

GLOBAL VALUE DOSSIER
FOR MINIMALLY INVASIVE SURGERY (MIS)
VENTRAL AND INGUINAL HERNIA REPAIR

Medtronic
Further, Together

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1. Ventral and inguinal hernia repair

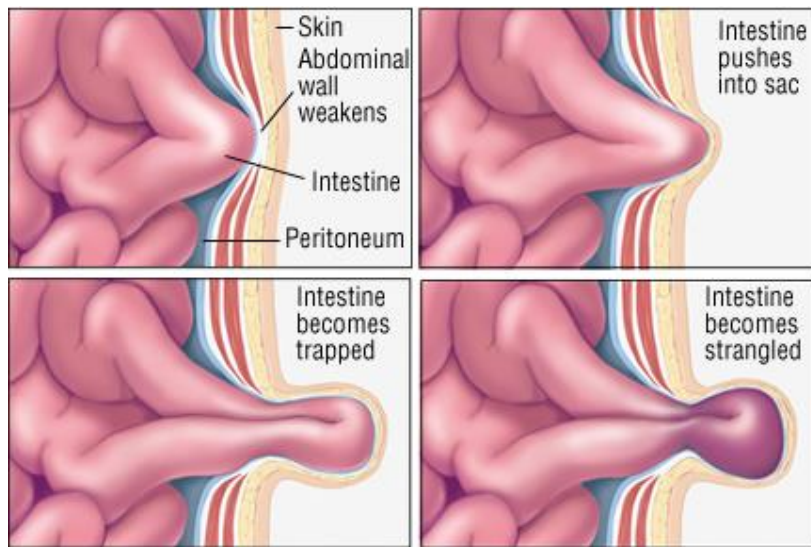
1.1. Overview of procedure

A hernia is a protrusion of tissue or part of an organ through bone, muscular tissue or membrane. Hernias may be classified as primary or incisional and may occur spontaneously as a result of weak muscles, congenital defects or trauma while incisional hernias occur at the site of previous surgical incisions and are believed to occur as a consequence of the fascia failing to heal fully after surgery. A strangulated hernia occurs when tissue becomes constricted by the abdominal wall (or other tissue) through which it is protruding, which in turn restricts blood supply to the tissue and can result in tissue necrosis if not treated; strangulated hernias are considered surgical emergencies (Figure 1-1) and surgery is associated with notably higher mortality compared with elective surgery. The reported rate of strangulation or incarceration ranges for 0.3–3% per year.¹

The most commonly occurring type of hernia is inguinal hernia, followed by incisional hernia. Indeed, inguinal hernias account for approximately 75% of all abdominal wall hernias; lifetime risk for inguinal hernia is 27% for men and 3% for women.² In 2001/2 approximately 70,000 inguinal hernia repairs were performed in England, accounting for approximately 100,000 bed days.³ Similarly, in the US over 800,000 inguinal hernia repairs are performed annually,⁴ whilst the corresponding figure for ventral hernia repairs in the US is 350,000 to 500,000 annually.⁵ In Canada 8% of inguinal hernia repairs are performed laparoscopically.⁶ Similarly, a large-scale US-based study from 2002–2003 reported that in the US 19.5% of outpatient inguinal hernia repairs were performed laparoscopically.⁷ In the same study patients who underwent laparoscopic repair were significantly younger, more likely to be white and have private insurance than those undergoing open repair. The economic burden associated with both inguinal and ventral hernia repair is substantial. In the US, the cost for ventral hernia repair in 2006 was an estimated USD 3.2 billion (2010 USD).⁸

Ventral hernias occur in the abdomen wall; sub-types of ventral hernia include incisional hernia, umbilical hernias and epigastric hernias and rates of incisional hernia of over 20% have been reported at 3 years after midline laparotomy.⁹ Inguinal hernias occur in or near the inguinal canal. Indirect inguinal hernias result from a weakening or incomplete closure of the abdominal wall following the descent of a male's testicles through this region prior to birth. Direct inguinal hernias arise due to weakening of the abdominal wall in the area around the inguinal canal. Indirect hernias are the most common type of inguinal hernia.

Figure 1-1 Strangulated hernia



Source: <http://www.drugs.com/health-guide/hernia.html>

Choices relating to the surgical repair of hernias are guided by the size and location of the hernia and range from reduction of the hernia and primary closure of the defect with simple suturing performed as an outpatient procedure to major reconstruction of the abdominal wall. Laparoscopic repair typically involves the placement of a synthetic mesh into the abdomen at the site of the hernia (see below).

Different techniques for laparoscopic inguinal hernia repair include:

- Total extraperitoneal (TEP) repair (not used for strangulated hernias)
- Transabdominal preperitoneal (TAPP) repair

In the 2014 European Hernia Society guidelines an approach of watchful waiting is considered acceptable for men with asymptomatic or minimally symptomatic inguinal hernias. Currently, most hernia repairs are tension-free repairs using mesh placed over the defect and then secured in place. In the Lichtenstein procedure for open repair of inguinal hernia the mesh is sutured in front of the hernia defect. Similarly, in TAPP repair the mesh is introduced through the defect from the peritoneal cavity and is then placed pre-peritoneal to it and the peritoneum closed dorsal to it. In TEP repair the mesh is placed over the defect from outside the peritoneum. Both TAPP and TEP repair require general, or spinal, anesthesia.

Mesh and mesh fixation

Several different types of mesh and fixation methods are currently available. Meshes can be categorized according to material, weight, and pore size and different types of meshes include non-absorbable synthetic meshes, composite meshes, absorbable meshes and also biologic meshes derived from animal tissue, each of which have their relative merits and limitations. For example, absorbable synthetic meshes are less susceptible to infection but weaken during the resorption process, which can lead to hernia recurrence. Polypropylene is one of the most common material used for mesh as is relatively inert, it does however, weaken over time due to oxidation. Polypropylene meshes with different coatings are also available as these can provide improved bio-compatibility. Meshes can also be categorized as either lightweight or heavyweight, with lightweight meshes being preferred when

flexibility and movement are key factors and heavyweight meshes are optimal when mechanical stability is a key factor. Progress in mesh development is ongoing, with recent developments including self-gripping polyester mesh, which has small absorbable “hooks” to promote adhesion to the abdominal wall, thereby decreasing the number of sutures and/or tacks needed for fixation, which in turn may minimize post-operative pain.

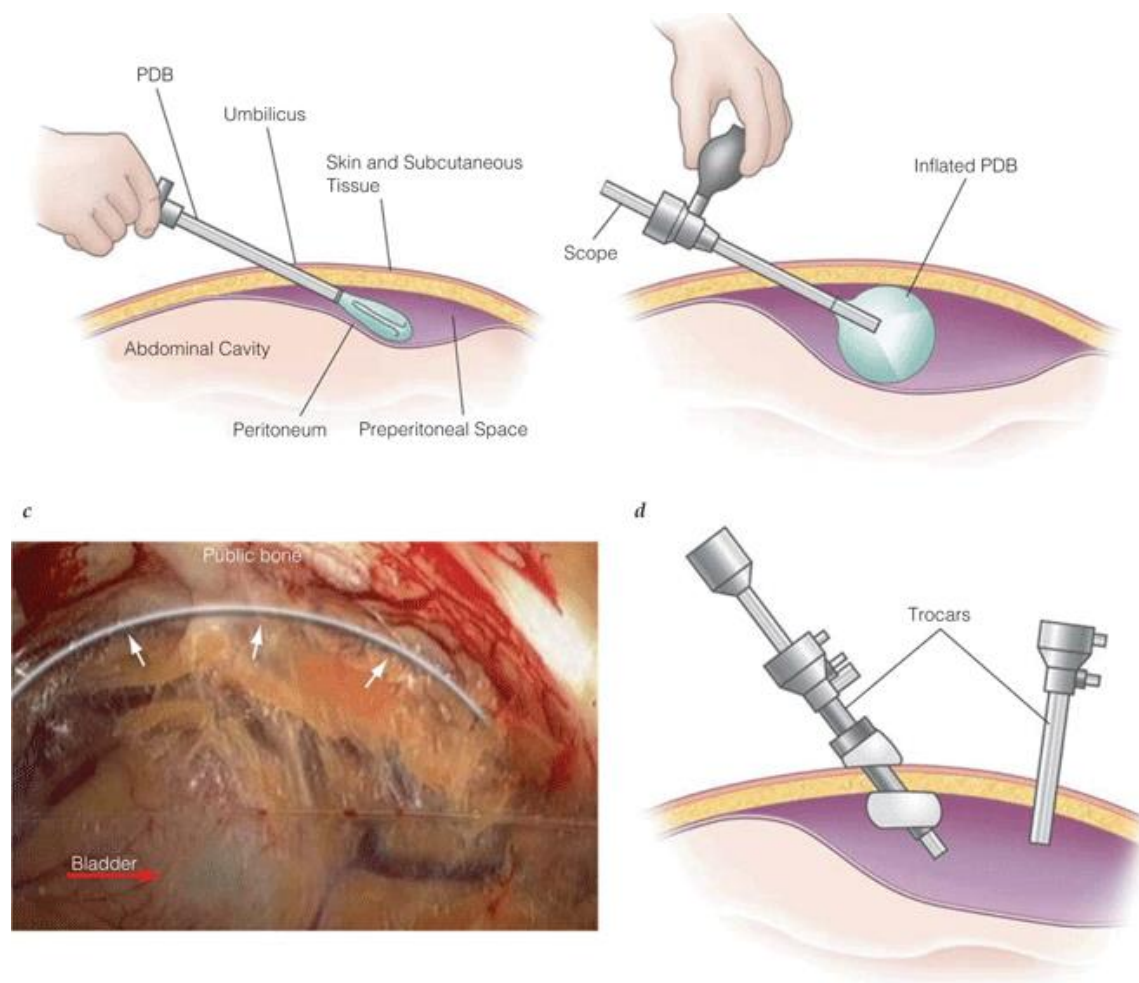
In addition to a wide variety of mesh types, there are number of different mesh fixation techniques available including absorbable or non-absorbable sutures, absorbable or non-absorbable tacks and fibrin glue.

Total extraperitoneal (TEP) inguinal hernia repair

This procedure involves an initial infraumbilical transverse incision of approximately 10 mm, subcutaneous fat is then separated to expose the anterior rectus sheath. Second, a longitudinal incision is made within the anterior rectus sheath on one side of the midline and the rectus muscle retracted laterally to create a space between the rectus muscle and the posterior rectus sheath. Next, a dissecting balloon is placed into the preperitoneal space and inflated thereby dissecting the preperitoneal space. When adequately dissected the balloon is then deflated and removed and the preperitoneal space insufflated with CO₂ (to 12 mmHg). Next a laparoscope is introduced through the umbilical port to inspect the preperitoneal space. Two additional incisions are made for port placement in the midline, one approximately 2–3 cm above the pubic symphysis and one midway between the pubic symphysis and the initial subumbilical port. Typically, dissection begins with exposure of Cooper’s ligament and the pubic tubercle. The hernia is then reduced (although small direct hernias may have already been reduced by the dissecting balloon). Direct inguinal and femoral hernias are reduced by applying cephalad traction to the hernia sac with countertraction. After this, synthetic mesh is introduced through the subumbilical port and placed over the space created such that it covers the site of the hernia. The mesh is then secured by sutures, tacks or glue. The preperitoneal space is then deflated and the ports closed using absorbable sutures.

A key advantage of the TEP procedure is that as the mesh is placed from outside the peritoneum, therefore the opportunities for violating the bowel or mesh adherence to the bowel are minimized.

Figure 1-2 Laparoscopic total extraperitoneal hernia repair



Shown is the preperitoneal distention balloon (PDB) system. The balloon is introduced into the preperitoneal space (a). As it is tunneled inferiorly toward the pubis, the balloon is inflated under laparoscopic vision (b). As the balloon is inflated, the pubic bone and peritoneal edge come into view (line and arrows) (c). Once the preperitoneal space is created, the balloon is removed and replaced with a blunt-tipped trocar. The preperitoneal space is insufflated under low pressure, additional trocars are placed, and the repair is begun (d)

Source:

http://www.sciamsurgery.com/sciamsurgery/institutional/figTabPopup.action?bookId=ACS&linkId=part05_ch22_fig15&type=fig

Transabdominal preperitoneal (TAPP) inguinal hernia repair

In a transabdominal preperitoneal (TAPP) inguinal hernia repair, an infraumbilical incision is made, subcutaneous tissues dissected, trocar placed and the abdomen insufflated (maintaining intraabdominal pressure at 12 mmHg). Two additional ports are then placed in the midline below the umbilicus or bilaterally in the midclavicular line. The abdomen is then visualized and closely inspected to identify anatomic landmarks and the hernia. The peritoneum overlying the hernia is then incised from superior to the medial umbilical ligament to the anterior superior iliac spine, making sure that the peritoneal flap is extended far enough such that it will cover the mesh entirely. A direct hernia can then be reduced if visible, or an indirect hernia dissected from the cord structures. The mesh is then introduced through the subumbilical trocar into the extraperitoneal space and placed over the hernia defect and fixed in place with a laparoscopic tacking device or with a fibrin sealant

or sutures. The peritoneum is then reapproximated, ports removed under direct vision and the fascial defect closed with sutures.

Laparoscopic ventral/incisional hernia repair

For laparoscopic ventral/incisional hernia repair the patient is placed in a low lithotomy position and the procedure is performed under general anesthesia. The nature of ventral/incisional hernia repair is influenced by the type (primary or incisional) and size of the hernia and may range from simple suturing to major reconstruction of the abdominal wall requiring the creation of muscle flaps and the use of large pieces of either biologic or synthetic mesh. The use of mesh is associated with a reduced long-term recurrence rate.¹⁰

Laparoscopic repair of ventral/incisional hernia typically involves use of one optical port with two or three additional ports for instruments (the placement and number of trocars used is dependent on both the size and location of the hernia). After gaining access to the abdominal cavity, pneumoperitoneum is established, maintaining a pressure of 12 mmHg throughout. If present, abdominal adhesions are lysed, taking care to avoid enterotomies. Following this, the hernia sac is reduced into the abdominal cavity, with any bleeding that may occur during this step controlled mechanically using either clips, sutures or Endoloops. If sufficiently small the hernia sac may be excised.

Mesh is then introduced (typically through a 10 mm trocar) and the size should be sufficient to allow an overlap of at least 5 cm from the edges of the hernia,¹¹ which is then fixed with absorbable or nonabsorbable tacks and often secured with transfixating sutures to prevent migration of the mesh, particularly in obese patients. Following inspection of the mesh, (with any adjustment that is required) pneumoperitoneum is released, the trocars removed under direct visualization and the incision sites closed with absorbable sutures.

Guidelines on laparoscopic hernia repair

Society of American Gastrointestinal and Endoscopic Surgeons, 2014 guidelines for laparoscopic hernia repair¹²

Laparoscopic ventral hernia repair, compared to open repair, has a lower rate of wound infections. Recurrence rates and postoperative pain are similar between the two techniques, during mid-term follow-up. The advantages offered by laparoscopic ventral hernia repair over open hernia repair in terms of decreased wound complication rates should be taken into consideration by surgeons and disclosed to patients during consultation and discussion of surgical options (++++, strong recommendations)

Special situations such as loss of domain, presence of abdominal skin grafts or active enterocutaneous wall defects may represent contraindications to laparoscopic repair (++, weak recommendation)

2014 European Hernia Society Guidelines: treatment of inguinal hernia in adults¹³

- Prolene™ Hernia System (PHS) and Plug and Patch (mesh plug) result in comparable outcome (recurrence and chronic pain) as the Lichtenstein technique (1–4 year follow-up) (Level 1A)
- PHS and Plug and Patch (mesh plug) can be considered as an alternative treatment for Lichtenstein inguinal hernia repair (Grade B)
- For recurrent hernias after conventional open repair, endoscopic inguinal hernia techniques result in less postoperative pain, faster reconvalescence and less chronic pain than the Lichtenstein technique (Level 1A)
- For the repair of recurrent hernias after conventional open repair, endoscopic inguinal hernia techniques are recommended (Grade A)
- Material reduced meshes have some advantages with respect to chronic pain and foreign body sensation in the first year(s) after open surgery. There is, however, no difference in the incidence of severe chronic pain. This advantage has not been shown in endoscopic repair (Level 1B)
- Traumatic mesh fixation (non-resorbable devices) in TEP (with heavyweight mesh) is unnecessary in most cases (Level 1A)
- There is possibly a short-term benefit (postoperative pain) of atraumatic mesh fixation in the Lichtenstein procedure and in endoscopic procedures (TAPP). It offers no benefit with respect to chronic pain (Level 1B)
- When using heavyweight meshes, traumatic mesh fixation in TEP endoscopic repair should be avoided (with exception for some cases like large direct hernias). A traumatic mesh fixation in the Lichtenstein technique and in TAPP endoscopic repair can be used without increasing the recurrence rate at 1 year (Grade B)

1.2. Clinical and economic outcomes associated with laparoscopic versus open ventral hernia repair

Key findings

Clinical outcomes

- **Length of stay:** Laparoscopic ventral hernia repair was consistently associated with a shorter length of stay than open repair^{27,29,31,32,33,38,41,43,46,47,48} and in several studies this difference achieved statistical significance^{27,31,32,33,38,41,43,47} (Figure 1-3)
- **Operating time:** In the majority of studies, operating times were longer for laparoscopic repair of ventral hernia than open repair^{30,33,34,36,37,38,46,47,48}; this difference was significant in several studies^{30,34,36,37,38,46,48} (Figure 1-4)
- **Surgical site infection:** The incidence of surgical site infection was consistently higher for open ventral hernia repair than for laparoscopic repair, this difference was significant in a meta-analysis²² and in several individual studies^{27,28,30,33,35,42,43,47} (Figure 1-5)
- **Blood loss:** Estimated blood loss was consistently and significantly lower with laparoscopic ventral hernia repair than with open ventral hernia repair^{43,44,60}
- **Blood transfusion:** The proportion of patients requiring blood transfusion was significantly lower with laparoscopic ventral hernia repair than with open repair^{28,32}
- **Mortality:** Two studies reported a significantly lower risk for post-operative mortality with laparoscopic ventral hernia repair versus open ventral hernia repair^{28,31}
- **Post-operative pain:** Pain scores were not significantly different with laparoscopic versus open ventral hernia repair^{21,23,43,44,45,48}
- **Recurrence:** There was no significant difference in recurrence rates between laparoscopic and open ventral hernia repair^{21,24,25,34,37,41,43,46,48}

Economic outcomes

- **Total costs:** In the majority of studies, total costs were lower for laparoscopic ventral hernia repair than for open ventral hernia repair, however, there were instances of higher costs reported for the laparoscopic procedure
 - **United States:** In US-based studies, total hospital costs were consistently lower for laparoscopic ventral hernia repair than for open repair^{29,31,,32,38}; this difference was significant in some studies^{31,32,51} (Figure 1-7)
 - **Europe:** In Europe (Switzerland and Spain), laparoscopic ventral hernia repair was consistently associated with lower total hospital costs^{47,52} (Figure 1-8)
 - **India:** In India, total costs were significantly higher for laparoscopic ventral hernia repair compared with open ventral hernia repair⁴⁴
- **Savings due to clinical benefits:** Two studies showed that although operating room costs were higher for laparoscopic ventral hernia repair overall costs were lower due to substantially lower costs associated with post-operative hospital stay^{12,47}

Other findings

Hernia size: Patients with large ventral/incisional hernias (≥ 10 cm) have greater post-operative pain and activity limitation than those with small hernia, but the magnitude of the difference is greater for patients undergoing open repair than for those undergoing laparoscopic repair.¹⁴

Mesh composition: Different types of mesh are available for ventral (incisional) hernia repairs; biologic mesh is associated with a lower incidence of infectious wound complications versus synthetic (non-biologic) mesh, but recurrence rates with both mesh types are similar.¹⁵

Mesh placement: In the repair of ventral hernias underlay or retrorectus mesh placement is associated with lower recurrence rates than onlay or interposition mesh placement. Interposition mesh placement is also associated with significantly higher infection rates relative to onlay, retrorectus or underlay mesh placement.¹⁶

Incidence: Rates of incisional hernia of over 20% have been reported at 3 years after midline laparotomy.⁹

Patient satisfaction: Predictors of poor patient satisfaction following laparoscopic ventral hernia include surgical site infection, complications, readmission, recurrence, poor cosmetic satisfaction, chronic pain and poor functional status.¹⁷

Barriers to use: In a survey of US-based surgeons, among those not performing laparoscopic ventral hernia repair, reasons for not using a laparoscopic approach included perception that it did not offer advantages over the open approach, risk of enterotomy, longer operating time, higher cost and lack of experience.¹⁸

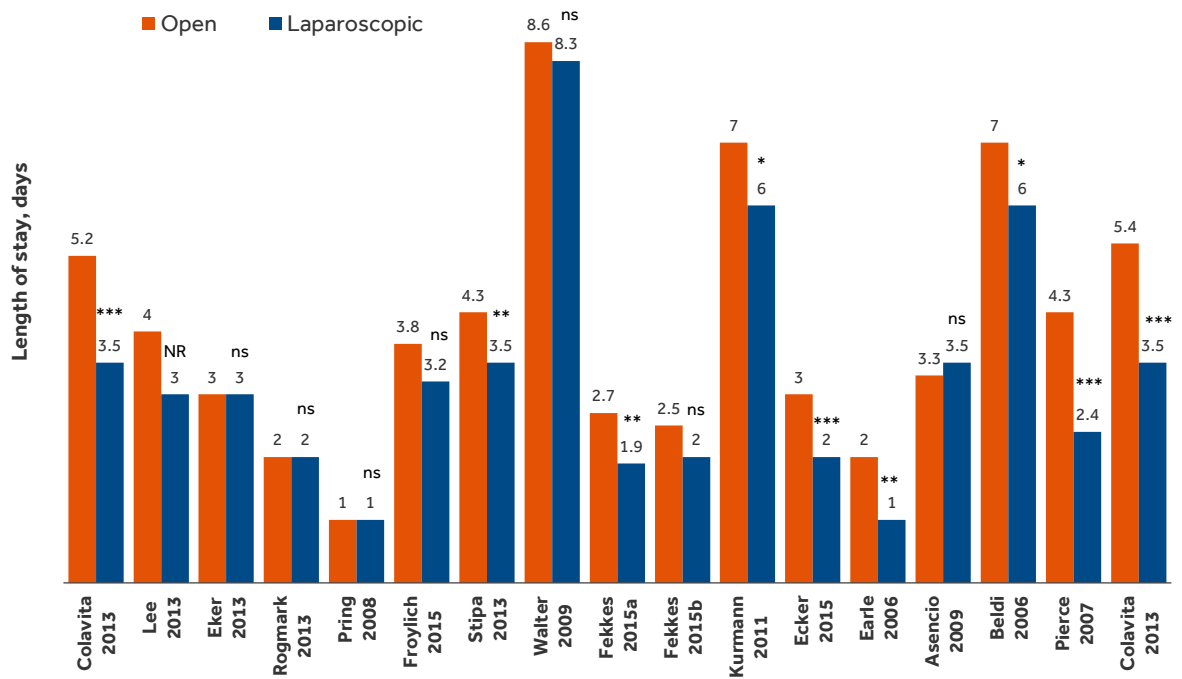
Surgeon volume: Surgeons who performed laparoscopic ventral hernia repair favored the laparoscopic approach due to lower recurrence rate, fewer complications, less pain, shorter length of stay and ease of procedure.¹⁸

Obesity: The incidence of perioperative complications in obese patients undergoing laparoscopic ventral hernia repair is similar to that found in non-obese patients.¹⁹

Recurrence rate: Reducing the recurrence rate has a considerable economic impact. In the US, a 1% reduction in recurrence rate would lead to a saving of USD 32 million annually.⁸

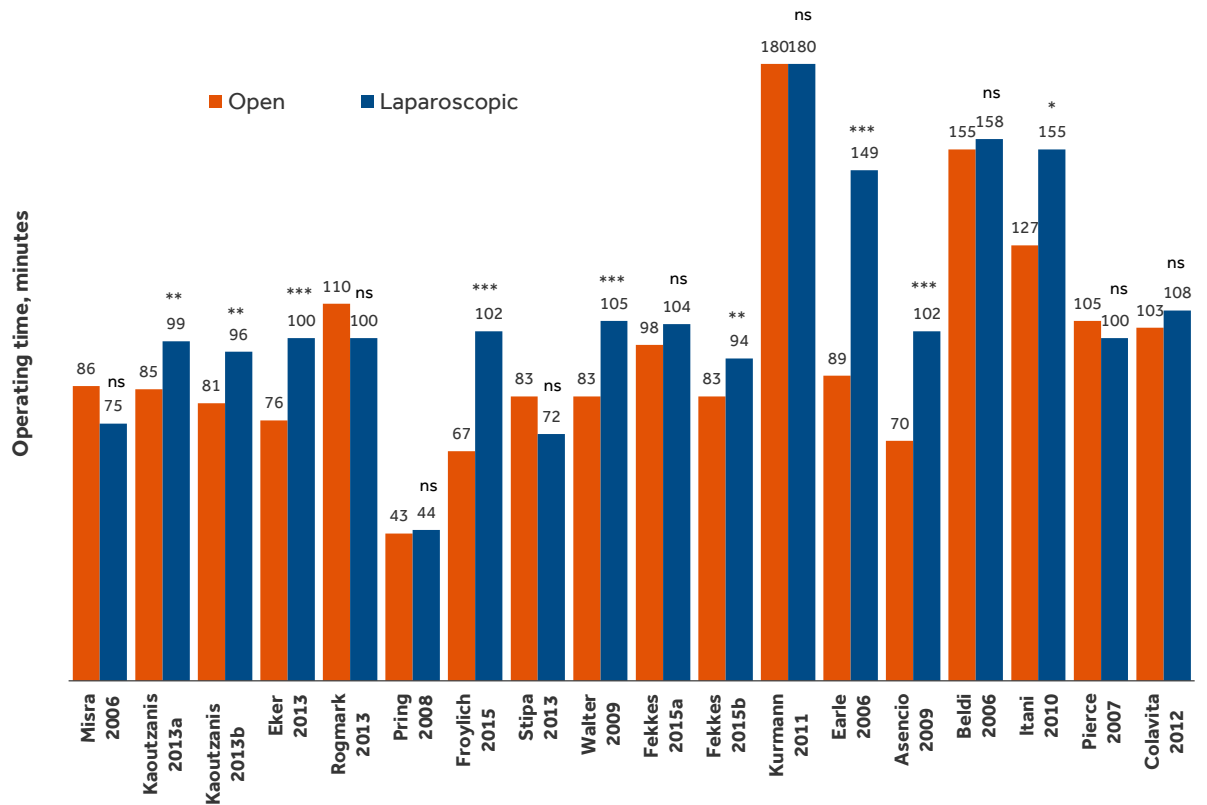
Primary versus incisional hernia: Laparoscopic repair of incisional hernia is associated with a higher conversion rate, longer operating time and higher recurrence rate relative to repair of primary ventral hernia.²⁰

Figure 1-3 Length of stay with open versus laparoscopic ventral hernia repair



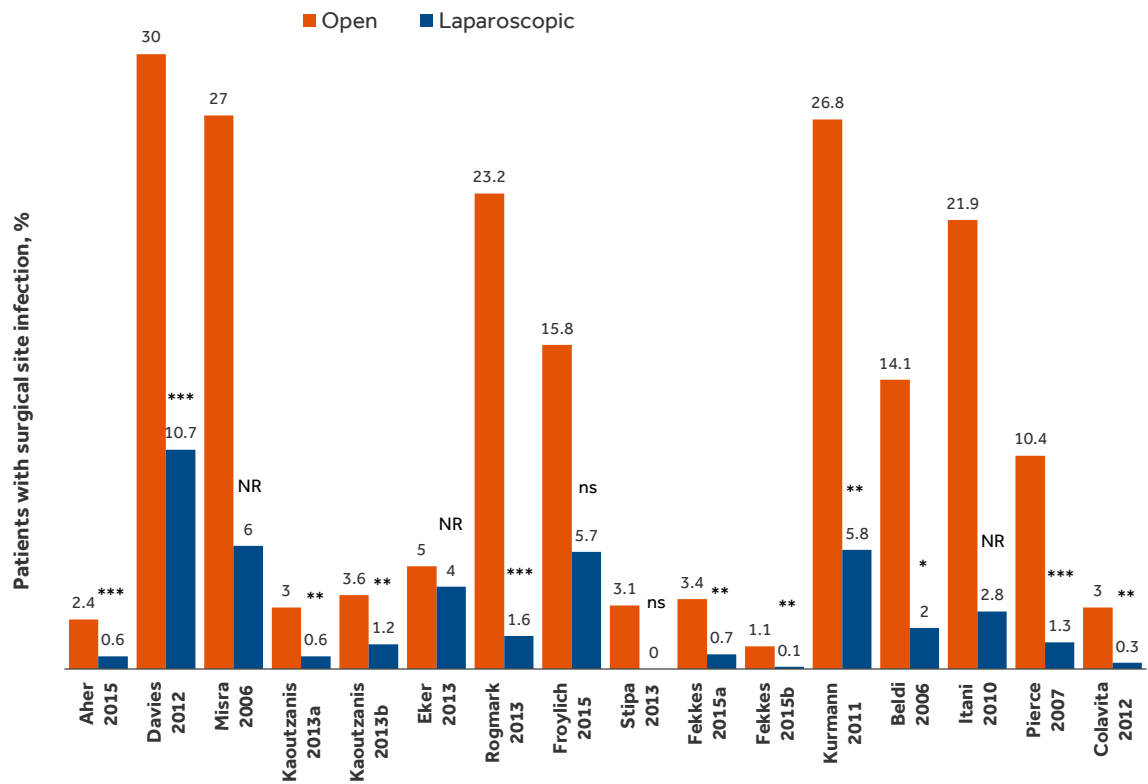
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-4 Operating time with open versus laparoscopic ventral hernia repair



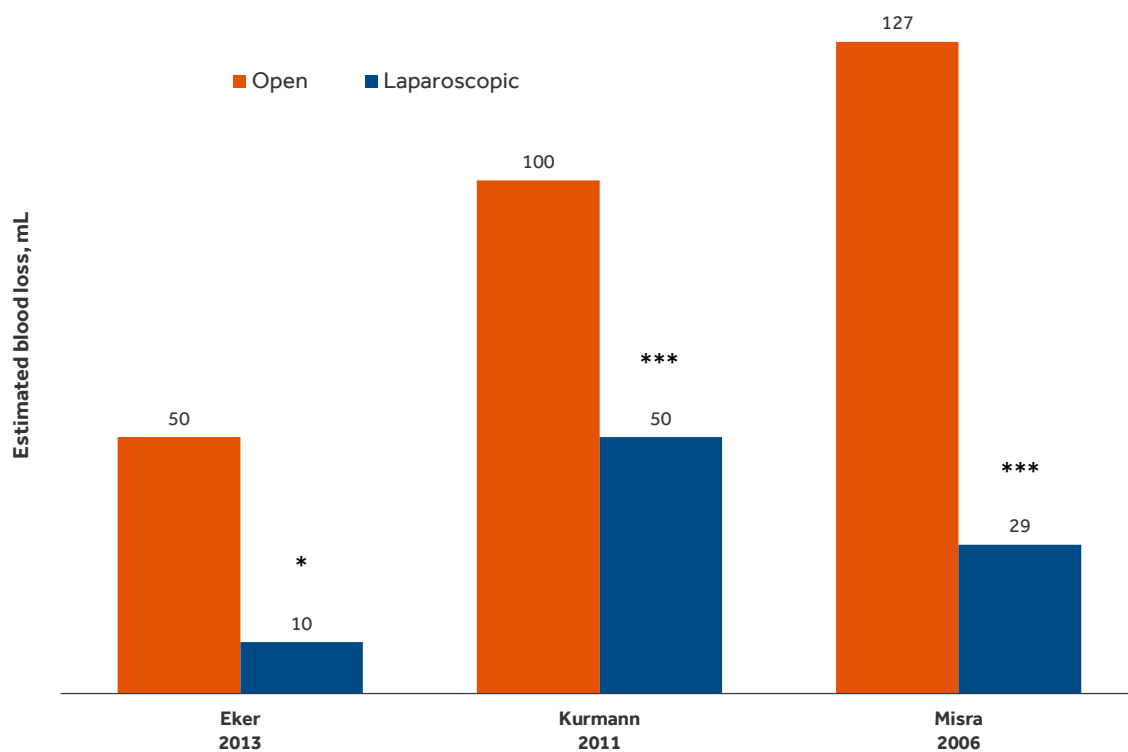
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-5 Incidence of surgical site infection with open versus laparoscopic ventral hernia repair



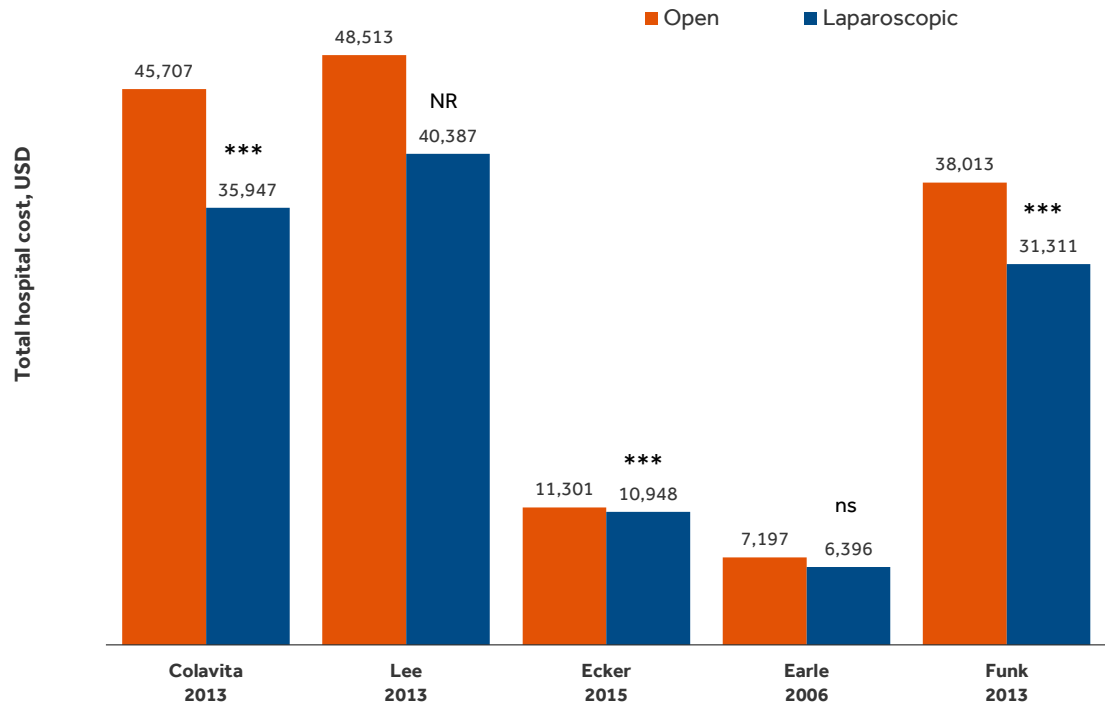
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-6 Estimated blood loss with open versus laparoscopic ventral hernia repair



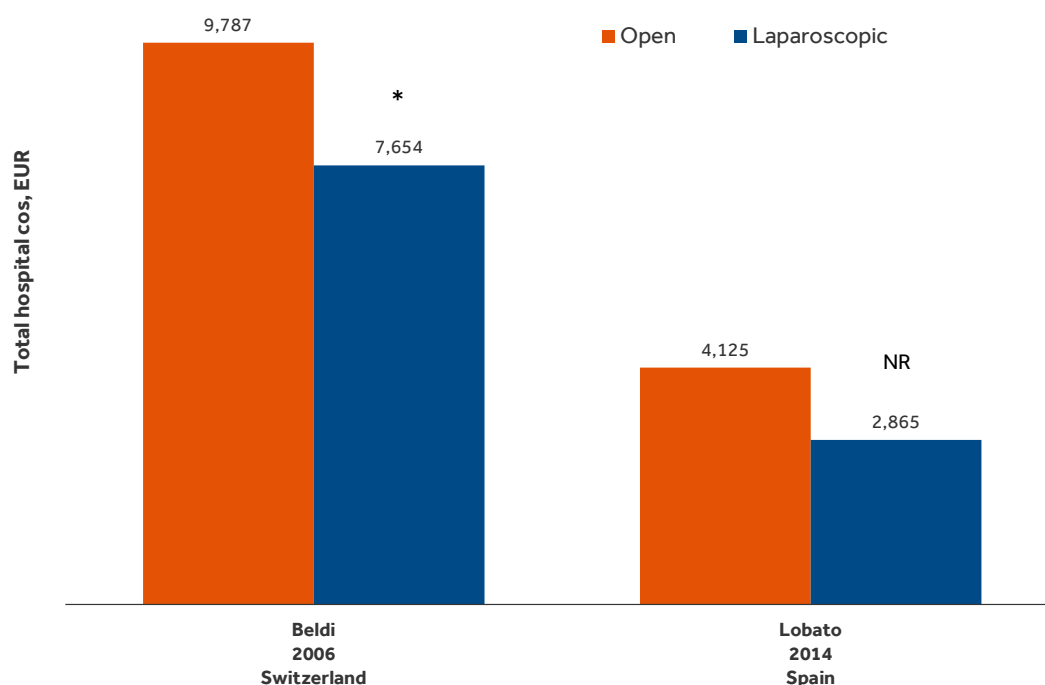
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-7 Total hospital costs of open versus laparoscopic ventral hernia repair in US-based studies



*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-8 Total hospital costs of open versus laparoscopic ventral hernia repair in studies conducted in Europe



*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

1.1.1. Clinical and economic evidence tables for ventral hernia

A summary of clinical evidence on laparoscopic compared with open ventral hernia repair from published meta-analyses and published studies is shown in Table 1-1 and Table 1-2, respectively. A summary of economic evidence from published cost studies is shown in Table 1-3.

In the following tables outcomes where p<0.05 are underlined.

Table 1-1 Summary of meta-analyses comparing laparoscopic versus open ventral hernia					
Authors	Details	Procedures	Outcome	OR (95% CI)	P value
Sauerland et al. 2011 ²¹	10 RCTs (N=880 patients)	Laparoscopic versus open surgery for primary ventral or incisional hernia repair	Post-operative		
			Acute pain	0.09 (-0.45, 0.62) ^a	0.75
			<u>Cost</u>	<u>2.49 (1.84, 3.14)^a</u>	<u><0.00001</u>
			Hernia recurrence	1.22 (0.62, 2.38) ^b	0.58
			Any complication	0.72 (0.42, 1.22) ^b	0.22
			<u>Local infection, all severities</u>	<u>0.26 (0.15, 0.46)^b</u>	<u>0.00001</u>
	Reoperation	0.80 (0.37, 1.75) ^b	0.58		
Arita et al. 2015 ²²	5 studies on primary ventral hernia, 15 studies on incisional ventral hernia	Laparoscopic ventral hernia repair versus open repair with mesh; separate analyses for primary ventral and incisional ventral hernia	Post-operative		
			SSI, primary ventral hernia	4.17 (2.03, 8.55) ^c	NR
			SSI, incisional ventral hernia	5.16 (2.79, 9.57) ^c	NR
Sajid et al. 2009 ²³	5 RCTs (N=366 patients)	Laparoscopic versus open repair of incisional/ventral hernia	Peri-operative		
			Operating time	-1.83 (-4.27, -1.47) ^a	0.143
			<u>Perioperative complications</u>	<u>0.49 (0.33, 0.73)^b</u>	<u><0.001</u>
			Post-operative		
			Postoperative pain	-0.04 (-0.41, 0.33) ^a	0.84
			<u>LoS, days</u>	<u>-1.82 (-3.21, -0.44)^a</u>	<u>0.010</u>
Zhang et al. 2014 ²⁴	11 studies (N=1,003 patients)	Laparoscopic versus open incisional and ventral hernia repair	Post-operative		
			Recurrence rate	1.21 (0.77, 1.91) ^b	0.41
			<u>Wound infection</u>	<u>0.19 (0.11, 0.32)^b</u>	<u><0.00001</u>
			<u>Bowel injury</u>	<u>3.68 (1.56, 8.67)^b</u>	<u>0.003</u>
Salvilla et al. 2012 ²⁵	N=15 observational studies (N=2,452 patients)	Laparoscopic versus open repair of ventral/incisional hernia	Peri-operative		
			<u>Operating time, minutes</u>	<u>59.33 (58.55, 60.11)^a</u>	<u><0.00001</u>
			Post-operative		
			<u>LoS, days</u>	<u>-1.00 (-1.09, -0.91)^a</u>	<u><0.00001</u>
			<u>Abscess</u>	<u>0.38 (0.16, 0.92)</u>	<u>0.03</u>
			<u>Wound infection</u>	<u>0.49 (0.29, 0.82)</u>	<u>0.0007</u>
			Seroma/hematoma	1.37 (0.87, 2.15)	0.18
			Ileus	0.57 (0.29, 1.11)	0.10
			Urinary retention	0.85 (0.18, 3.92)	0.83
Recurrence	0.48 (0.22, 1.04)	0.06			

Table 1-1 Summary of meta-analyses comparing laparoscopic versus open ventral hernia					
Authors	Details	Procedures	Outcome	OR (95% CI)	P value
Awaiz et al. 2015 ²⁶	N=6 studies (N=751 patients)	Laparoscopic versus open mesh repair for elective incisional hernia	Peri-operative		
			Operating time, minutes	-0.08 (-4.46, 4.30) ^a	0.97
			Post-operative		
			<u>Bowel complications</u>	<u>2.56 (1.15, 5.72)</u>	<u>0.02</u>
			Overall complications	1.07 (0.33, 3.42)	0.91
			Wound infection	0.49 (0.09, 2.67)	0.41
			Hematoma/seroma	1.54 (0.58, 4.09)	0.38
			Re-operation	0.32 (0.07, 1.43)	0.14
			LoS, days	-0.83 (-2.22, 0.56) ^a	0.24
Time to oral intake, days	0.16 (-1.97, 2.28)	0.89			

CI, confidence interval; LoS, length of stay; OR, odds ratio; SSI, surgical site infection

Values below 1.00 favor laparoscopic ventral hernia repair

^aMean difference, negative values favor laparoscopic approach

^bRR (risk ratio), values below 1 favor laparoscopic surgery

^cValues above 1 favor laparoscopic

Table 1-2 Summary of key clinical studies comparing open versus laparoscopic ventral hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
Pierce et al. 2007²⁷	Multinational	Pooled analysis of 45 studies (n=4,582 laparoscopic, n=758 open)	Open versus laparoscopic ventral hernia repair (published 1996–2006)	Peri-operative			
				Mean operating time, minutes	105	100	0.61
				Post-operative			
				Mean LoS, days	<u>4.3</u>	<u>2.4</u>	<u>0.0004</u>
				Wound infection, %	<u>10.4</u>	<u>1.3</u>	<u><0.0001</u>
				Total wound complications, %	<u>16.8</u>	<u>3.8</u>	<u><0.0001</u>
Aher et al. 2015²⁸	United States	Retrospective national database analysis, n=90,721 open; n=26,286 laparoscopic	Open versus laparoscopic ventral hernia repair (2009–2012)	Post-operative			
				Mortality, %	<u>0.37</u>	<u>0.23</u>	<u>0.0008</u>
				Return to OR, %	<u>2.0</u>	<u>1.4%</u>	<u><0.0001</u>
				Transfusion, %	<u>0.2</u>	<u>0.1</u>	<u>0.0163</u>
				Superficial incisional infection, %	<u>2.4</u>	<u>0.6</u>	<u><0.0001</u>
				Deep incisional infection, %	<u>0.9</u>	<u>0.2</u>	<u><0.0001</u>
				Organ space infection, %	<u>0.5</u>	<u>0.4</u>	<u>0.056</u>
				No complication, %	<u>92</u>	<u>96</u>	<u><0.0001</u>
Lee et al. 2013²⁹	United States	Retrospective cohort analysis (national database) of obese patients, n=39,485 open; n=8,176 laparoscopic	Open versus laparoscopic ventral hernia repair in obese patients (2008–2009)	Peri-operative			
				Accidental puncture or laceration, %	2.7	1.6	NR
				Post-operative			
				Median LoS, days	4	3	NR
				All complications, %	13.7	6.3	NR
				Wound complications, %	1.5	0.1	NR
				Pulmonary complications, %	4.8	2.4	NR
Kaoutzanis et al. 2013³⁰	United States	Retrospective national database analysis of prospectively collected data, n=21,462 open, n=5,303 laparoscopic (propensity matched)	Open versus laparoscopic ventral/incisional hernia repair (2009–2010)	Reductable			
				Peri-operative			
				Mean operating time, minutes	<u>85</u>	<u>99</u>	<u><0.01</u>
				Post-operative			
				Superficial SSI, %	<u>3.0</u>	<u>0.6</u>	<u><0.01</u>
				Deep SSI, %	<u>1.1</u>	<u>0.2</u>	<u><0.01</u>
				Wound disruption, %	<u>0.6</u>	<u>0.1</u>	<u><0.01</u>
				Organ/space SSI, %	<u>0.8</u>	<u>0.4</u>	<u>0.01</u>
				Total, %	5.5	1.2	NR

Table 1-2 Summary of key clinical studies comparing open versus laparoscopic ventral hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
				Incarcerated/strangulated Peri-operative			
				<u>Mean operating time, minutes</u>	<u>81</u>	<u>96</u>	<u><0.01</u>
				Post-operative			
				<u>Superficial SSI, %</u>	<u>3.6</u>	<u>1.2</u>	<u><0.01</u>
				<u>Deep SSI, %</u>	<u>1.5</u>	<u>0.2</u>	<u><0.01</u>
				<u>Wound disruption, %</u>	<u>0.8</u>	<u>0.1</u>	<u>0.02</u>
				<u>Organ/space SSI, %</u>	<u>0.7</u>	<u>0.9</u>	<u>0.41</u>
				<u>Total, %</u>	<u>6.6</u>	<u>2.4</u>	<u>NR</u>
Colavita et al. 2013³¹	United States	Retrospective national database analysis, n=5,032 laparoscopic, n=13,191 open	Laparoscopic ventral hernia repair versus open ventral hernia repair with mesh (2009)	Post-operative			
				<u>Mean (SD) LoS, days</u>	<u>5.2 (6.4)</u>	<u>3.5 (5.0)</u>	<u><0.0001</u>
				<u>Routine discharge, %</u>	<u>81</u>	<u>91</u>	<u><0.0001</u>
				<u>Defined complication, %</u>	<u>8.2</u>	<u>4.0</u>	<u><0.0001</u>
				<u>Mortality, %</u>	<u>0.88</u>	<u>0.36</u>	<u>0.0002</u>
Ecker et al. 2015³²	United States	Retrospective analysis, n=9,228 open, n=4,339 laparoscopic	Elective open versus laparoscopic ventral hernia repair with mesh (2007–2011)	Post-operative			
				<u>Wound infection, %</u>	<u>1.9</u>	<u>0.9</u>	<u><0.001</u>
				<u>Blood transfusion, %</u>	<u>4.3</u>	<u>1.8</u>	<u><0.001</u>
				<u>Death, %</u>	<u>0.26</u>	<u>0.21</u>	<u>0.56</u>
				<u>Median (IQR) LoS, days</u>	<u>3 (3)</u>	<u>2 (3)</u>	<u><0.001</u>
				<u>Hospital discharge to home, %</u>	<u>96</u>	<u>98</u>	<u><0.001</u>
Fekkes et al. 2015³³	United States	Retrospective database analysis, N=12,004 patients	Open versus laparoscopic ventral hernia repair in obese versus non-obese patients (2011)	BMI >30 kg/m² Peri-operative			
				<u>Mean (SD) operating time, minutes</u>	<u>98 (76)</u>	<u>103 (60)</u>	<u>0.08</u>
				Post-operative			
				<u>Mean (SD) LoS, days</u>	<u>2.72 (7.93)</u>	<u>1.86 (4.70)</u>	<u><0.01</u>
				<u>Blood transfusion, %</u>	<u>1.3</u>	<u>0.2</u>	<u><0.01</u>
				<u>Superficial SSI, %</u>	<u>3.4</u>	<u>0.7</u>	<u><0.01</u>
				<u>Deep SSI, %</u>	<u>1.6</u>	<u>0.6</u>	<u>0.02</u>
				<u>Organ/space SSI, %</u>	<u>0.8</u>	<u>0.3</u>	<u>0.12</u>

Table 1-2 Summary of key clinical studies comparing open versus laparoscopic ventral hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
				BMI <30 kg/m²			
				Peri-operative			
				Mean (SD) operating time, minutes	83 (68)	94 (52)	<0.01
				Post-operative			
				Mean (SD) LoS, days	2.50 (9.92)	2.04 (13.39)	0.28
				Blood transfusion, %	1.3	0.5	0.06
				Superficial SSI, %	1.5	0.4	0.01
				Deep SSI, %	1.1	0.1	0.01
				Organ/space SSI, %	0.4	0.4	0.94
Eker et al. 2013³⁴	United States	Multicenter RCT, n=107 open, n=99 laparoscopic	Laparoscopic versus open ventral incisional hernia repair (1999–2006)	Peri-operative			
				Mean (SD) operating time, minutes	76 (33)	100 (49)	0.001
				Median (IQR) blood loss, mL	50 (10, 100)	10 (1, 40)	0.05
				Intraoperative complications, %	2%	10%	0.049
				Conversion, %	—	8.5	—
				Post-operative			
				Wound drain, %	45%	3%	<0.001
				Median (IQR) LoS, days	3 (2, 5)	3 (2, 4)	0.50
				Post-operative complications, %	26	37	0.13
				Wound infection, %	5	4	NR
				Recurrence, %	14	18	0.30
Rogmark et al. 2013³⁵	Sweden	Multicenter RCT (ProLOVE), n=64 laparoscopic, n=69 open	Laparoscopic versus open techniques for midline incisional hernia repair (2005–2009)	Peri-operative			
				Conversions, %	—	8%	—
				Median (IQR) operating time, minutes	110 (78, 137)	100 (70, 139)	<0.5
				Post-operative			
				Median (IQR) LoS, days	2 (1, 3)	2 (1.5, 3)	<0.861
				Reoperation, %	8.7	1.6	<0.117
				SSI, %	23.2	1.6	<0.001
Itani et al. 2010³⁶	United States	RCT, n=73 open, n=73 laparoscopic	Laparoscopic versus open (with mesh) ventral incisional hernia repair (2004–2007)	Peri-operative			
				Median operating time, minutes	127	155	0.02
				Post-operative			
				Overall complications to 8 weeks, %	48	32	0.03
				SSI, %	21.9	2.8	NR

Table 1-2 Summary of key clinical studies comparing open versus laparoscopic ventral hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
Asencio et al. 2009³⁷	Spain	Multicenter open-label randomized clinical trial, n=39 open, n=45 laparoscopic	Open versus laparoscopic incisional hernia repair	Peri-operative			
				Mean (95% CI) operating time, minutes	<u>70.0</u> (62.9, 77.1)	<u>101.9</u> (91.7, 112.1)	<u><0.001</u>
				Conversions (95% CI)	—	11.1 (1.6, 20.7)	
				Post-operative			
				Local complications, % (95% CI)	<u>5.1</u> (0.0, 12.1)	<u>33.3</u> (19.6, 47.1)	<u>0.001</u>
				Mean (95% CI) LoS, days	3.3 (2.8, 3.9)	3.5 (2.7, 4.3)	0.787
Earle et al. 2006³⁸	United States	Single center retrospective analysis of prospectively collected data, n=415 open, n=469 laparoscopic	Open versus laparoscopic incisional hernia repair (1999–2004)	Peri-operative			
				Mean (SD) operating room time, minutes	<u>89 (4)</u>	<u>149 (4)</u>	<u><0.001</u>
				Post-operative			
				Mean (SD) LoS, days	<u>2 (0.6)</u>	<u>1 (0.2)</u>	<u>0.005</u>
				30-day post-operative hospital encounters, %	13	16	0.47
				Recurrence at 1 year, % (95% CI)	7.9 (0, 16.5)	9.8 (0.7, 18.8)	0.771
Colavita et al. 2012³⁹	Multinational	Retrospective database analysis, n=402 open, n=308 laparoscopic	Laparoscopic versus open ventral hernia repair (2007–2011)	Peri-operative			
				Mean (SD) operating time, minutes	103 (74)	108 (56)	0.360
				Post-operative			
				Mean (SD) LoS, days	<u>5.4 (4.4)</u>	<u>3.5 (2.5)</u>	<u><0.001</u>
				SSI, %	<u>3.0</u>	<u>0.3</u>	<u>0.004</u>
Resting pain at 1 month, %	<u>17.9</u>	<u>31.0</u>	<u>0.0001</u>				
Ahonen-Siirtola et al. 2015⁴⁰	Finland	Retrospective analysis, n=291 open, n=527 laparoscopic	Open versus laparoscopic incisional ventral hernia repair (2006–2012)	Peri-operative			
				Mean (SD) operating time, minutes	121 (83)	105 (52)	0.093
				Mean (SD) blood loss, mL	<u>32 (78)</u>	<u>13 (36)</u>	<u>0.028</u>
				Post-operative			
				Mean (SD) LoS, days	<u>6 (9)</u>	<u>4 (4)</u>	<u><0.001</u>
				Re-operation, %	<u>5.5</u>	<u>2.1</u>	<u>0.013</u>
				Complications, %	23.4	18.4	0.090
SSI, %	<u>8.6</u>	<u>3.2</u>	<u>0.001</u>				
Seroma/hematoma, %	6.9	5.3	0.36				

Table 1-2 Summary of key clinical studies comparing open versus laparoscopic ventral hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
Stipa et al. 2013 ⁴¹	Italy	Retrospective single center analysis, n=126 open, n=126 laparoscopic	Laparoscopic versus open incisional hernia repair (2005–2012)	Peri-operative			
				Mean (SD) operating time, minutes	83 (35.2)	72 (29.2)	ns
				Post-operative			
				<u>Mean (range) LoS, days</u>	<u>4.3 (2, 12)</u>	<u>3.5 (1, 14)</u>	<u>0.002</u>
				<u>Complications, %</u>	<u>13.4</u>	<u>3.9</u>	<u>0.012</u>
				Wound infection, %	3.1	0	ns
				Recurrence, %	5.5	4.7	ns
				Pain Visual Analog Scale			
At 24 h	7	4	nr				
At 48 h	6	3	nr				
At 72 h	4	2	nr				
Davies et al. 2012 ⁴²	United States	Retrospective single center study, n=110 open, n=158 laparoscopic	Laparoscopic versus open ventral hernia repair (2004–2006)	Post-operative			
				<u>Superficial SSI, %</u>	<u>30.0%</u>	<u>10.7%</u>	<u><0.0001</u>
				Reoperation, %	21.8	16.4%	0.270
				Deep SSI, %	5.4	2.5	0.214
				Organ space SSI, %	1.8	0.6	0.364
				All short-term complications, %	4.5	1.3	0.127
				All long-term complications, %	56	47	0.137
Kurmann et al. 2011 ⁴³	Switzerland	Prospective long-term study, n=56 open, n=69 laparoscopic	Open versus laparoscopic incisional hernia repair for large hernias (≥5 cm) (2003–2009)	Peri-operative			
				Median (range) operating time, minutes	180 (85, 375)	180 (69, 360)	ns
				<u>Median (range) blood loss, mL</u>	<u>100 (20, 2500)</u>	<u>50 (10, 450)</u>	<u>0.001</u>
				Conversion rate, %	—	10	—
				Post-operative			
				<u>Median (range) LoS, days</u>	<u>7 (1, 67)</u>	<u>6 (1, 23)</u>	<u>0.014</u>
				<u>SSI, %</u>	<u>26.8</u>	<u>5.8</u>	<u>0.006</u>
				Recurrence, %	17.9	15.9	ns
Reoperation, %	29	25	ns				
Median (range) return to work, weeks	6 (0, 28)	3 (0, 50)	ns				
Misra et al. 2006 ⁴⁴	India	Prospective randomized study,	Open versus laparoscopic repair for incisional and	Peri-operative			
				Mean operative time, minutes	86	75	0.371
				<u>Mean blood loss, mL</u>	<u>127</u>	<u>29</u>	<u>0.001</u>

Table 1-2 Summary of key clinical studies comparing open versus laparoscopic ventral hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
		n=33 open, n=33 laparoscopic	primary ventral hernia (2003–2005)	Post-operative Superficial wound infection, % Deep wound infection, % Post-operative pain VAS score Day 1 VAS score Day 2 VAS score Day 3	27 3 6.05 4.43 2.16	6 0 5.95 4.75 2.33	NR NR 0.857 NR NR
Pring et al. 2008⁴⁵	Australia	Single center RCT, n=24 open, n=30 laparoscopic	Laparoscopic versus open ventral hernia repair (2003–2005)	Peri-operative Mean (SD) operating time, minutes Post-operative Median (IQR) LoS, days Median (IQR) time to return to normal activities, weeks Wound infection, %	43 (11) 1 (1, 1.8) 4 (2.3, 6) 16.7	44 (14) 1 (1, 2) 4 (3, 4.3) 3.3	0.77 0.43 0.92 0.1
Froylich et al. 2015⁴⁶	Israel	Retrospective chart review, n=151 open, n=35 laparoscopic	Laparoscopic versus open ventral hernia repair in obese patients (2004–2012)	Peri-operative Mean (SD) operating time, minutes Post-operative Mean (SD) LoS, days Post-operative complications, % Wound infection, % Recurrence, %	67 (36) 3.8 (2.73) 20.5 15.8 27	102 (42) 3.2 (1.75) 17.1 5.7 20	0.0001 0.234 0.53 0.09 0.28
Beldi et al. 2006⁴⁷	Switzerland	Retrospective analysis of prospective data, n=92 open, n=49 laparoscopic	Open versus laparoscopic ventral hernia repair (2003–2005)	Peri-operative Median operating time, minutes Post-operative Median (range) LoS, days SSI, %	155 7 (2, 87) 14	158 6 (3, 32) 2	0.28 0.02 0.03
Wolter et al. 2009⁴⁸	Germany	Retrospective single center analysis, n=82 open, n=41 laparoscopic	Open (with mesh) versus laparoscopic incisional hernia repair (2004–2006)	Peri-operative Mean (range) operating time, minutes Post-operative Mean (range) LoS, days Post-operative pain (VAS) Recurrence, % Complications, %	83 (17, 210) 8.6 (2, 26) 0.5–4 8.6 23	105 (37, 240) 8.3 (2, 31) 1–4 23.4 20	0.001 0.81 0.82 0.089 NR

Table 1-2 Summary of key clinical studies comparing open versus laparoscopic ventral hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	Laparoscopic	P value
				Re-operation, %	9.1	4.9	NR
				Mortality, %	2.3	0	NR
Liang et al. 2013⁴⁹	United States	Retrospective single center analysis, n=79 open, n=79 laparoscopic (case matched study)	Open mesh versus laparoscopic mesh repair of primary ventral hernia (2000–2010)	Post-operative			
				Superficial SSI, %	<u>27.8</u>	<u>7.6</u>	<u><0.01</u>
				Deep SSI, %	2.5	0	0.48
				Organ or space SSI, %	1.3	0	0.99
				Total SSI, %	<u>34.2</u>	<u>7.6</u>	<u><0.01</u>
				Seroma, %	8.9	20.3	0.10
				Urinary retention, %	1.3	6.3	0.22
				Median (range) LoS, days	<u>0 (0, 10)</u>	<u>1 (0, 13)</u>	<u><0.01</u>
			Re-operation, %	6.3	2.5	0.45	
Tsuruta et al. 2014⁵⁰	Japan	Retrospective single center analysis, n=21 open, n=24 laparoscopic	Open mesh repair versus laparoscopic mesh repair of ventral and incisional hernia (2008–2012)	Peri-operative			
				Mean (SD) operating time, minutes	152 (51)	143 (40)	0.25
				Post-operative			
				Mean (SD) LoS, days	<u>13.4 (11.5)</u>	<u>6.8 (3.6)</u>	<u>0.01</u>
			Total complications, %	<u>27</u>	<u>13</u>	<u>0.03</u>	
			SSI, %	4.8	4.2	NR	

BMI, body mass index; CI, confidence interval; IQR, interquartile range; LoS, length of stay; NR, not reported; ns, not significant; RCT, randomized controlled trial; SD, standard deviation; SSI, surgical site infection; VAS, visual analog scale

Table 1-3 Summary of key studies comparing economic outcomes of open versus laparoscopic ventral hernia								
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	Laparoscopic	P value
Colavita et al. 2013³¹	United States	Retrospective national data analysis, n=5,032 laparoscopic, n=13,191 open	Laparoscopic ventral hernia repair versus open ventral hernia repair with mesh (2009)	USD (2009)	<u>Total hospital charges</u>	<u>45,707</u> <u>(6,1035)</u>	<u>35,947</u> <u>(3,4883)</u>	<u><0.0001</u>
Misra et al. 2006⁴⁴	India	Prospective randomized study, n=33 open, n=33 laparoscopic	Open versus laparoscopic repair for incisional and primary ventral hernia (2003–2005)	INR (year not stated)	<u>Total cost</u>	<u>1,537</u> <u>(1,063)</u>	<u>13,787</u> <u>(6,792)</u>	<u>0.01</u>
Lee et al. 2013²⁹	United States	Retrospective analysis (national data) of obese patients, n=39,485 open; n=8,176 laparoscopic	Open versus laparoscopic ventral hernia repair in obese patients (2008–2009)	USD (year not stated)	Mean total hospital charges	48,513	40,387	NR
Ecker et al. 2015³²	United States	Retrospective analysis, n=9,228 open, n=4,339 laparoscopic	Elective open versus laparoscopic ventral hernia repair with mesh (2007–2011)	USD (year not stated)	<u>Total hospital costs</u>	<u>11,301 (11,692)</u>	<u>10,948 (8,870)</u>	<u><0.001</u>
Earle et al. 2006³⁸	United States	Single center retrospective analysis of prospectively collected data, n=415 open, n=469 laparoscopic	Open versus laparoscopic incisional hernia repair (1999–2004)	USD (year not stated)	<u>Operating supply cost</u> Total hospital cost Cost post-operative encounter Cost post-operative ER admission Cost post-operative readmission	<u>664 (113)</u> 7,197 (1,819) 1,959 (427) 523 (73) 3,176 (216)	<u>2,237 (71)</u> 6,396 (477) 2,102 (426) 414 (31) 3,101 (190)	<u><0.001</u> 0.59 0.83 0.56 0.94

Table 1-3 Summary of key studies comparing economic outcomes of open versus laparoscopic ventral hernia								
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	Laparoscopic	P value
Beldi et al. 2006 ⁴⁷	Switzerland	Retrospective analysis of prospective data, n=92 open, n=49 laparoscopic	Open versus laparoscopic ventral hernia repair (2003–2005)	EUR (2005)	<u>Mean (SD) overall costs</u>	<u>9,787 (8,021)</u>	<u>7,654 (3,204)</u>	<u>0.02</u>
					<u>Mean (SD) surgery cost</u>	<u>2,314 (925)</u>	<u>2,853 (1,147)</u>	<u>0.03</u>
					<u>Mean (SD) hospital cost</u>	<u>7,312 (7,697)</u>	<u>4,902 (2,514)</u>	<u>0.04</u>
Funk et al. 2013 ⁵¹	United States	Retrospective database analysis	Open versus laparoscopic ventral hernia repair (2009–2010)	USD (2009–2010)	Mean hospital charges			
					<u>Umbilical</u>	<u>40,649</u>	<u>31,384</u>	<u><0.001</u>
					<u>Incisional</u>	<u>36,857</u>	<u>32,358</u>	<u><0.001</u>
					<u>Ventral</u>	<u>38,013</u>	<u>31,311</u>	<u><0.001</u>
Lobato et al. 2014 ⁵²	Spain	Prospective study, n=70 open, n=70 laparoscopic	Open versus laparoscopic repair of primary and incisional anterior abdominal wall hernia repair (2004–2009)	EUR (year not stated)	Total cost (including procedure and hospital stay)	4,125	2,865	NR

ER, emergency room; NR, not reported; SD; standard deviation

1.3. Clinical and economic outcomes associated with laparoscopic versus open inguinal hernia repair

Key findings

Clinical outcomes

- **Length of stay:** Laparoscopic inguinal hernia repair was consistently associated with a shorter length of stay compared with open repair^{63,64,67,68,69,70,72,73} with this difference achieving statistical significance in four studies^{68,69,70,73} (Figure 1-9)
- **Operating time:** Laparoscopic inguinal hernia repair was associated with a significantly shorter operating time compared with open repair in several studies^{62,64,68,69} although no significant difference between open and laparoscopic inguinal hernia repair was reported in several other studies^{63,65,71,72,74} (Figure 1-10)
- **Unilateral versus bilateral:** The difference in operating time between laparoscopic and open inguinal hernia repair was more pronounced for bilateral hernia repair than for unilateral hernia repair⁶⁸
- **Surgical site infection:** The incidence of surgical site infection was consistently lower with laparoscopic inguinal hernia repair than with open repair^{59,61,62,65,66,68,69,72} and in three studies this difference achieved statistical significance^{61,68,72} (Figure 1-11)
- **Recurrence:** All except one study reported no significant difference in recurrence rates for laparoscopic versus open repair of inguinal hernias^{56,58,60,63,69,70,72}
- **Return to normal activities/work:** Three meta-analyses showed that laparoscopic inguinal hernia repair was associated with a significantly quicker return to work/normal activities compared with open repair^{56,57,58}
- **Post-operative complications:** Four studies showed no significant difference between open and laparoscopic inguinal hernia repair in terms of overall complications;^{64,66,68,71} however, one meta-analysis showed a significantly lower complication rate with laparoscopic repair⁵⁶
- **Blood transfusion:** One study reported transfusion rates, the proportion of patients requiring blood transfusion was lower with laparoscopic inguinal hernia repair than with open repair, but not significantly so⁶⁶

Economic outcomes

- **Total costs:** Overall, findings of cost studies showed inconsistency between settings
 - **Europe:** Findings of European cost studies were inconsistent; in Germany both TEP and TAPP were associated with significantly lower total hospital costs than open inguinal hernia repair⁷³; however, in Sweden TEP was associated with significantly higher costs than open repair⁷⁹
 - **Canada:** In Canada, laparoscopic inguinal hernia repair is associated with higher total costs than open repair; however, this difference is only significant for unilateral inguinal hernia repair⁷⁸

- **United States:** In two US-based studies laparoscopic inguinal hernia repair was associated with significantly higher total hospital charges than open repair^{7,67}
- **Savings due to clinical benefits:** Evidence from a Canadian study showed that although operating room costs are higher for laparoscopic inguinal hernia repair, total costs are lower due to lower costs for post-operative hospital stay⁷⁸

Other findings

Post-operative pain: In the immediate post-surgery period patients undergoing laparoscopic inguinal hernia repair had less pain at rest and during normal activities than those undergoing open repair.^{59,61}

Costs TEP versus TAPP: In a cost study in India TEP and TAPP inguinal hernia repair were associated with similar costs⁷⁵; however, in a German study TAPP repair was associated with notably higher costs than TEP repair.⁷³

Predictors: In Canada, significant predictors for the use of a laparoscopic approach for inguinal hernia repair include younger age, fewer comorbidities, bilateral hernias and recurrent hernias.⁶

Operating time: In comparisons of TEP versus TAPP inguinal hernia repair; TEP repair was associated with a significantly shorter operating time than TAPP repair.^{75,76}

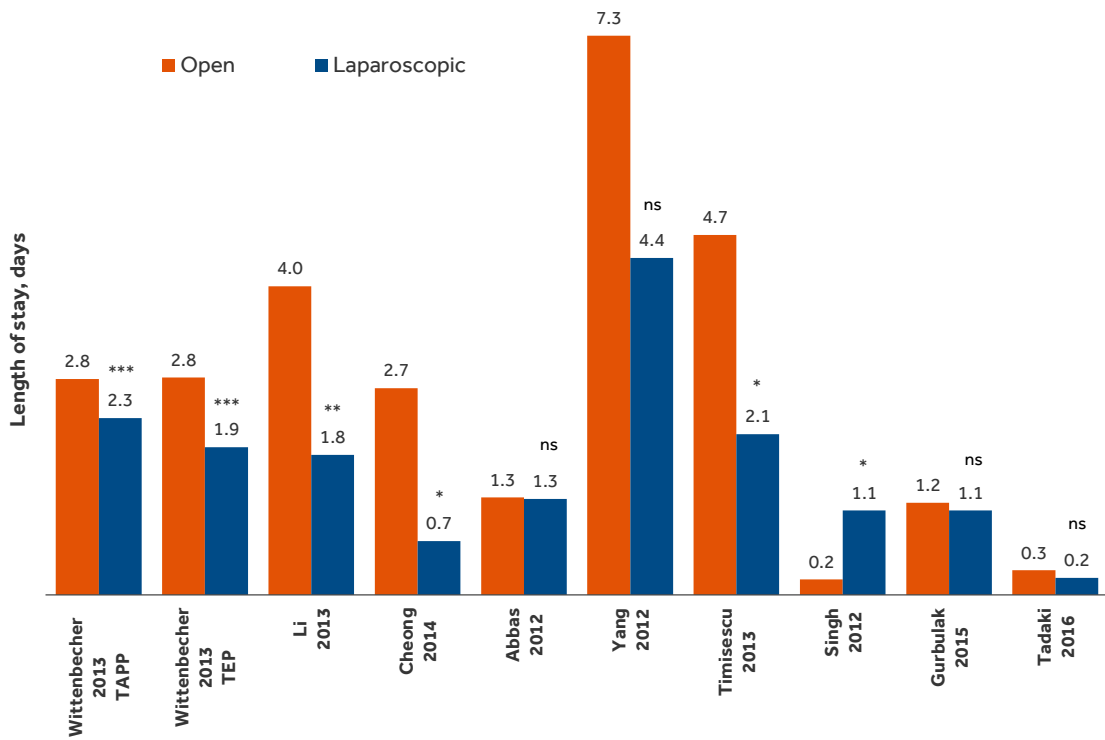
Post-operative pain: Post-operative pain scores up to 6 weeks post-surgery were significantly lower with TEP inguinal hernia repair versus TAPP repair.⁷⁵

Chronic pain: The proportion of patients with long-term chronic pain after surgery was significantly higher for patients undergoing open inguinal hernia repair than for patients undergoing laparoscopic repair.^{60,68}

Quality of life: One study showed that at post-operative Week 4 patients who had undergone laparoscopic inguinal hernia repair had significantly higher SF-36 total scores compared with those who had undergone open repair.⁶³

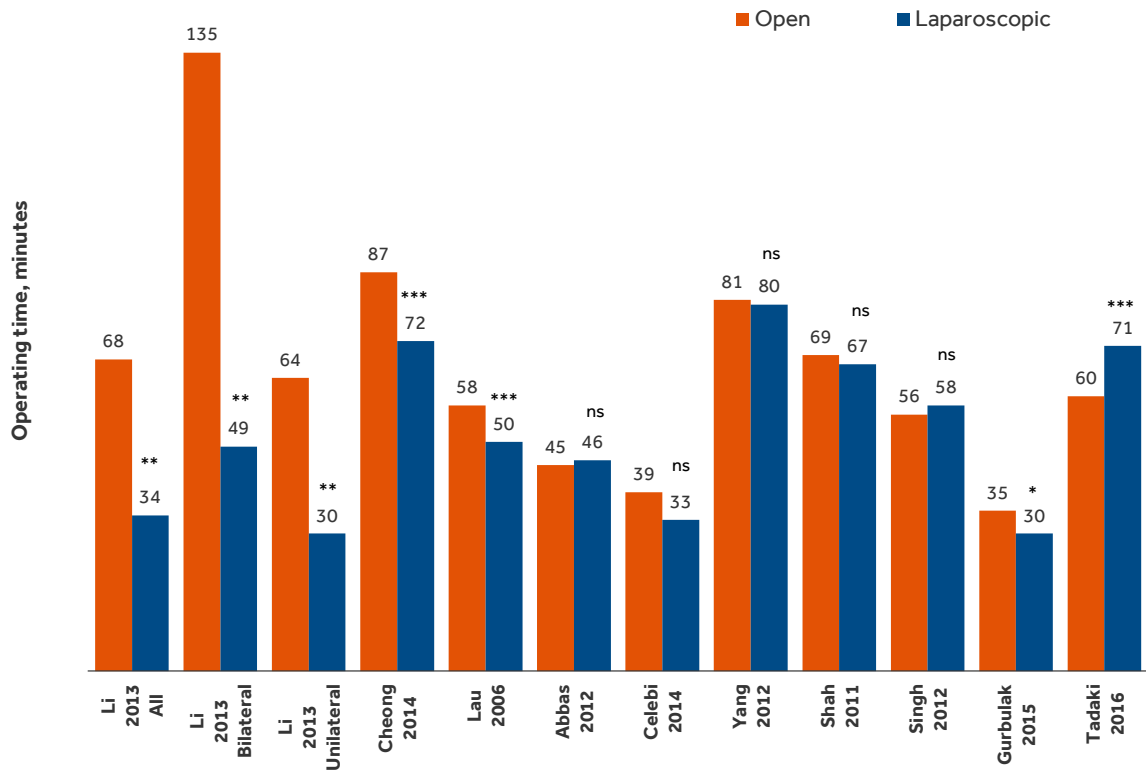
Choice of mesh: In open inguinal hernia repair the use of lightweight mesh is associated with reduced groin pain relative to heavyweight mesh and does not increase risk of recurrence.⁵³ Additionally, in open repair glue mesh fixation is associated with shorter operating time than suture mesh fixation but similar rates of post-operative complications and post-operative pain.⁵⁴

Figure 1-9 Length of stay with open versus laparoscopic inguinal hernia repair



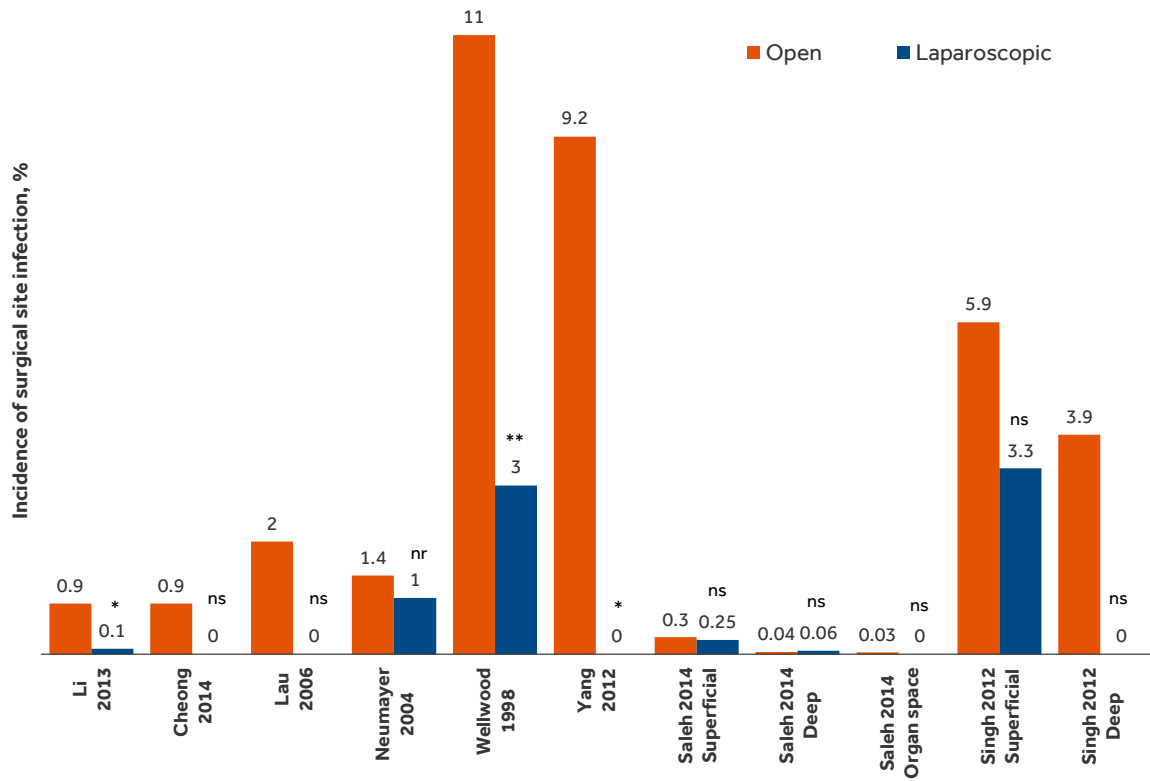
*p<0.05; **p<0.01; ***p<0.001; nr, not reported; ns, not significant

Figure 1-10 Operating time with open versus laparoscopic inguinal hernia repair



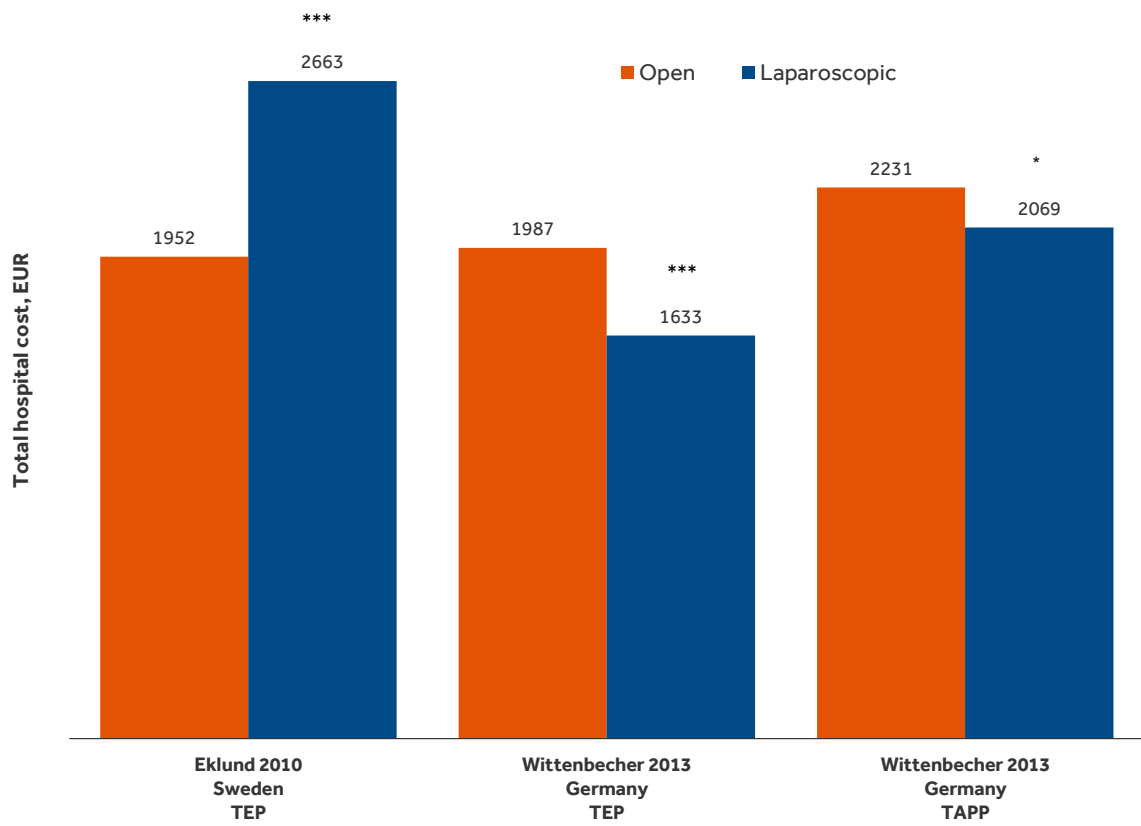
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-11 Incidence of surgical site infection with open versus laparoscopic inguinal hernia repair



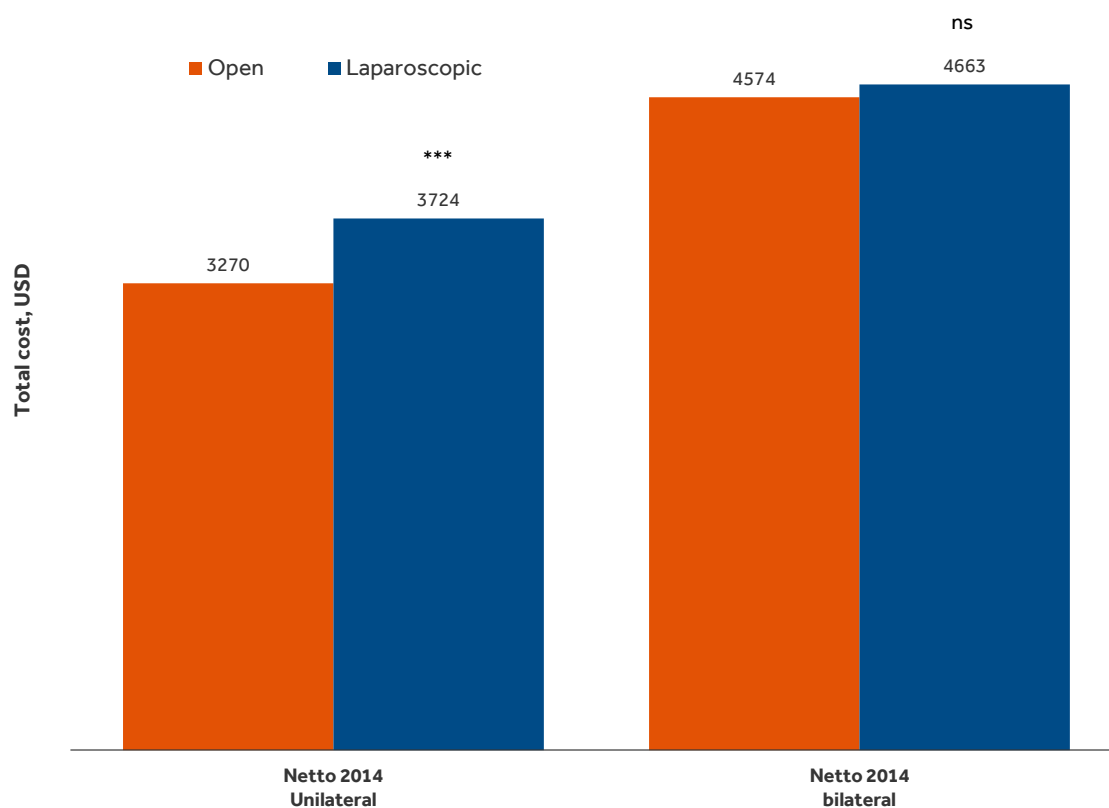
*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-12 Total hospital costs with open versus laparoscopic inguinal hernia repair



*p<0.05; **p<0.01; ***p<0.001; NR, not reported; ns, not significant

Figure 1-13 Total costs for open versus inguinal hernia repair in Canada



*p<0.05; **p<0.01; ***p<0.001; ns, not significant

1.1.2. Clinical and economic evidence tables for inguinal hernia

A summary of clinical evidence on minimally invasive compared with open surgery from published meta-analyses and published studies is shown in Table 1-4 and Table 1-5, respectively. A summary of economic evidence from published cost studies is shown in Table 1-6.

In the following tables outcomes where p<0.05 are underlined.

Table 1-4 Summary of meta-analyses comparing laparoscopic versus open inguinal hernia					
Authors	Details	Procedures	Outcome	OR (95% CI)	P value
O'Reilly et al. 2012 ⁵⁵	N=27 RCTs, N=7,161 patients	Open versus laparoscopic repair of primary inguinal hernia	Peri-operative		
			<u>Complications</u>	<u>1.22 (1.04, 1.42)^a</u>	<u>0.015</u>
			Post-operative		
			<u>Recurrence</u>	<u>2.06 (1.26, 3.37)^a</u>	<u>0.004</u>
			<u>Chronic groin pain</u>	<u>0.66 (0.51, 0.87)^a</u>	<u>0.003</u>
Zhu et al. 2014 ⁵⁶	N=12 studies (n=10 RCTs and n=2 comparative studies) N=1,157 patients	Open (extraperitoneal) mesh repair versus laparoscopic (TEPP) inguinal hernia repair	Peri-operative		
			Intra-operative complications	1.60 (0.33, 7.78)	0.564
			<u>Operating time, minutes</u>	<u>1.05 (0.04, 2.05)^b</u>	<u>0.041</u>
			Post-operative		
			Recurrence	1.39 (0.60, 3.23)	0.829
			<u>Total complications</u>	<u>0.54 (0.37, 0.83)</u>	<u>0.002</u>
			Chronic pain	0.70 (0.24, 2.06)	0.297
			Wound infection	0.49 (0.19, 1.27)	0.141
			Scrotal/testicular problems	0.70 (0.27, 1.78)	0.453
			<u>Urinary problems</u>	<u>0.21 (0.06, 0.67)</u>	<u>0.008</u>
			<u>LoS, days</u>	<u>-2.00 (-2.36, -1.63)^b</u>	<u>0.000</u>
<u>Return to normal activities/work, days</u>	<u>-1.80 (-3.32, -0.28)^b</u>	<u>0.021</u>			
Pisanu et al. 2015 ⁵⁷	N=7 RCTs, N=647 patients	Open (Lichtenstein) versus laparoscopic (TAP or TEPP) repair of recurrent inguinal hernia	Peri-operative		
			<u>Operating time, minutes</u>	<u>0.46 (0.03, 0.89)^b</u>	<u>0.04</u>
			Post-operative		
			<u>Chronic inguinal pain</u>	<u>0.39 (0.21, 0.72)</u>	<u>0.003</u>
			Hematoma/seroma	0.51 (0.17, 1.55)	0.24
			<u>Time to normal activities, days</u>	<u>-0.81 (-1.40, -0.23)^b</u>	<u>0.006</u>
Li et al. 2014 ⁵⁸	N=11 studies (n=5 RCTs and n=5 comparative studies), N=1,311 patients	Open versus laparoscopic procedures for recurrent inguinal hernia (1999–2012)	Peri-operative		
			Operating time (subgroup 1 analysis)	3.45 (-4.66, 11.57) ^b	0.40
			Operating time (subgroup 2 analysis)	3.74 (-4.92, 12.39) ^b	0.40
			Post-operative		
			Recurrence	-0.01 (-0.06, 0.03) ^c	0.36
			Recurrence (RCTs only)	-0.01 (-0.06, 0.03) ^c	0.62
			Post-operative acute pain	0.48 (0.14, 1.69)	0.25
			Post-operative chronic pain	-0.04 (-0.10, 0.02) ^c	0.22

Table 1-4 Summary of meta-analyses comparing laparoscopic versus open inguinal hernia					
Authors	Details	Procedures	Outcome	OR (95% CI)	P value
			<u>Post-operative wound infection</u>	<u>-0.02 (-0.04, -0.00)^c</u>	<u>0.02</u>
			<u>Post-operative wound infection (RCTs only)</u>	<u>0.23 (0.07, 0.76)</u>	<u>0.02</u>
			Post-operative hematomas and seromas	0.69 (0.36, 1.30)	0.25
			<u>Time to return to work (subgroup 1 analysis)</u>	<u>-5.15 (-7.43, -2.87)</u>	<u><0.00001</u>
			<u>Time to return to work (subgroup 2 analysis)</u>	<u>-5.36 (-7.73, -3.00)</u>	<u><0.00001</u>

CI, confidence interval; OR, odds ratio; RCT, randomized controlled trial

For odds ratios, values below 1.00 favor laparoscopic, values above 1.00 favor open repair

^aRelative risk values above 1 favor open

^bMean difference, negative values favor laparoscopic, positive values favor open repair

^cRisk difference, negative values favor laparoscopic, positive values favor open repair

Table 1-5 Summary of key clinical studies comparing open versus laparoscopic inguinal hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value
Neumayer et al. 2004 ⁵⁹	United States	RCT, n=994 open, n=989 laparoscopic	Laparoscopic mesh (TAP or TEPP) versus open mesh repair of inguinal hernia (1999–2001)	Peri-operative			
				Intraoperative complication, %	1.9	4.8	NR
				Post-operative			
				Wound infection, %	1.4%	1.0	NR
				Post-discharge			
				2-year recurrence, %	4.9	10.1	NR
Eker et al. 2012 ⁶⁰	Netherlands	Prospective multicenter RCT, n=336 laparoscopic (TEP), n=324 Lichtenstein repair	TEP versus Lichtenstein repair for inguinal hernia (2000–2004)	Peri-operative			
				Conversions, %		6.3	—
				Post-discharge			
				Recurrence, %	8.1	4.9	0.10
				Chronic pain at 5 years, %	<u>28.0</u>	<u>14.9</u>	<u>0.004</u>
Wellwood et al. 1998 ⁶¹	United Kingdom	RCT, n=200 open, n=200 laparoscopic	Tension-free open mesh versus laparoscopic (TAPP) repair of inguinal hernia (1995–1996)	Post-operative			
				Wound infection, %	<u>11</u>	<u>3</u>	<u><0.01</u>
				Readmission, %	3	2	0.50
Lau et al. 2006 ⁶²	China	RCT, n=100 open, n=100 laparoscopic	Laparoscopic (TEP) versus open (Lichtenstein hernioplasty) for primary inguinal hernia repair in men (2002–2004)	Peri-operative			
				Mean (SD) operating time, minutes	<u>58 (17.6)</u>	<u>50 (13.2)</u>	<u><0.001</u>
				Post-operative			
				Wound infection, %	2	0	0.477
Abbas et al. 2012 ⁶³	Egypt	RCT, n=88 TAPP, n=97 open	TAPP versus open (Lichtenstein) repair for unilateral uncomplicated groin hernia	Peri-operative			
				Mean (SD) operating time, minutes	45 (10)	46 (9)	0.513
				Post-operative			
				Mean (SD) LoS, days	1.27 (0.87)	1.25 (1.19)	0.907
				Technical failure, %	0	1.1	0.294
				Wound infection, %	3.1	0	0.097
				Chronic pain, %	7.2	2.3	0.12
				Recurrence, %	5.2	3.4	0.561
				Mean (SD) SF-36 score at Week 4	<u>75.7 (14.9)</u>	<u>79.4 (13.0)</u>	<u>0.031</u>

Table 1-5 Summary of key clinical studies comparing open versus laparoscopic inguinal hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value
Gurbulak et al. 2015 ⁶⁴	Turkey	RCT, n=73 laparoscopic (TEP), n=75 open (Lichtenstein)	Open (Lichtenstein) versus laparoscopic (TEP) repair of unilateral inguinal hernia (2012–2014)	Peri-operative			
				<u>Mean (range) operating time, minutes</u>	<u>35 (27, 60)</u>	<u>30 (19, 55)</u>	<u>0.01</u>
				Post-operative			
				Mean (range) LoS, days	1.2 (1, 2)	1.1 (1, 2)	0.95
				Early complications, %	14.3	4.7	0.24
Singh et al. 2012 ⁶⁵	India	RCT, n=60 laparoscopic, n=57 open	Open mesh versus laparoscopic (TAPP or TEP) repair of inguinal hernia (2009–2010)	Peri-operative			
				Mean (SD) operating time, minutes	56 (11)	58 (12)	0.7
				Post-operative			
				<u>Parenteral analgesia, days >1, %</u>	<u>14</u>	<u>40</u>	<u>0.04</u>
				<u>Median oral analgesic, days</u>	<u>10</u>	<u>7</u>	<u>0.02</u>
				<u>Median LoS, days</u>	<u>0.2</u>	<u>1.1</u>	<u>0.04</u>
				Superficial wound infection, %	5.9	3.3	0.8
				Deep wound infection, %	3.9	0	0.6
				<u>Seroma, %</u>	<u>1.7</u>	<u>13.3</u>	<u>0.03</u>
				Testicular pain, %	10.5	1.7	0.1
				<u>Mean (SD) pain score at 24 h</u>	<u>4.4 (1.7)</u>	<u>3.0 (1.2)</u>	<u>0.001</u>
Saleh et al. 2014 ⁶⁶	Canada	Prospective cohort study, n=6,356 laparoscopic, n=31,289 open	Open versus laparoscopic unilateral first time inguinal hernia repair (2005–2010)	Post-operative			
				30-day mortality, %	0.05	0.02	0.3374
				Overall complications, %	0.98	0.98	1.00
				Major complications, %	0.54	0.49	0.5744
				Superficial SSI, %	0.30	0.25	0.6098
				Deep SSI, %	0.04	0.06	0.5122
				Organ space SSI, %	0.03	0	0.2299
				Transfusion, %	0.09	0.04	0.6422
Tadaki et al. 2016 ⁶⁷	United States	Retrospective database study, n=5,468 open, n=775 laparoscopic	Open versus laparoscopic hernia repair (2008–2011)	Peri-operative			
				<u>Mean (SD) operating time, minutes</u>	<u>60 (29)</u>	<u>71 (38)</u>	<u><0.001</u>
				<u>Mean (SD) duration of anesthesia, minutes</u>	<u>96 (35)</u>	<u>112 (44)</u>	<u><0.001</u>
				Post-operative			
				Mean (SD) LoS, days	0.32 (3.01)	0.22 (0.86)	0.322
				Mean (SD) length of stay, days	0.32 (3.23)	0.21 (0.80)	0.357

Table 1-5 Summary of key clinical studies comparing open versus laparoscopic inguinal hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value
Li et al. 2013 ⁶⁸	China	Retrospective analysis, n=1,230 laparoscopic, n=530 open	Laparoscopic (TAPP and TEP) versus open peritoneal inguinal hernia repair (modified Kugel hemiorrhaphy) (2008–2010)	Peri-operative			
				Mean (SD) operating time, minutes	68 (39)	34 (21)	<0.01
				Mean (SD) operating time, bilateral, minutes	13 (52)	49 (23)	<0.01
				Mean (SD) operating time, unilateral, minutes	64 (35)	30 (18)	<0.01
				Intraoperative complications, %	0.75	0.73	1.00
				Post-operative			
				Mean (SD) LoS, days	4.03 (2.49)	1.83 (1.59)	<0.01
				Short-term post-operative complication, %	10	8.6	0.353
Wound infection, %	0.94	0.08	0.016				
Long-term chronic pain, %	7.3	1.4	0.01				
Cheong et al. 2014 ⁶⁹	Singapore	Retrospective analysis, n=352 open, n=168 laparoscopic	Laparoscopic (TAPP and TEP) versus open repair for inguinal hernia (2010)	Peri-operative			
				Mean (SD) operating time, minutes	87(30)	72 (34)	<0.001
				Post-operative			
				Mean (SD) LoS, days	2.7 (10.9)	0.7 (0.8)	0.020
				Recurrence, %	3.7	4.2	ns
Chronic pain, %	1.7	0	ns				
Wound infection, %	0.9	0	ns				
Timisescu et al. 2013 ⁷⁰	Romania	Retrospective single center analysis, n=91 open, n=234 laparoscopic	Open (Lichtenstein) versus laparoscopic (TEP) repair of bilateral inguinal hernia (2006–2011)	Post-operative			
				Mean (SD) LoS, days	4.7 (2)	2.1 (1.2)	<0.05
				Infection, %	0	5.5	NR
				Hematoma, %	0.9	9.9	<0.05
				Seroma, %	0	2.2	NR
				Acute urinary retention, %	0	4.4	NR
Recurrence, %	0.4	1.1	ns				
Shah et al. 2011 ⁷¹	United States	Retrospective chart review, n=61 open mesh repair, n=111 laparoscopic mesh repair (n=76 TEP, n=35 TAPP)	Open versus laparoscopic (TAPP or TEP) mesh repair for recurrent inguinal hernia	Peri-operative			
				Mean (SD) operating time, minutes	69 (38)	67 (26)	0.53
				Post-operative			
				Overall complications, %	15.3	13.1	0.70
Chronic pain, %	8.2	10.8	0.58				
Recurrence, %	8.2	3.6	0.28				

Table 1-5 Summary of key clinical studies comparing open versus laparoscopic inguinal hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value
Yang et al. 2012 ⁷²	China	Retrospective database analysis, n=57 laparoscopic, n=131 open	Open versus laparoscopic hernia repair for acute strangulated groin hernia (2007–2011)	Peri-operative			
				Mean (SD) operating time, minutes	81 (35)	80 (30)	0.863
				Post-operative			
				Mean (SD) LoS, days	7.3 (2.4)	4.4 (2.0)	0.307
				<u>Wound infection, %</u>	<u>9.2</u>	<u>0</u>	<u>0.018</u>
				Hematoma, %	3.8	3.5	0.918
Seroma, %	5.3	14.0	0.074				
Recurrence, %	2.3	1.8	0.815				
Wittenbecher et al. 2013 ⁷³	Germany	Retrospective database analysis	TEP versus TAPP versus open surgery with mesh for non-incarcerated inguinal hernia repair	Post-operative			
				<u>TAPP versus open mesh, mean (SD) LoS, days</u>	<u>2.82 (1.10)</u>	<u>2.31 (1.08)</u>	<u><0.0001</u>
				<u>TEP versus open mesh, mean (SD) LoS, days</u>	<u>2.84 (1.81)</u>	<u>1.93 (1.18)</u>	<u><0.0001</u>
Celebi et al. 2014 ⁷⁴	Turkey	Single-blind single center study, n=32 open, n=30 laparoscopic	Open versus laparoscopic inguinal hernia repair for bilateral hernia in boys (2011–2013)	Peri-operative			
				Mean (SD) operating time, minutes	39 (3)	33 (3.2)	0.067
				Post-operative			
				Mean (range) time to normal activities, days	1.8 (1, 3)	2.4 (1, 4)	0.32
				Median (SD) analgesic doses requested	12.5 (10.2)	8.8 (6.6)	0.315
Median (SD) analgesic doses delivered	11.9 (5.6)	8.4 (6.6)	0.321				
Comparisons of TEP versus TAP					TAPP	TEP	
Bansal et al. 2013 ⁷⁵	India	Randomized trial of TAPP versus TEP, n=160 TEP, n=154 TAPP	TAPP versus TEP for uncomplicated groin hernia (2007–2012)	Peri-operative			
				<u>Mean (SD) operating time, minutes</u>	<u>69 (24)</u>	<u>62 (22)</u>	<u>0.027</u>
				Post-operative			
				Mean (SD) LoS, days	1.05 (0.21)	1.02 (0.15)	0.2
				Wound infection, %	3.2	1.8	0.3
				Return to walking normally, days	1.93 (0.53)	1.96 (0.64)	0.8
				Mean (SD) pain, VAS			
				<u>At 1 h</u>	<u>2.27 (0.87)</u>	<u>2.16 (0.75)</u>	<u>0.1</u>
<u>At 6 hours</u>	<u>2.39 (1.1)</u>	<u>2.17 (1.37)</u>	<u>0.006</u>				
<u>At 24 hours</u>	<u>1.93 (0.64)</u>	<u>1.77 (1.1)</u>	<u>0.001</u>				

Table 1-5 Summary of key clinical studies comparing open versus laparoscopic inguinal hernia							
Study	Setting	Study details	Procedure (year performed)	Summary of clinical findings Endpoint	Open	MIS	P value
				At 7 days	<u>1.75 (0.72)</u>	<u>1.44 (0.96)</u>	<u>0.002</u>
				At 6 weeks	<u>1.46 (0.54)</u>	<u>1.27 (0.92)</u>	<u>0.002</u>
Köckerling et al. 2015 ⁷⁶	Germany	Retrospective analysis of prospectively collected registry data, n=10,887 TAPP, n=6,700 TEP	TEP versus TAP for primary unilateral inguinal hernia	Peri-operative Mean (SD) operating time, minutes	TAPP <u>53 (24)</u>	TEP <u>49 (22)</u>	<u><0.0001</u>
				Post-operative Mean (SD) LoS, days	<u>1.93 (2.22)</u>	<u>1.88 (2.19)</u>	<u><0.0001</u>
				Intraoperative complications, %	1.40	1.19	0.2763
				Post-operative complications, %	<u>3.97</u>	<u>1.70</u>	<u><0.0001</u>
				Reoperation, %	0.90	0.82	0.6165
				Infection, %	0.04	0.04	1
				Bleeding, %	<u>0.82</u>	<u>1.15</u>	<u>0.03</u>
Shah et al. 2011 ⁷¹	United States	Retrospective chart review, n=61 open mesh repair, n=111 laparoscopic mesh repair (n=76 TEP, n=35 TAPP)	Open versus laparoscopic (TAPP or TEP) mesh repair for recurrent inguinal hernia	Peri-operative Mean (SD) operating time, minutes	TAPP 70 (26)	TEP 66 (25)	0.44
				Post-operative Overall complications, %	11.4	17.1	0.44
				Chronic pain, %	11.4	10.5	0.89
				Recurrence, %	5.7	2.6	0.59
Gass et al. 2012 ⁷⁷	Switzerland	Retrospective database analysis, n=3,457 TEP, n=1,095 TAPP	TEP versus TAPP for unilateral inguinal hernia repair (1995–2006)	Peri-operative Mean (SD) operating time, minutes	TAPP <u>59 (27)</u>	TEP <u>67 (31)</u>	<u><0.0001</u>
				Conversions to open, %	<u>0.2</u>	<u>1.0</u>	<u>0.011</u>
				Intra-operative complication, %	<u>0.9</u>	<u>1.9</u>	<u>0.029</u>
				Post-operative Surgical complication, %	<u>0.8</u>	<u>2.3</u>	<u>0.003</u>
				General complication, %	0.4	0.7	0.195
				Mean (SD) LoS, days	<u>2.9 (2.4)</u>	<u>2.3 (6.4)</u>	<u>0.002</u>

LoS, length of stay; RCT, randomized controlled trial; SD, standard deviation; SSI, surgical site infection; TAPP, transabdominal preperitoneal; TEP, total extraperitoneal inguinal hernioplasty; VAS, visual analog scale

Table 1-6 Summary of key studies comparing economic outcomes of open versus laparoscopic inguinal hernia								
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	Laparoscopic	P value
Netto et al. 2014 ⁷⁸	Canada	Retrospective review of a prospectively maintained database, n=117 open, n=94 laparoscopic	Elective open or laparoscopic inguinal herniorrhaphy (2009–2011)	CAD (2012)	Unilateral inguinal herniorrhaphy, median (IQR)			
					<u>Day surgery</u>	<u>261 (141,337)</u>	<u>323 (257, 373)</u>	<u><0.001</u>
					<u>Total OR</u>	<u>2,399 (2,016, 2,763)</u>	<u>3,092 (2,476, 3,509)</u>	<u><0.001</u>
					<u>Total</u>	<u>3,270 (2776, 3,819)</u>	<u>3,724 (3,163, 4,375)</u>	<u><0.001</u>
					Bilateral inguinal herniorrhaphy, median (IQR)			
					Day surgery	221 (145, 363)	266 (234, 365)	0.222
					Total OR	3,472 (3,118, 3,703)	3,941 (3,196, 4,316)	0.145
					<u>Ward</u>	<u>66 (33, 297)</u>	<u>0 (0, 63)</u>	<u>0.012</u>
					Total	4,574 (4,215, 6,361)	4,663 (4,179, 5,228)	0.827
					Eklund et al. 2010 ⁷⁹	Sweden	Cost minimization analysis based on RCT data n=705 open (Lichtenstein), n=665 laparoscopic (TEP)	TEP versus Lichtenstein procedure for primary unilateral inguinal hernia
<u>Hospital cost</u>	<u>1,952</u>	<u>2,663</u>	<u><0.001</u>					
Community cost	2,250	1,671	NR					
Total cost	4,202	4,333	NR					
Recurrence or complication (5 years)								
Hospital cost	2,062	2,760	NR					
Community cost	1,754	2,466	NR					
Total cost	3,816	5,225	NR					
Wittenbecher et al. 2013 ⁷³	Germany	Retrospective database analysis	TEP and TAPP versus open surgery with mesh for non-incarcerated inguinal hernia repair	EUR (2008)	TEP versus open mesh, mean (SD) costs			
					<u>Total cost</u>	<u>1,987 (697)</u>	<u>1,633 (436)</u>	<u><0.0001</u>
					<u>Operating theatre</u>	<u>987 (448)</u>	<u>730 (269)</u>	<u><0.0001</u>
					Anesthesia	305 (141)	294 (98)	0.135
					<u>Ward</u>	<u>644 (220)</u>	<u>552 (210)</u>	<u><0.001</u>

Table 1-6 Summary of key studies comparing economic outcomes of open versus laparoscopic inguinal hernia								
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	Laparoscopic	P value
					TAPP versus open mesh, mean (SD) costs			
					<u>Total cost</u>	<u>2,231 (727)</u>	<u>2,069 (547)</u>	<u>0.0148</u>
					Operating theatre	1,024 (419)	1,032 (355)	0.7821
					Anesthesia	402 (159)	400 (110)	0.5748
					<u>Ward</u>	<u>699 (318)</u>	<u>551 (205)</u>	<u><0.0001</u>
Smink et al. 2009⁷	United States	Retrospective study of outpatient hernia repair cases (n=11,351 open; n=46,821 laparoscopic)	Open versus laparoscopic inguinal hernia repair	USD (2002/3)	<u>Total hospital charges</u>	<u>8,854</u>	<u>12,860</u>	<u><0.001</u>
					Total charges, ambulatory surgery centers	3,575	6,973	NR
Bourgon et al. 2015⁸⁰	United States	Retrospective cohort study, n=4,710 open (loco-regional anesthesia), n=7,905 open (general anesthesia), n=3,203 laparoscopic	Open (under general or loco-regional anesthesia) versus laparoscopic inguinal hernia repair (2009–2010)	USD (2009–2010)	<u>Total (95% CI) mean adjusted charges</u>	Locoregional anesthesia <u>6,845</u> <u>(6,746, 6,945)</u>	<u>11,340</u> <u>(11,124, 11,559)</u>	<u><0.001</u>
						General anesthesia 7,839 (7,752, 7,926)		
Tadaki et al. 2016⁶⁷	United States	Retrospective database study, n=5,468 open, n=775 laparoscopic	Open versus laparoscopic hernia repair (2008–2011)	USD (year not stated)	<u>Median (IQR) total direct costs</u>	<u>4,360</u> <u>(3,148, 6,416)</u>	<u>5,105</u> <u>(3,778, 7,140)</u>	<u><0.001</u>
					<u>Median (IQR) surgical supplies</u>	<u>717</u> <u>(483, 1097)</u>	<u>1,361</u> <u>(767, 2,025)</u>	<u><0.001</u>
					Median (IQR) OR services	1,334 (1,063, 1,698)	1,389 (1,206, 1,728)	0.250
					<u>Median (IQR) other surgical</u>	<u>237 (158, 334)</u>	<u>304 (175, 437)</u>	<u><0.001</u>

Table 1-6 Summary of key studies comparing economic outcomes of open versus laparoscopic inguinal hernia								
Study	Setting	Study details	Procedures	Currency (Cost year)	Cost Outcome	Open	Laparoscopic	P value
Comparison of TAPP versus TEP						TAPP	TEP	
Bansal et al. 2013⁷⁵	India	Randomized trial of TAPP versus TEP, n=160 TEP, n=154 TAPP	TAPP versus TEP for uncomplicated groin hernia (2007–2012)	INR (year not stated)	Mean total cost	13,932 (6,849–33,189)	13,484 (7,827–24,949)	0.2

CI, confidence interval; IQR, interquartile range; OR, operating room; PACU, post-anesthesia care unit SD, standard deviation; TAPP, transabdominal preperitoneal; TEP, total extraperitoneal inguinal

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