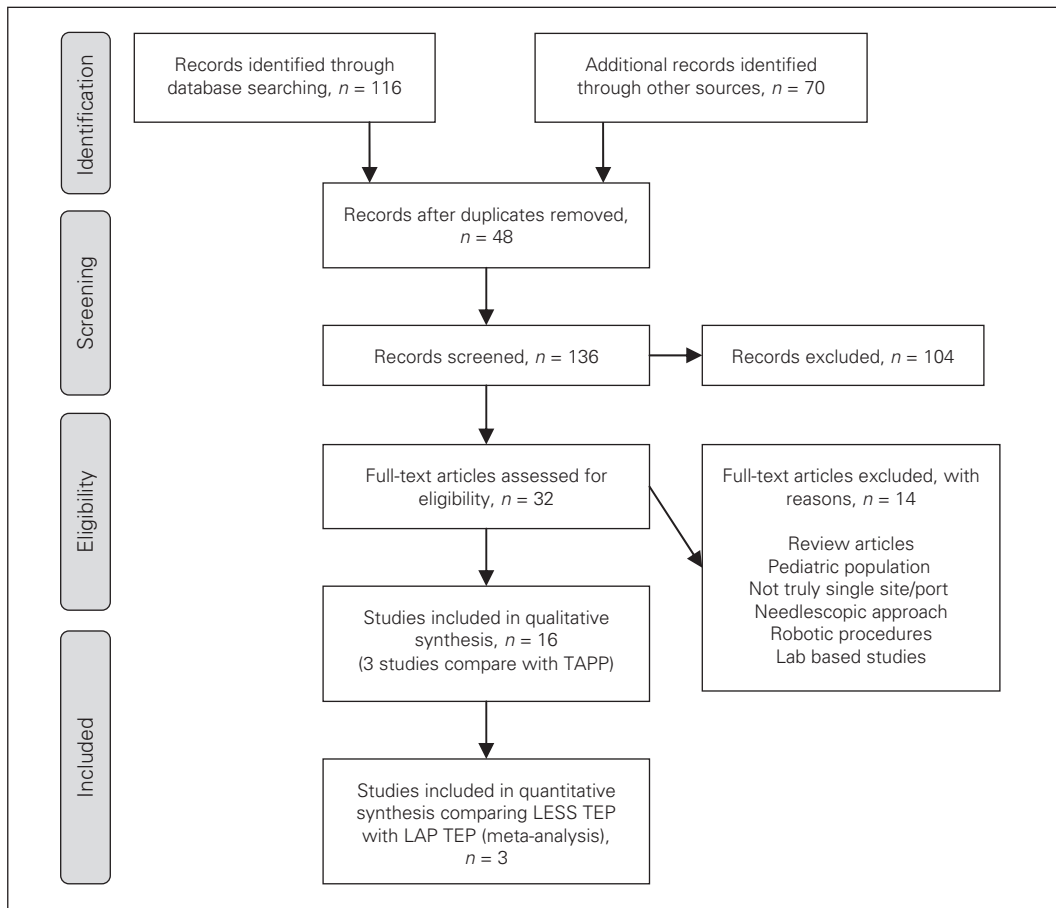
*Surgical technique*

Nine studies reported on the use of a balloon to create a preperitoneal space.<sup>15,19,35,37,38,41,42,44,47</sup> Seven studies used a single port access device.<sup>15,19,36,38,39,41,43</sup> Other techniques included the use of 3 ports through a single incision.<sup>35,37,42,44,46,47</sup> A range of 0–45° cameras and straight, curved, articulating or manually bent instruments were used.<sup>15,19,35-39,41-44,46,47</sup> Two studies<sup>36,43</sup> did not report their mesh fixation method and 1 did not use any form of fixation.<sup>19</sup>

*Outcomes after the LESS TEP approach*

**Perioperative data**

The mean duration of surgery was 40–98 minutes for unilateral hernia repairs<sup>15,19,35-37,39,41,42,44,46,47</sup> and 41–121 minutes for bilateral hernia repairs.<sup>15,36,38,39,41-44,46,47</sup> Six patients required conversion, although no conversions were to a formal open procedure.<sup>15,36,41,42,46</sup> There were only 2 reported intraoperative complications involving bleeding or



**Fig. 1.** Study selection. LAP = laparoscopic; LESS = laparoendoscopic single site surgery; TAPP = transabdominal preperitoneal; TEP = totally extraperitoneal.

Table 1. Characteristics of studies included in our review and meta-analysis (part 1 of 2)

Characteristic	Cugura et al. <sup>35,37</sup>	Jacob et al. <sup>38</sup>	Bucher et al. <sup>38</sup>	Surgit et al. <sup>36</sup>	Agrawal et al. <sup>39</sup>	Tran <sup>15</sup>	Do et al. <sup>18</sup>	Chung et al. <sup>42</sup>	He et al. <sup>43</sup>	Tai et al. <sup>44**</sup>	Shih et al. <sup>47</sup>	Kim et al. <sup>46</sup>
No. of patients	1	3	4	23	16	68	10	100	3	7	30	60
Age, yr (range)	60	NR	NR	48.4 (23-67)	65.5 (21-87)	44 (18-83)	43.7 (28-64)	48 (18-82)	64.6 (49-73)	46.5 (21-80)*	NR	58.5 (24-85)
Sex, male:female	1:0	2:1	—	18:5	16:0	66:2	10:0	85:15	3:0	—	—	58:2
Surgical technique												
Preperitoneal space-maker	Balloon	Balloon	No balloon	Balloon	No balloon	Balloon	Balloon	Balloon	No balloon	Balloon	Balloon	No balloon
Ports	3 ports via 1 incision	Single port device	Single port device	Single port device	Single port device	Single port device	Single port device	3 ports via 1 incision	Single port device	3 ports via 1 incision*	3 ports via 1 incision	3 ports via 1 incision
Camera	—	45°	—	30°	—	30°	30°	30°	30°	30°*	0°	30°
Instruments	Standard straight	Standard straight	Standard straight	Articulating/standard	Standard straight	Curved	Curved/standard	Standard straight	Standard straight	Standard straight*	Curved, manually bent	Standard straight
Incision length, cm (range)	2.5	2.5	Larger than standard TEP	2	3 (2.5-4.5)	2.5	2.8 (2.3-3.2)	2	2	1.5*	2	2-2.5
Fixed	Yes	Tacks	—	Tacks	Tacks	Tacks, glue	No fixation	Tacks	—	Tacks*	Tacks	Tacks
Duration of surgery; n, min (range) or min ± SD			60 (52-64)					64.2 (40-175)				
Unilateral hernia	n = 1, 90	NA	n = 3	n = 19, 48.4 (32-62)	n = 13, 40 (25-75)	n = 36, 50 (35-90)	n = 10, 53.6 (45-65)	n = 83	NA	60	n = 24, 98.3 ± 26.7	n = 57; indirect: 65.2 (33-150), direct: 52.6 (32-80)
Bilateral hernias	NA	n = 3, 79.3	n = 1	n = 4, 96.7 (85-120)	n = 3, 70 (60-75)	n = 32, 80 (60-125)	NA	n = 17	n = 3, 41 (26-65)	78.5 (52-110)	n = 6, 121.4 ± 13.5	n = 3, 77 (66-90)
Hospital stay, d (range)	2	1, not recorded for 2 patients	—	1.17 (1-2)	< 1	1 overnight patient	2	1.54 (1-11)	3	1.4	1.85	2.15
Conversion	0	0	1, bleeding; 1 extra port inserted	1, large hernia and adhesions; 2 extra ports inserted	0	1, unable to deploy port; 2 extra ports inserted	0	2, peritoneal tear and adhesions; LESS TAPP performed	0	0	0	1, ommental incarceration, conversion to TAPP

Table 1. Characteristics of studies included in our review and meta-analysis (part 2 of 2)

Characteristic	Cugura et al. <sup>35,37</sup>	Jacob et al. <sup>38</sup>	Bucher et al. <sup>36</sup>	Surgit et al. <sup>41</sup>	Agrawal et al. <sup>39</sup>	Tran <sup>15</sup>	Do et al. <sup>19</sup>	Chung et al. <sup>42</sup>	He et al. <sup>43</sup>	Tai et al. <sup>44*</sup>	Shih et al. <sup>47</sup>	Kim et al. <sup>46</sup>
Intraoperative complications, no.	0	0	1, bleeding	0	0	—	0	1, peritoneal tear	—	No major complications	0	0
Postoperative recovery	Uneventful	Uneventful	Uneventful	Uneventful	Uneventful	Uneventful	Uneventful	2 had urinary retention	Uneventful	1 had ileus and seroma	2 had seroma	2: 1 had seroma, 1 had urinary retention
Patient satisfaction (scale: 1–5)	—	—	—	—	—	None were dissatisfied	—	—	—	87.5% satisfied*	—	—
Pain	—	—	—	—	n = 1, transient pain in testicle postoperatively	Most patients stopped analgesics within 48 h	No complaints of pain	5 patients had groin ache	Minimal pain at discharge	—	—	—
Return to activity, d	—	—	—	—	—	7–14	—	5.6 (1–30)	—	—	—	—
Other follow-up	—	—	—	—	No complications	No complications	—	Early complications: 1 epididymitis, 1 wound infection, 1 wound dehiscence, 11 seroma/haematoma	No wound complications reported	No wound complications reported	—	—
2 wk	—	No complications	—	—	—	—	—	—	—	—	—	—
1 mo	—	n = 1, no complications	—	—	—	—	—	—	—	—	—	—
2–3 mo	—	—	—	—	n = 2, minor wound complications	—	—	—	—	—	—	—
10–14 mo	—	—	—	—	—	—	—	—	—	—	—	—
Recurrence, no.	—	None at 2 wk	None at 14 wk	None at 1 mo	None at 2–3 mo	None at 1–10 mo	None at 1 mo	1 and 10 mo	None at 1 mo	—	None at 6 mo	—

NR = not reported; SD = standard deviation; TAPP = transabdominal preperitoneal; TEP = totally extraperitoneal.

\* Results combined with TAPP hernia repairs.

a peritoneal tear.<sup>36,42</sup> Hospital stay ranged from less than a day to 2.15 days.<sup>15,19,35,37-39,41-44,46,47</sup> Postoperative recovery was uneventful all but 7 patients: seroma developed in 5 patients, 1 went into ileus and 1 experienced urinary retention).<sup>42,44,46,47</sup>

**Follow-up**

Follow-up ranged from 2 weeks to 14 months. Patients reported only minimal discomfort or ache.<sup>15,39,42,43</sup> There were only minor complications: epididymitis, wound infection, dehiscence and seroma/hematomas.<sup>39,42</sup> Two studies reported on return to activities after a range of 5–14 days.<sup>15,42</sup> There were no recurrences reported up to 14 months after the operation.<sup>15,19,36,38,39,41-43,47</sup>

**Comparison with LAP TEP approach**

Three studies<sup>22,40,45</sup> reported on a total of 128 patients in the LESS TEP group and 159 in the LAP TEP group.

**Duration of surgery**

**Unilateral hernia repairs**

Three studies<sup>22,40,45</sup> contributed to a summative outcome. There was significant heterogeneity among trials ( $Q_2 = 6.24, p = 0.040, I^2 = 68$ ); therefore the fixed-effects model was inappropriate. There was no difference in duration of

surgery between LESS TEP and LAP TEP (random-effects model: SMD = 0.16, 95% confidence interval [CI] -0.48 to 0.80,  $z = 0.49, p = 0.63$ ; Fig. 2).

**Bilateral hernia repairs**

Three studies<sup>22,40,45</sup> contributed to a summative outcome. There was no significant heterogeneity among trials ( $Q_2 = 0.34, p = 0.84, I^2 = 0$ ). There was no difference in duration of surgery between LESS TEP and LAP TEP (fixed-effects model: SMD = 0.18, 95% CI -0.16 to 0.52,  $z = 1.06, p = 0.29$ ; Fig. 3).

**Hospital stay**

Three studies<sup>22,40,45</sup> reported on hospital stay. There was no significant heterogeneity among trials ( $Q_2 = 0.00, p > 0.99, I^2 = 0$ ). There was no difference between groups [fixed-effects model: SMD = 0.00, 95% CI -0.23 to 0.23,  $z = 0.00, p > 0.99$ ; Fig. 4).

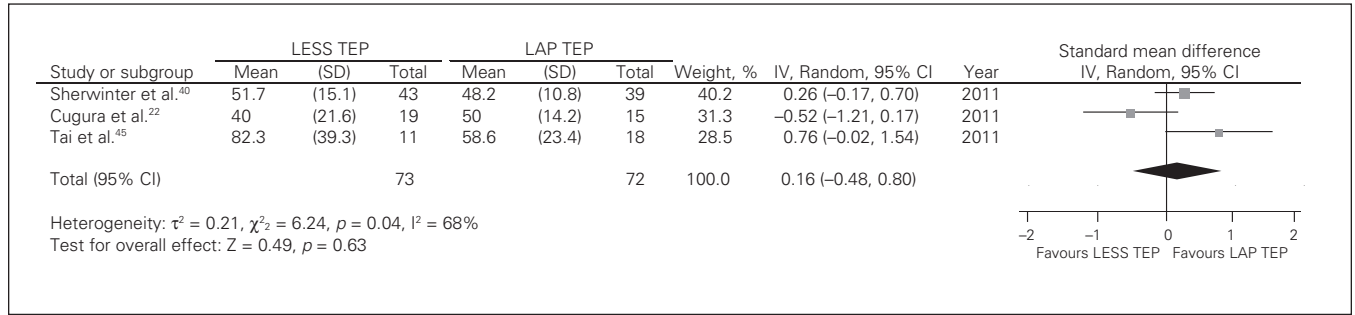
**Intraoperative complications and conversions**

There was no significant heterogeneity among trials ( $Q_1 = 0.05, p = 0.82, I^2 = 0$ ). There was no difference between techniques according to the studies included<sup>22,45</sup> (fixed-effects model: RR = 1.25, 95% CI 0.18–8.51,  $z = 0.23, p = 0.82$ ). None of the patients required conversions.<sup>22,40,45</sup>

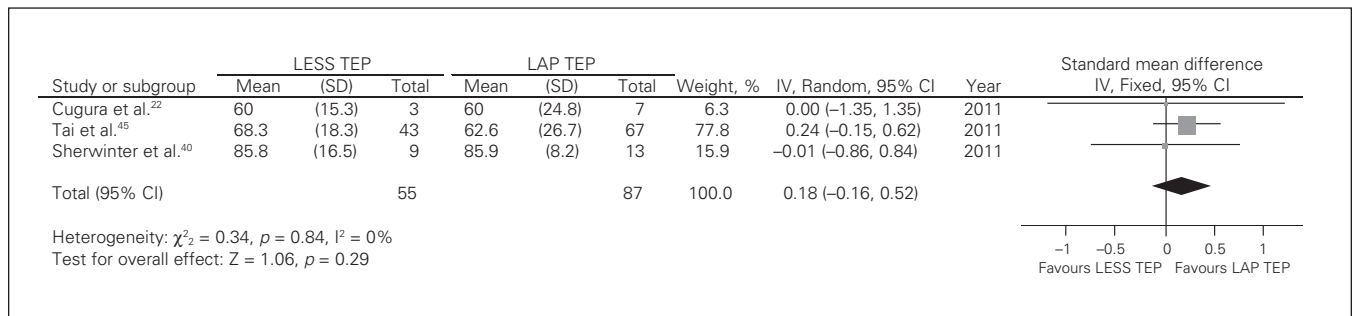
**Table 2. Characteristics of studies comparing LESS TEP with LAP TEP**

Characteristic	Sherwinter et al. <sup>40</sup>		Tai et al. <sup>45</sup>		Cugura et al. <sup>22</sup>	
	LAP TEP	LESS TEP	LAP TEP	LESS TEP	LAP TEP	LESS TEP
No. of patients	52	52	22	22	85	54
Age, yr (range) or yr ± SD	33.7 ± 11.3	37.5 ± 11.9	58.5 (17–79)	55 (20–84)	56.4	46.9
Surgical technique	Preperitoneal space formed with balloon 1 × 11 mm, 2 × 5 mm ports (through single incision for LESS TEP), mesh fixed		Preperitoneal space formed with balloon 1 × 10 mm, 2 × 5 mm ports (through single incision via glove for LESS TEP), 30° camera and straight or curved instruments, mesh fixed		Preperitoneal space formed with balloon 1 × 10 mm, 2 × 5 mm ports (through single incision for LESS TEP), 0/30° camera and straight instruments, mesh fixed in majority of cases	
Duration of surgery; n, min ± SD						
Unilateral hernia	n = 39, 48.2 ± 10.8	n = 43, 51.7 ± 15.1	n = 19, 40 ± 21.6	n = 15, 50 ± 14.2	n = 18, 58.6 ± 23.4	n = 11, 82.3 ± 39.3
Bilateral hernias	n = 13, 85.9 ± 8.2	n = 9, 85.8 ± 16.5	n = 3, 60 ± 15.3	n = 7, 60 ± 24.8	n = 67, 62.6 ± 26.7	n = 43, 68.3 ± 18.3
Hospital stay, d ± SD	0.19 ± 0.07	0.19 ± 0.06	2.0 ± 1.6	2.0 ± 1.3	1.7 ± 0.8	1.7 ± 1.5
Intraoperative complications, no.	—	—	0	0	0	0
Length of incision(s), cm (range)	—	—	3.5 (2.5–4.5)	2 (1.5–2.5)	Umbilical incision: 1.5 cm	Umbilical incision: 1.5 cm
Patient satisfaction, scale: 1–5 ± SD	—	—	—	—	4.1 ± 0.8	3.9 ± 0.7
Pain,						
24 hr	—	—	—	—	3.4 ± 1.7	3.6 ± 2.1
1 wk	—	—	—	—	1.57 ± 2.31	0.29 ± 0.66
Return to activity, d ± SD	11.88 ± 6.07	10.94 ± 5.7	—	—	3.8 ± 1.2	3.4 ± 1.5
Recurrence, no.	0	0	0	1 mesh displacement	0	0

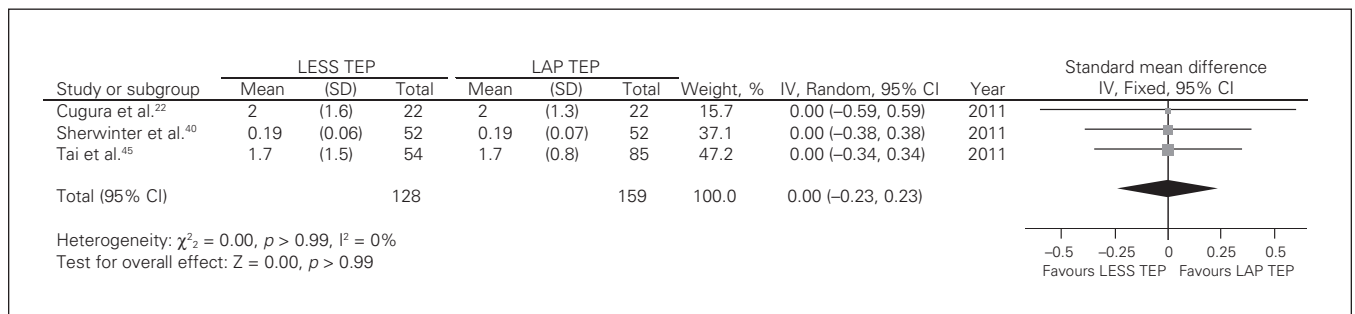
LAP = laparoscopic; LESS = laparoendoscopic single site; SD = standard deviation; TEP = totally extraperitoneal.



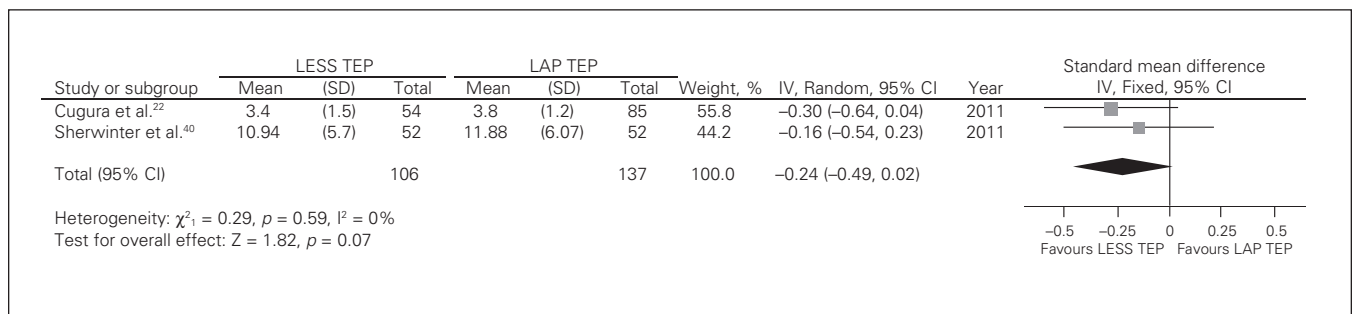
**Fig. 2.** Duration of surgery for unilateral hernias. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.



**Fig. 3.** Duration of surgery for bilateral hernias. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.



**Fig. 4.** Hospital stay. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.



**Fig. 5.** Return to activity. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.

### Cosmesis and follow-up

The length of the incision in the umbilicus was similar in both techniques (1.5–2 cm);<sup>22,45</sup> however, the total length of all incisions was slightly less in the LESS TEP group than the LAP TEP group (2 cm v. 3.5 cm, respectively).<sup>22</sup> This difference did not appear to translate into less satisfaction in the LAP TEP group.<sup>45</sup>

One study<sup>40</sup> reported 5 and 6 minor complications in the LAP TEP and LESS TEP groups, respectively. There were 4 patients with seromas and 1 patient with bladder dysfunction after LAP TEP, and there were 3 patients with seromas and 3 with bladder dysfunction after LESS TEP.

### Pain

Only 1 study<sup>45</sup> reported on pain. After 24 hours, there appeared to be no difference between techniques; however, after 1 week patients who underwent LESS TEP had significantly less pain. One study<sup>40</sup> reported on analgesic use, and although patients undergoing LESS TEP required painkillers for less time than those in the LAP TEP group, the difference was not significant.

### Return to activity

Two studies<sup>22,40</sup> reported on return to activity. There was no significant heterogeneity among trials ( $Q_1 = 0.29$ ,  $p = 0.59$ ,  $I^2 = 0$ ). Patients in the LESS TEP group restarted activity earlier, and this difference approached statistical significance (fixed-effects model: SMD =  $-0.16$ , 95% CI  $-0.49$  to  $0.02$ ,  $z = 1.82$ ,  $p = 0.07$ ; Fig. 5).

### Recurrence

There was no significant heterogeneity among trials ( $Q_1 = 0.05$ ,  $p = 0.82$ ,  $I^2 = 0$ ). There was no difference between techniques according to the studies included<sup>22,45</sup> (fixed-effects model: RR =  $1.25$ , 95% CI  $0.18$ – $8.51$ ,  $z = 0.23$ ,  $p = 0.82$ ).

## DISCUSSION

The nature of surgery has led to developments in techniques to reduce the postoperative stress response and improvement in cosmesis. These include robotic laparoscopy, natural orifice transluminal endoscopic surgery (NOTES) and, increasingly, minimally invasive and LESS surgery.<sup>49,50</sup> One of the main challenges to robotic surgery is cost;<sup>51</sup> NOTES may be unacceptable to certain groups of patients, whereas LESS may be the most preferred approach.<sup>23</sup>

### Main findings

This paper examined the role of LESS TEP for inguinal hernia repairs and compared it with LAP TEP. Duration of surgery for unilateral and bilateral repairs showed a great variation but appeared comparable to conventional TEP performed by surgeons on different points of their learning curve.<sup>52,53</sup> The conversion rate was low (0.02%)

and no conversions were to a formal open technique; surgeons preferred to convert to TAPP or add further ports. Postoperative recovery was largely uneventful, and very few complications were noted. No recurrence was noted up to 14 months after surgery, and most patients returned to activity within 2 weeks.

Formal comparison with LAP TEP showed no significant difference in duration of surgery, hospital stay, intraoperative complications, conversions or recurrence. The LESS TEP procedure had a slightly smaller total incision length than LAP TEP. There are equivocal results in relation to pain and analgesic requirements. There was a trend for patients in the LESS TEP group to return to activity earlier, but the difference did not achieve statistical significance ( $p = 0.07$ ); this result is consistent with the literature showing faster recovery in other settings.<sup>54</sup>

### Importance

The importance of these findings is that for patients with inguinal hernias, a range of safe and effective options is available and may be used to treat dual pathologies.<sup>55</sup> Furthermore the LESS technique may offer patients the ability to return to activity earlier, which may be especially important for those who are self-employed.<sup>56</sup> This article also suggests that current evidence is strong enough to warrant further trials to establish the role of this technique. Although some articles suggest cosmesis may be better with LESS TEP, LAP TEP is an acceptable technique with good postoperative outcomes.<sup>57</sup>

### Appraisal of evidence

Owing to investment in newer or different instruments or ports, some suggest that LESS techniques are more expensive than conventional laparoscopic techniques; however, recent studies have shown comparability between the 2 techniques.<sup>58,59</sup> There is a learning curve associated with LESS techniques; however, it may not be as steep as initially perceived<sup>60,61</sup> and depends on a number of factors, including the type of port used for access.<sup>62</sup> Nonetheless, experienced surgeons ought to perform or supervise these procedures to ensure adequate training. Furthermore, in the initial stages there may be a higher rate of postoperative complications until such time that the learning curve has reached a plateau.<sup>63</sup> Technical challenges include access,<sup>64</sup> poor triangulation and lack of space leading to instrument clash,<sup>65</sup> which may be overcome by the use of 30° cameras.<sup>22</sup> Instrument control may also be less intuitive.<sup>41</sup> One disadvantage to LAP TEP is that if complications arise conversion to either LAP TAP or open surgery may be the only options, whereas with LESS TEP conversion to conventional LAP TEP is also an option.

Future advances include robotic surgery; however, recent studies have shown similar durations of surgery, and



although remote operating is a definite advantage, costs may be prohibitive.<sup>51</sup>

From a patient perspective, single incision surgery is more appealing presumably owing to potential cosmetic benefits; however, this should be in the context of an appropriate safety profile.<sup>66</sup> The cosmetic concern may be greater in children, with recent studies showing good outcomes.<sup>67,68</sup> One factor regarding cosmesis is the position of the scar, with some reports suggesting an intraumbilical or crescentic incision giving the best outcomes.<sup>15,22</sup>

### Heterogeneity

The literature varied greatly in terms of specifics involved with the LESS TEP technique. In our literature review, some authors used a balloon<sup>15,19,35,38,41,42,44,47</sup> to create the preperitoneal space, whereas others used blunt dissection.<sup>25,39,43,46</sup> A range and combination of straight or curved and articulating instruments and 0°–45° cameras were used. Only 1 study reported no mesh fixation.<sup>19</sup>

In our pooled analysis comparing LESS TEP with LAP TEP, there was significant heterogeneity in the duration of surgery for unilateral repairs. This may be related to slightly different technique variations and differences in learning curve. This finding is in keeping with the lack of heterogeneity in duration of bilateral repair, reflecting progression in the number of procedures performed. However, most of the included studies did not state where the bilateral hernias were in relation to their learning curve. There was no significant heterogeneity in relation to hospital stay, recurrence, intraoperative complications or return to activity, which probably reflects similar clinical and follow-up protocols among the centres. Although there was no significant heterogeneity, there were some clinical differences in the type of technique used (Table 2). For example, some authors used a homemade port,<sup>45</sup> some used different cameras and 1 group did not fix the mesh in all patients.<sup>22</sup> Only 1 study reported the type of analgesics used and their discharge protocols.<sup>40</sup> The activities to which patients returned were not clearly identified, and convalescence may have been very different depending on age, sex and type of employment.<sup>56</sup> Other limitations to our study include the use of assessments of the papers according to set criteria. Although this may give an indication to the strength of the study, it may not highlight potential weaknesses, including detailed differences that were not documented in the studies, such as site of pain (umbilical v. pubic due to tacks) or sequelae of complications.

The degree of clinical heterogeneity means firm conclusions for practice need to be made with caution.

### Quality assessment

We did not formally assess the quality of the studies included in our initial review. This was generally because of the small numbers in the series and because of the relative

paucity of studies in the literature. In our early meta-analysis there was only 1 study<sup>22</sup> that stated it was a randomized controlled trial of moderate quality; however, the study did not detail sample size calculations, allocation concealment or analysis based on intention to treat, which may lead to significant bias in reporting outcomes. Furthermore, this same trial did not specifically state it was double-blind. The remaining 2 studies were comparative studies, and 1 was a comparison with a historical cohort, which presents inherent weaknesses. One study<sup>45</sup> did not report inclusion or exclusion criteria; the other study<sup>40</sup> did not state clearly their diagnostic criteria or identify standardized outcome forms. It is too early to comment on publication bias.

### Future studies

Further prospective randomized studies focusing on cosmesis, postoperative pain, analgesic requirements and return to activity are required to assess whether LESS TEP has an advantage over LAP TEP.<sup>69</sup> Clear definitions of pain and return to activity should be given with examination of the type of job conducted, as it may be that LESS TEP may benefit particular groups of workers. Studies should consider the learning curve of the surgeon to ensure appropriate comparisons with LAP TEP in relation to duration of surgery and hospital stay. Our review highlights the need for a multicentre randomized controlled trial with appropriate follow up.

### CONCLUSION

The LESS TEP hernia repair is a relatively new technique and appears to be safe and effective. Advantages, such as less visible scarring, mean patients may opt for LESS TEP over LAP TEP. Further studies with clear definitions of outcome measures and robust follow up to assess patient satisfaction, return to normal daily activities and recurrence are required to strengthen the evidence.

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