Laparoscopic versus open repair for ventral hernia

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REVIEWS

Laparoscopic ventral hernia repair: a systematic review

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Abstract
Background Laparoscopic ventral hernia repair may be an alternative to open mesh repair as it avoids a large abdominal incision, and thus potentially reduces pain and hospital stay. This review aimed to assess the safety and efficacy of laparoscopic ventral hernia repair in comparison with open ventral hernia repair.
Method A systematic review was conducted, with comprehensive searches identifying six randomised controlled trials (RCTs) and eight nonrandomised comparative studies.
Results The laparoscopic approach may have a lower recurrence rate than the open approach and required a shorter hospital stay. Five RCTs (Barbaros et al., Hernia 11:51–56, 2007; Misra et al., Surg Endosc 20:1839–1845, 2006; Navarra et al., Surg Laparosc Endosc Percutan Tech 17:86–90, 2007; Moreno-Egea et al., Arch Surg 137:266–1268, 2002; Carbajo et al., Surg Endosc 13:250–252, 1999) reported no conversion (0%) to open surgery, and four nonrandomised studies reported conversions to open surgery ranging from 0% to 14%. Open approach complications generally were wound related, whereas the laparoscopic approach reported both wound- and procedure-related complications and these appeared to be less frequently reported.
Conclusion Based on current evidence, the relative safety and efficacy of the laparoscopic approach in comparison with the open approach remains uncertain. The laparoscopic approach may be more suitable for straightforward hernias, with open repair reserved for the more complex hernias. Laparoscopic ventral hernia repair appears to be an acceptable alternative that can be offered by surgeons proficient in advanced laparoscopic techniques.

Keywords Hernia · Ventral/surgery · Laparoscopy · Surgical procedures, operative · Surgical mesh · Humans

Abbreviations
RCT Randomised controlled trial

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Ventral hernias are the second most common type of abdominal hernias, after inguinal hernias [1], and account for approximately 10% of all hernias [2]. Ventral hernia, also known as abdominal wall hernia or incisional hernia, is defined as protrusion of a portion of an organ or tissue through the abdominal wall [3]. The inner lining of the abdomen pushes through the abdominal wall that has been weakened due to either a congenital defect or previous surgical incision (e.g. alimentary surgery, vascular surgery, genital tract surgery, or laparoscopy). The resulting balloon-like sac may trap or incarcerate a loop of intestine or other abdominal contents, which could cause potentially serious problems requiring emergency surgery [4].

Ventral hernias are an important long-term morbidity of conventional surgery [5, 6] as they usually develop within

Meta-analysis

Meta-analysis of randomized controlled trials comparing open and laparoscopic ventral and incisional hernia repair with mesh

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Background: Laparoscopic ventral and incisional hernia repair has been reported in a number of small trials to have equivalent or superior outcomes to open repair.

Methods: Randomized controlled trials comparing laparoscopic and open incisional or ventral hernia repair with mesh that included data on effectiveness and safety were included in a meta-analysis.

Results: Eight studies met the inclusion criteria. There was no difference between groups in hernia recurrence rates (relative risk 1·02 (95 per cent confidence interval (c.i.) 0·41 to 2·54)). Duration of surgery varied. Mean length of hospital stay was shorter after laparoscopic repair in six of the included studies; the longest mean stay was 5·7 days for laparoscopic and 10 days for open surgery. Laparoscopic hernia repair was associated with fewer wound infections (relative risk 0·22 (95 per cent c.i. 0·09 to 0·54)), and a trend toward fewer haemorrhagic complications and infections requiring mesh removal.

Conclusion: Laparoscopic repair of ventral and incisional hernia is at least as effective, if not superior to, the open approach in a number of outcomes.

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BJS

Laparoscopic versus open surgical techniques for ventral or incisional hernia repair (Review)

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Laparoscopic versus open surgical techniques for ventral or incisional hernia repair

- 10 RCT, total number of 880 patients: all RCT which compare open with laparoscopic repair
- Primary ventral or incisional hernia
- No trials on umbilical or parastomal hernia

Description of the intervention

- Open suture techniques – recurrence rate up to 54% : are considered no longer appropriate (except for very small hernias)
- Epifascial or "Onlay " repair: mesh prostheses placed between the subcutaneous fat tissue and abdominal fascia
- Retromuscular or "sublay" repair: inside the posterior rectus sheath
- Intraperitoneal onlay mesh repair, IPOM: Inside the abdominal cavity

Description of the intervention

- Currently, open retromuscular prosthetic repair (Rives-Stoppa techniques) using non-resorbable mash is the most accepted treatment for incisional hernia and for some primary ventral hernia
- Recurrence rate – 15 to 30%
- Drawbacks: seroma, haemotoma, mesh infection, chronic pain, stiffness of the abdominal wall

Description of the intervention

- Laparoscopic repair- after reducing the hernia contents, the hernia sac is left unresected.
- The mesh should overlap the hernia orifice by at least 5 cm
- Laparoscopic hernia repair requires anti adhesive or two-sided (composite) materials

Outcomes

- Primary: ***hernia recurrence***

- Secondary :

- Duration of surgery
- Enterotomy
- Local seroma or haemotoma
- Necessity for and duration of ICU stay
- Reoperation
- Time until return to normal activities

Outcomes

- - length of hospital stay
- - local infection
- - quality of life
- - acute pain
- - chronic pain > 6 months
- - patient satisfaction
- - cost of therapy

- Total 88 full text articles
- 10 trials met inclusion criteria

Ascenio 2009; Barbaros 2006; Buunen 2010; Carbajo 1999; Itani 2010; Misra 2006; Moreno-Egea 2002; Navarra 2007; Olmi 2007; Pring 2008

Nearly all studies included patients with primary ventral hernia , incisional hernia, or both

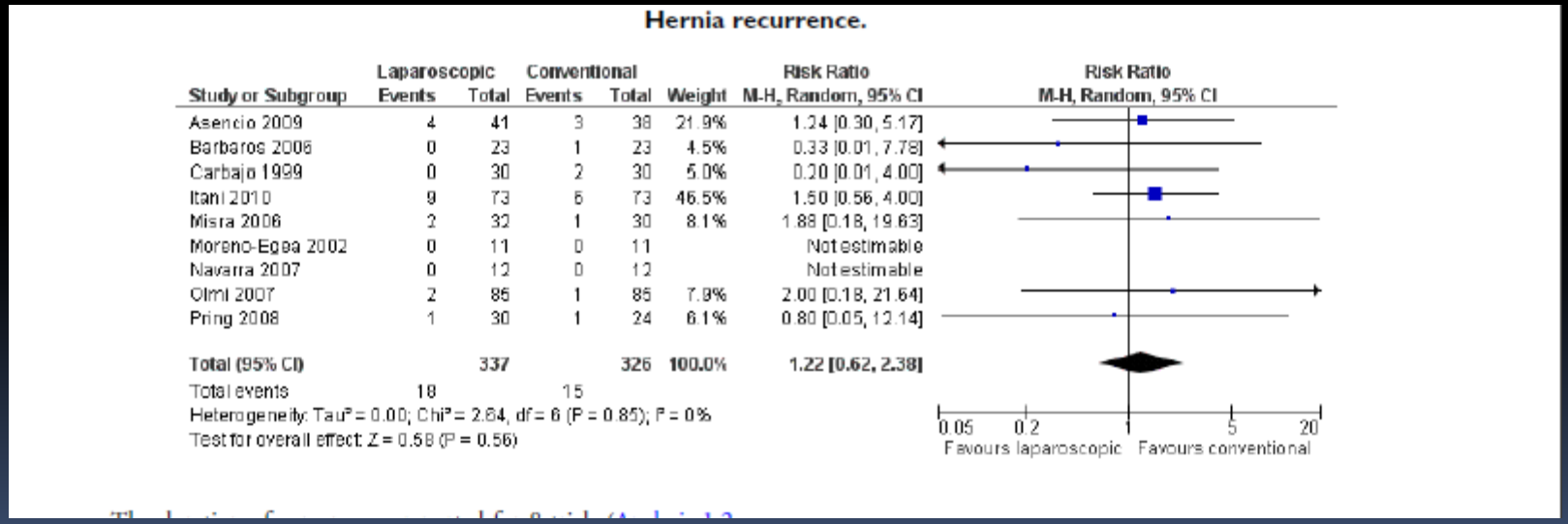
- Most trials included only hernias with a diameter of > 3 cm
- Some trials did not include very large hearnias (e.g.>15 cm)
- Laparoscopic technique:

- 3 or 4 trocars
- Non-resorbable mesh
- Mesh overlap > 3 cm

- Open surgery – sublay (i.e. retromuscular) repair in the majority of trials
- Duration of follow-up: 2 years or longer in 5 trials; 1 -2 years in 4 trials

Recurrence rate

- Recurrence rate was not significantly different between two techniques (RR 1.22; 95% CI 0.62-2.38)

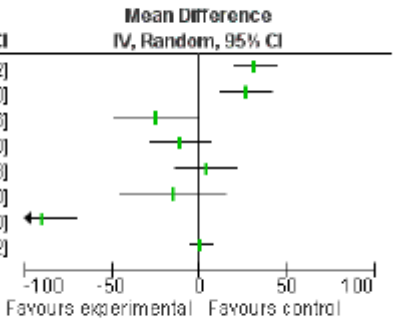


Duration of surgery

- Some trials found that laparoscopic surgery took significantly longer than open, whereas the opposite was true in other trials

Figure 4. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.2 Duration of surgery. (No pooling done because of heterogeneity)

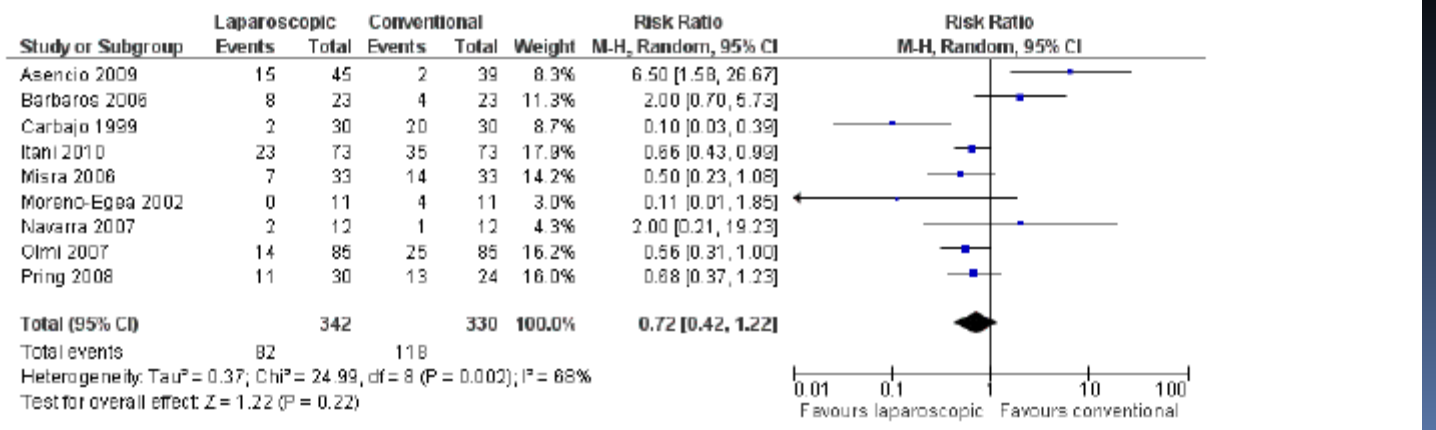
Study or Subgroup	Laparoscopic Mean	SD	Total	Conventional Mean	SD	Total	Mean Difference IV, Random, 95% CI
Asencio 2009	101.88	33.925	45	70	21.77	39	31.88 [19.84, 43.92]
Barbaros 2006	99	32	23	72	18	23	27.00 [12.00, 42.00]
Carbajo 1999	87	40	30	111.5	55	30	-24.50 [-48.84, -0.16]
Misra 2006	75	37.1	33	86	35	33	-11.00 [-28.40, 6.40]
Moreno-Egea 2002	45	22.5	11	41	20.1	11	4.00 [-13.83, 21.83]
Navarra 2007	73.7	31.52	12	88.7	43.51	12	-15.00 [-45.40, 15.40]
Olmi 2007	61	31.953	85	150.9	87	85	-89.90 [-109.60, -70.20]
Pring 2008	43.5	14	30	42.5	11.2	24	1.00 [-5.72, 7.72]



Any complications

- The overall complication rate failed to show an advantage for one of the two technuques.
- Itani (Archives of surgery 2010;145(4) 322-8) – complications are less frequent but more severe after laparoscopic surgery

Figure 5. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.3 Any complication.



Enterotomies

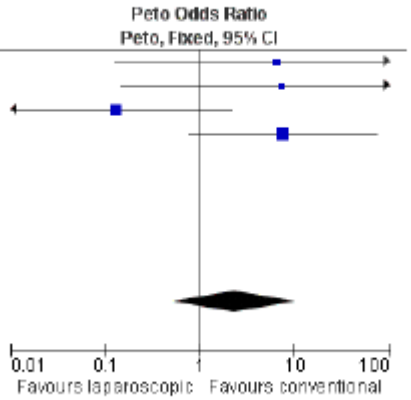
- The overall low frequency of enterotomy might have compromised the power of comparison
- With inconsequential serosal tear – significantly worse for laparoscopic group

Enterotomies

Figure 6. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.4 Enterotomy.

Study or Subgroup	Favours laparoscopic Events	Total	Conventional Events	Total	Weight	Peto Odds Ratio Peto, Fixed, 95% CI
Asencio 2009	1	45	0	39	14.4%	6.47 [0.13, 329.19]
Barbaros 2006	1	23	0	23	14.5%	7.39 [0.15, 372.38]
Carbajo 1999	0	30	2	30	28.4%	0.13 [0.01, 2.14]
Itani 2010	3	73	0	73	42.8%	7.60 [0.78, 74.21]
Misra 2006	0	33	0	33		Not estimable
Moreno-Egea 2002	0	11	0	11		Not estimable
Navarra 2007	0	12	0	12		Not estimable
Olmi 2007	0	85	0	85		Not estimable
Pring 2008	0	11	0	13		Not estimable
Total (95% CI)		**323**		**319**	**100.0%**	**2.33 [0.53, 10.35]**
Total events	5		2			

Heterogeneity: Chi² = 5.70, df = 3 (P = 0.13); I² = 47%
Test for overall effect: Z = 1.11 (P = 0.27)



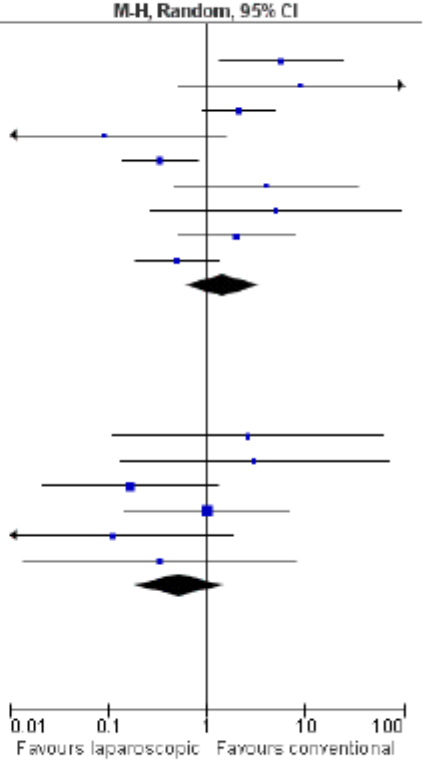
Local seroma or hematoma

- Baunen (Surgical endoscopy 2010;23) – seroma rate to be doubled in laparoscopic repair
- Itany 2010 – threefold higher seroma rate after open surgery
- Local hematoma was similarly likely to occure after laparoscopic and open repair

Local seroma or hematoma

Figure 7. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.5 Local seroma or hematoma.

Study or Subgroup	Laparoscopic Events	Total	Conventional Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
1.5.1 Seroma						
Asencio 2009	13	46	2	39	12.5%	5.63 [1.35, 23.44]
Barbaros 2008	4	23	0	23	6.2%	9.00 [0.51, 158.17]
Buunen 2010	15	104	7	104	16.0%	2.14 [0.91, 5.04]
Carbajo 1999 (1)	0	30	5	30	6.2%	0.09 [0.01, 1.57]
Itani 2010	6	73	18	73	15.9%	0.33 [0.14, 0.79]
Misra 2006	4	33	1	33	8.8%	4.00 [0.47, 33.91]
Navarra 2007	2	12	0	12	6.0%	5.00 [0.27, 94.34]
Olmi 2007	6	85	3	85	13.0%	2.00 [0.52, 7.74]
Pring 2008	5	30	8	24	15.3%	0.50 [0.19, 1.33]
Subtotal (95% CI)		**435**		**423**	**100.0%**	**1.42 [0.60, 3.40]**
Total events	55		44			
Heterogeneity: Tau² = 1.04; Chi² = 25.44, df = 8 (P = 0.001); I² = 69%						
Test for overall effect: Z = 0.80 (P = 0.43)						
1.5.2 Hematoma						
Asencio 2009	1	46	0	39	10.8%	2.61 [0.11, 62.26]
Barbaros 2008	1	23	0	23	11.0%	3.00 [0.13, 70.02]
Carbajo 1999 (2)	1	30	6	30	25.3%	0.17 [0.02, 1.30]
Itani 2010	2	73	2	73	28.5%	1.00 [0.14, 6.91]
Moreno-Egea 2002	0	11	4	11	13.7%	0.11 [0.01, 1.85]
Olmi 2007	0	85	1	85	10.7%	0.33 [0.01, 8.07]
Subtotal (95% CI)		**267**		**261**	**100.0%**	**0.52 [0.18, 1.49]**
Total events	5		13			
Heterogeneity: Tau² = 0.03; Chi² = 5.09, df = 5 (P = 0.40); I² = 2%						
Test for overall effect: Z = 1.21 (P = 0.23)						



(1) Only the rate of massive seroma was extracted from this study.
(2) This includes mild and moderate hematoma (3 cases each in conventional group).

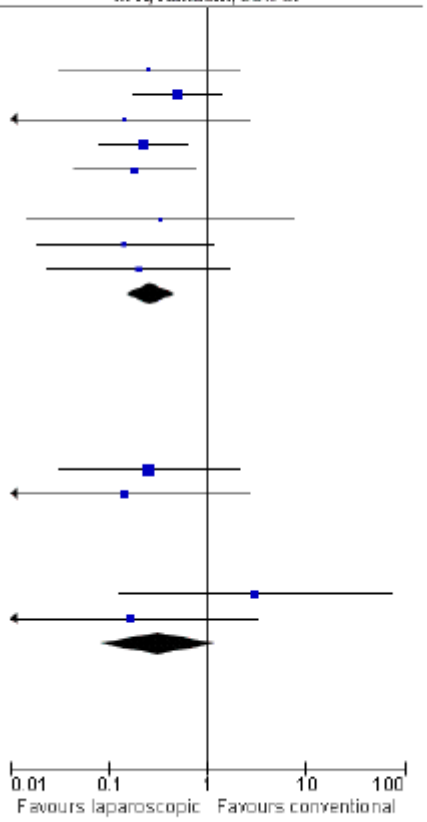
Local wound infection

- Fourfold less likely to occur after laparoscopic than after open surgery
- Mesh removal- higher frequencies in the open surgery groups (Barbaros 2006 – 17%, Carbajo 1999 – 10%)

Local wound infection

Figure 8. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.6 Local infection.

Study or Subgroup	Laparoscopic Events	Laparoscopic Total	Conventional Events	Conventional Total	Weight	Risk Ratio M-H, Random, 95% CI
1.6.1 Local infection (irregardless of severity)						
Asencio 2009	0	45	0	39		Not estimable
Barbaros 2006	1	23	4	23	6.9%	0.25 [0.03, 2.07]
Buunen 2010	5	104	10	104	28.5%	0.50 [0.18, 1.41]
Carbajo 1999	0	30	3	30	3.6%	0.14 [0.01, 2.65]
Itani 2010 (1)	4	73	18	73	28.8%	0.22 [0.08, 0.62]
Misra 2006	2	33	11	33	15.1%	0.18 [0.04, 0.76]
Moreno-Egea 2002	0	11	0	11		Not estimable
Navarra 2007	0	12	1	12	3.2%	0.33 [0.01, 7.45]
Olmi 2007	1	85	7	85	7.2%	0.14 [0.02, 1.14]
Pring 2008	1	30	4	24	6.8%	0.20 [0.02, 1.67]
Subtotal (95% CI)		**446**		**434**	**100.0%**	**0.26 [0.15, 0.46]**
Total events	14		58			
Heterogeneity: Tau² = 0.00; Chi² = 2.45, df = 7 (P = 0.93); I² = 0%						
Test for overall effect: Z = 4.73 (P < 0.00001)						
1.6.2 Local infection requiring mesh removal						
Asencio 2009	0	45	0	39		Not estimable
Barbaros 2006 (2)	1	23	4	23	40.6%	0.25 [0.03, 2.07]
Carbajo 1999	0	30	3	30	21.3%	0.14 [0.01, 2.65]
Misra 2006	0	33	0	33		Not estimable
Moreno-Egea 2002	0	11	0	11		Not estimable
Navarra 2007	0	12	0	12		Not estimable
Olmi 2007	1	85	0	85	17.8%	3.00 [0.12, 72.62]
Pring 2008	0	30	2	24	20.3%	0.16 [0.01, 3.21]
Subtotal (95% CI)		**269**		**257**	**100.0%**	**0.32 [0.08, 1.22]**
Total events	2		9			
Heterogeneity: Tau² = 0.00; Chi² = 2.44, df = 3 (P = 0.49); I² = 0%						
Test for overall effect: Z = 1.67 (P = 0.09)						



(1) This includes intraabdominal abscess (2 cases in each group)
(2) One additional case of "mesh rejection" was not included in this analysis.

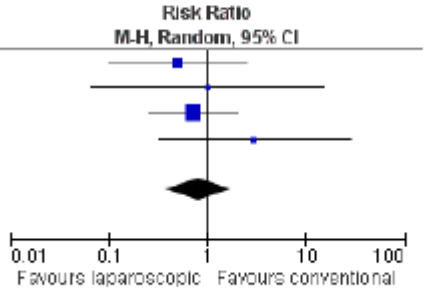
Reoperations

- Without a difference but with a trend towards a higher risk in open surgery

Figure 9. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.7 Reoperation.

Study or Subgroup	Laparoscopic Events	Laparoscopic Total	Conventional Events	Conventional Total	Weight	Risk Ratio M-H, Random, 95% CI
Barbaros 2008	2	23	4	23	23.8%	0.50 [0.10, 2.47]
Carbajo 1999	1	30	1	30	8.2%	1.00 [0.07, 15.26]
Misra 2006	5	33	7	33	56.0%	0.71 [0.25, 2.02]
Olmi 2007	3	85	1	85	12.1%	3.00 [0.32, 28.27]
Total (95% CI)		**171**		**171**	**100.0%**	**0.80 [0.37, 1.75]**
Total events	11		13			

Heterogeneity: Tau² = 0.00; Chi² = 1.76, df = 3 (P = 0.62); I² = 0%
Test for overall effect: Z = 0.56 (P = 0.58)



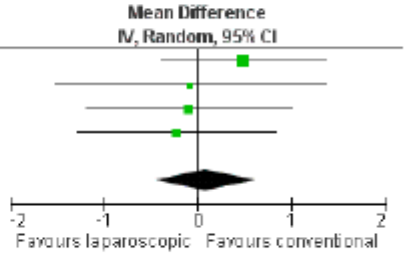
Acute pain

- Pain intensity similar between the two techniques

Figure 10. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.8 Acute pain (VAS or NRS data).

	Laparoscopic			Conventional				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Asencio 2009	4.766	1.975	45	4.286	2.1	39	37.1%	0.48 [-0.40, 1.36]
Barbaros 2006	1.53	2.5	23	1.61	2.5	23	13.6%	-0.08 [-1.52, 1.36]
Misra 2006	5.95	2.26	33	6.05	2.26	33	23.9%	-0.10 [-1.19, 0.99]
Pring 2008	6.067	1.893	30	6.292	2.032	24	25.4%	-0.22 [-1.28, 0.83]
Total (95% CI)			**131**			**119**	**100.0%**	**0.09 [-0.45, 0.62]**

Heterogeneity: Tau² = 0.00; Chi² = 1.27, df = 3 (P = 0.74); I² = 0%
Test for overall effect: Z = 0.32 (P = 0.75)



Quality-of-life

- Ascenio 2009- early after surgery: no difference between groups
- Return to activities: Pring 2008 – no difference between groups, Itany 2010 – nearly significant advantage favoring laparoscopic surgery

Quality-of-life

Figure 11. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.9 Quality-of-life (short-term, 7 d).

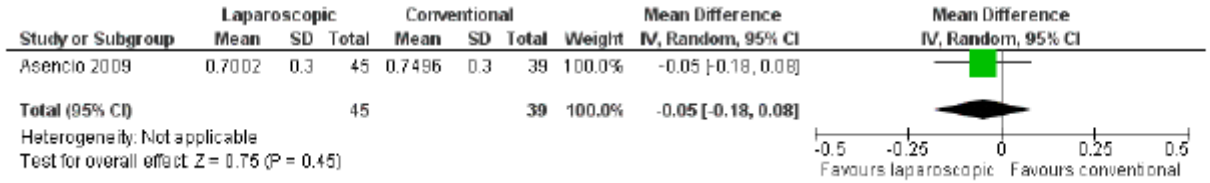


Figure 15. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.11 Quality-of-life (long-term, >6 m).

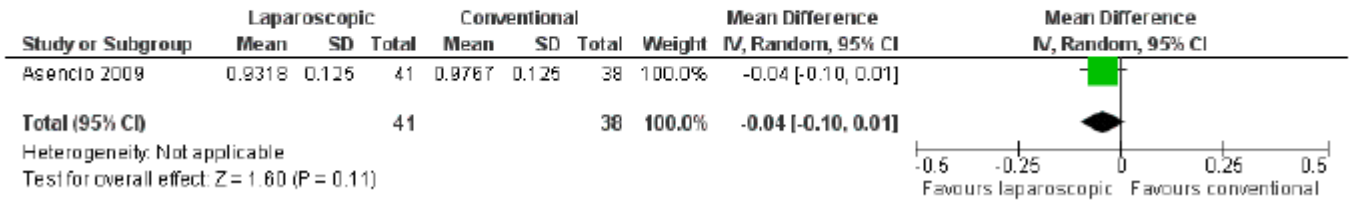
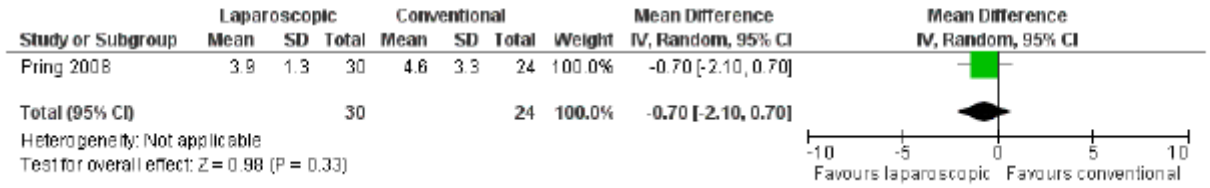


Figure 14. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.11 Time until return to normal activities or work.



Length of hospital stay

- 6 of 9 trials found a significant advantage for laparoscopic group
- Hospital stay can only be reduced by laparoscopic surgery

Figure 12. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.10 Length of hospital stay.

Study or Subgroup	Laparoscopic Mean	SD	Total	Conventional Mean	SD	Total	Mean Difference IV, Random, 95% CI
Asencio 2009	3.46	2.6	39	3.33	1.76	45	0.13 [-0.83, 1.09]
Barbaros 2006	2.5	1.5	21	6.3	4.2	23	-3.80 [-5.63, -1.97]
Carbajo 1999	2.23	2.23	30	9.06	9.06	30	-6.83 [-10.17, -3.49]
Itani 2010	4	3.5	73	3.9	3.1	73	0.10 [-0.97, 1.17]
Misra 2006	1.47	2.93	33	3.43	2.93	33	-1.96 [-3.37, -0.55]
Moreno-Egea 2002	1.1	1.1	11	5.2	5.2	11	-4.10 [-7.24, -0.96]
Navarra 2007	5.7	3.55	12	10	8	12	-4.30 [-9.25, 0.65]
Olmi 2007	2.7	2.315	85	9.9	21.755	85	-7.20 [-11.85, -2.55]
Pring 2008	1.467	0.8996	30	1.333	0.817	24	0.13 [-0.32, 0.59]

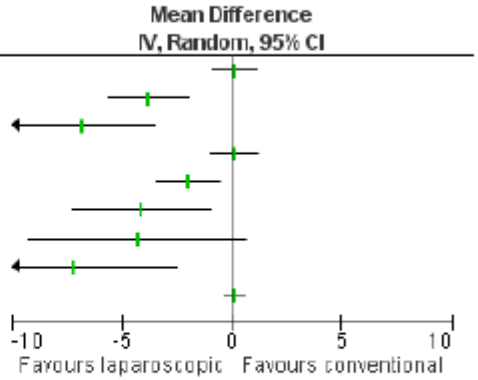


Figure 13. Forest plot of comparison: 4 Sensitivity analysis 3: Length of hospital stay, outcome: 4.10 Length of hospital stay.

Study or Subgroup	Laparoscopic Mean	SD	Total	Conventional Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
4.1.1 Trials with >= 5 days hospital stay in control group								
Barbaros 2006	2.5	1.5	21	6.3	4.2	23	51.7%	-3.80 [-5.63, -1.97]
Carbajo 1999	2.23	2.23	30	9.06	9.06	30	15.6%	-6.83 [-10.17, -3.49]
Moreno-Egea 2002	1.1	1.1	11	5.2	5.2	11	17.6%	-4.10 [-7.24, -0.96]
Navarra 2007	5.7	3.55	12	10	8	12	7.1%	-4.30 [-9.25, 0.65]
Olmi 2007	2.7	2.315	85	9.9	21.755	85	8.0%	-7.20 [-11.85, -2.55]
Subtotal (95% CI)			**159**			**161**	**100.0%**	**-4.63 [-5.95, -3.32]**
Heterogeneity: Tau² = 0.00; Chi² = 3.76, df = 4 (P = 0.44); I² = 0%								
Test for overall effect: Z = 6.89 (P < 0.00001)								
4.1.2 Trials with <5 days hospital stay in control group								
Asencio 2009	3.46	2.6	39	3.33	1.76	45	24.6%	0.13 [-0.83, 1.09]
Itani 2010	4	3.5	73	3.9	3.1	73	22.4%	0.10 [-0.97, 1.17]
Misra 2006	1.47	2.93	33	3.43	2.93	33	16.6%	-1.96 [-3.37, -0.55]
Pring 2008	1.467	0.8996	30	1.333	0.817	24	36.5%	0.13 [-0.32, 0.59]
Subtotal (95% CI)			**175**			**175**	**100.0%**	**-0.22 [-0.96, 0.52]**
Heterogeneity: Tau² = 0.33; Chi² = 7.81, df = 3 (P = 0.05); I² = 62%								
Test for overall effect: Z = 0.59 (P = 0.56)								

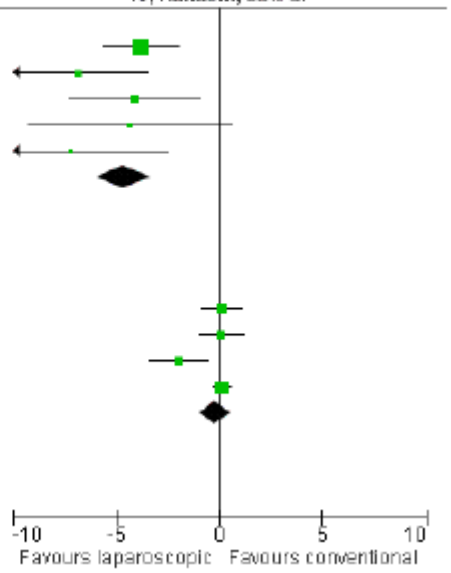


Figure 16. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.12 Chronic pain (VAS or NRS data).

Study or Subgroup	Laparoscopic Mean	SD	Total	Conventional Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Asencio 2009	1.038	1.53	41	0.6	1.53	38	100.0%	0.44 [-0.24, 1.11]
Total (95% CI)			**41**			38	**100.0%**	**0.44 [-0.24, 1.11]**

Heterogeneity: Not applicable
Test for overall effect: Z = 1.27 (P = 0.20)

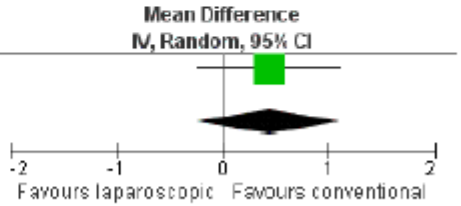
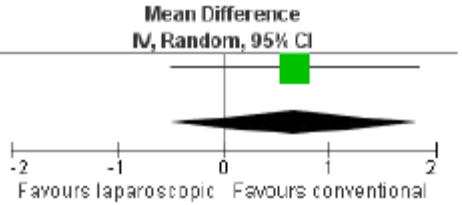


Figure 17. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.13 Patient satisfaction and cosmetic appearance.

Study or Subgroup	Laparoscopic Mean	SD	Total	Conventional Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Misra 2006	8.27	2.4	33	7.6	2.4	33	100.0%	0.67 [-0.49, 1.83]
Total (95% CI)			33			33	**100.0%**	**0.67 [-0.49, 1.83]**

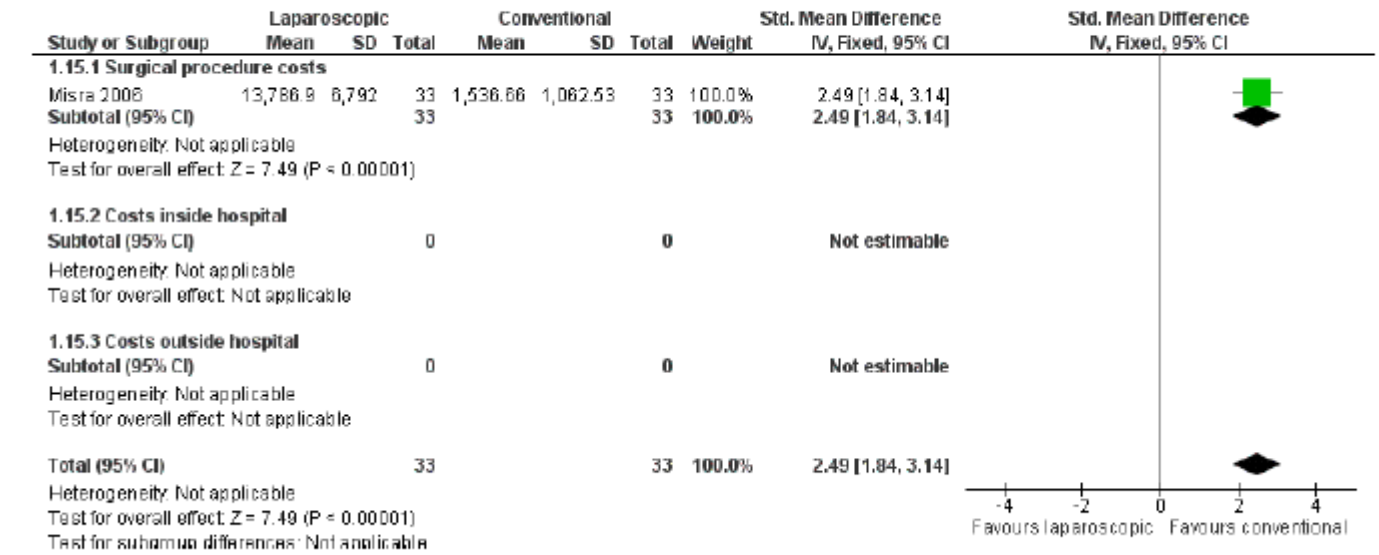
Heterogeneity: Not applicable
Test for overall effect: Z = 1.13 (P = 0.26)



Costs of therapy

- The costs of laparoscopic repair 9 times higher than for an open procedure

Figure 18. Forest plot of comparison: 1 Laparoscopic versus open repair (overall analysis), outcome: 1.14 Costs of therapy.



Costs of therapy

- Olmi 2007 – it may be possible that shorter hospital stay after laparoscopic surgery makes this type of surgery cost-efficient

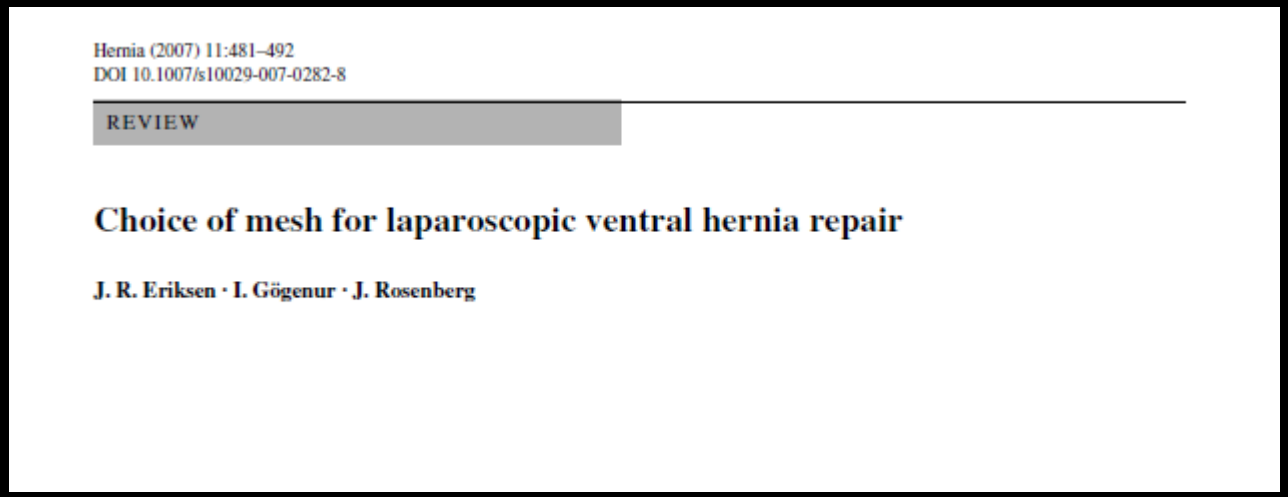
Summery of main results

- Total number of patients is too small
- Short duration of follow-up
- Laparoscopic approach allows to inspect the whole previous incision and to cover it with mesh
- Laparoscopic repair does not include closure of the hernia orifice
- The lower risk of wound infection after laparoscopic hernia repair is fully in-line with other laparoscopic techniques

Summery of main results

- Wound infection after open surgery can become clinically problematic, as it may require removal of an infected mesh
- Intraabdominal complications are theoretically more common after laparoscopic surgery
- No difference in rates of enterotomy
- Including serosal tears – significantly higher bowel injury rate would have resulted

- The non significant results on seroma formation have to be interpreted with caution because of the statistical heterogeneity of the pooled results
- The fact that postoperative pain is very similar differs from findings in other laparoscopic procedures (transfascial sutures?)



Hernia (2007) 11:481–492
DOI 10.1007/s10029-007-0282-8

REVIEW

Choice of mesh for laparoscopic ventral hernia repair

J. R. Eriksen · I. Gögenur · J. Rosenberg

- The ideal mesh:

- non-carcinogenic
- chemically inactive
- cause non allergic or hypersensitivity reactions
- sterilizable

- From the surgeons (and patients) point of view:

- Minimal adhesion formation
- No infection and fistula formation
- Excellent tissue ingrowths with minimal shrinkage
- Minimal pain and seroma formation

(*Ann Surg 2011;253:16–26*)

ORIGINAL STUDY

A Review of Available Prosthetics for Ventral Hernia Repair

Vidya Shankaran, MD, Daniel J. Weber, BS†, R. Lawrence Reed, II, MD‡, and Fred A. Luchette, MD, MS*†*

Objective: To review mesh products currently available for ventral hernia repair and to evaluate their efficacy in complex repair, including contaminated

METHODS

This review is based on a systematic search of Medline and

TABLE 1. Characteristics of the Ideal Mesh Compared With Available Meshes*

Characteristics	Stainless Steel	Polypropylene	Polyester	ePTFE	Absorbable	Composite	Biologics
Noncarcinogenic	√	√	√	√	√	√	√
Chemically inert	√	√	√	√	–	√/–	√
Resists mechanical strain	√	√	√	√	–	√	√
Capable of being sterilized	√	√	√	√	√	√	√
Controlled foreign body reaction†	√	√/–	√/–	√	√	–	√
Amenable to fabrication in the necessary form	√	√	√	√	√	√	√
No allergic or hypersensitivity reaction	√/–	√	√	√	√	√	√
Resistant to infection	√	–	–	–	√	-	√
Barrier to adhesions on visceral side	–	–	–	√	√/–	√	√
Responds similarly to autologous tissue	–	–	–	–	–	√	√

*This table demonstrates how currently used mesh prostheses comply with the characteristics of ideal mesh as first described by Cumberland and Scales.
† All mesh products excite a disorganized foreign body reaction; however, these reactions do not generally interfere with clinical applicability.

TABLE 2. Classes of Ventral Hernia Mesh

Prosthetic Class	Types
1. Synthetics	Polypropylene
	Polyester
	ePTFE
	Absorbables
2. Composites	Coatings
	Dual-sided
3. Biologic sources	Human
	Porcine
	Bovine

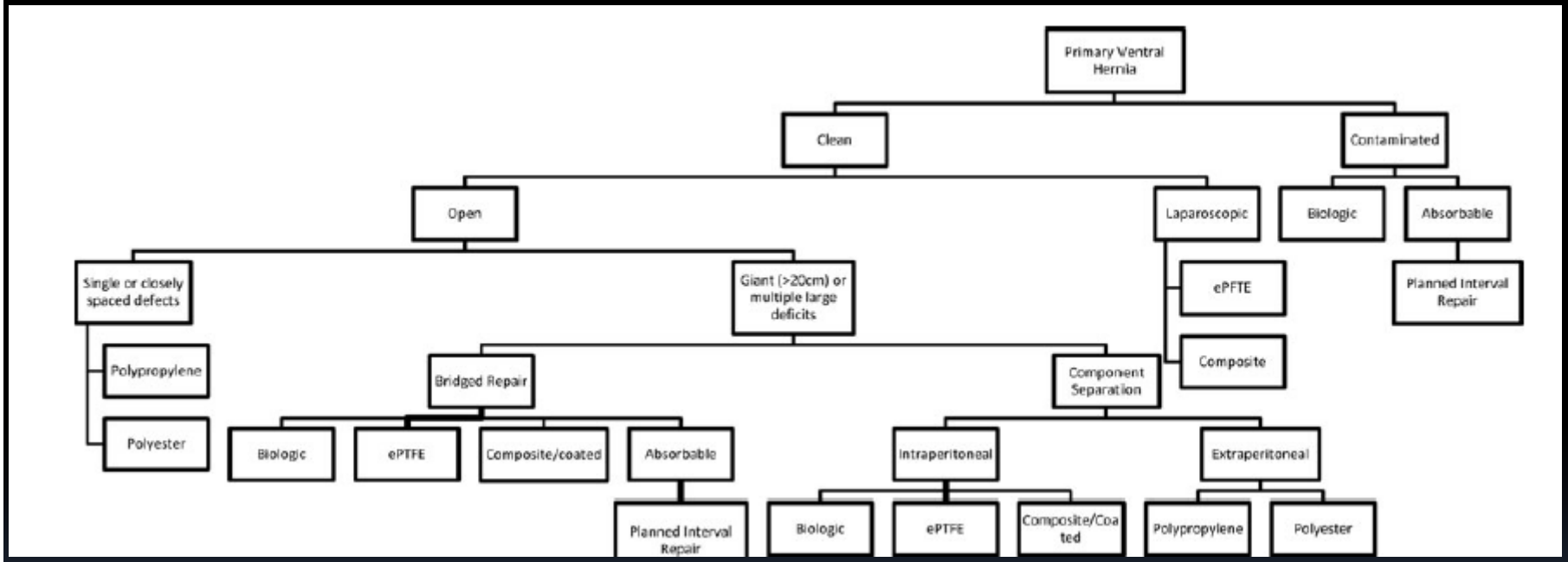
TABLE 3. Types of Synthetic Mesh

Class	Name	Manufacturer	Pore Size	Tensile Strength	Thickness
Heavyweight polypropylene					
	Prolene	Ethicon, Inc.	1–2 mm	89 N/cm	0.6 mm
	Marlex	Bard Inc.	0.1–0.8 mm	59 N/cm	0.65 mm
Lightweight polypropylene					
	Vypro	Ethicon, Inc.	3–5 mm	16 N/cm	0.4 mm
	ProLite	Atrium Medical Corp.	1 mm	56 N/cm	0.5 mm
Polyester					
	Dacron	Dupont	0.3–0.7 mm	ND	0.20 mm
	Mersilene	Ethicon, Inc.	0.6–1.0 mm	19.5 N/cm	0.25 mm
ePTFE					
	Goretex	W. L. Gore and Associates, Inc.	<25 μm	> 16 N/cm	1.0 mm
	Mycromesh	W. L. Gore and Associates, Inc.	Macro- and microporous	> 16 N/cm	1.0 mm
	MotifMESH	Proxy Biomedical	<1 μm	29–33.5 N/cm	0.15 mm

TABLE 4. Types of Composite Prosthetics

Class	Name	Components	Manufacturer	Pore Size	Tensile Strength (N/cm)
Coated mesh	Ultrapro	LW Polypropylene/Poliglecaprone	Ethicon	3–4 mm	68.6
	Sepramesh	Polypropylene/Seprafilm (carboxy-methylcellulose)	Genzyme Biosurgery	Nonporous bioresorbable membrane	ND
	TiMESH	LW Polypropylene/Titanium coating	GP Surgical	>1 mm	>16
	C-Qur	LW Polypropylene/omega-3 fatty acid	Atrium Medical Corp.	ND	ND
	Proceed	LW Polypropylene/polydioxanone-oxidized regenerated cellulose	Ethicon	2.0 mm	66
	Parietex	Polyester/Collagen-polyethylene-glycerol coating	Covidien/ Sofradim	1.0–1.7 mm	42
Dual-sided	Composix	LW or HW Polypropylene/ ePTFE	Bard	Macro- and microporous	
	DualMesh	Double-sided ePTFE with differing surface properties	W. L. Gore	Nonporous	

Mesh use guidelines for primary hernia repair



Mesh use guidelines for recurrent hernia repair