Inguinal Hernia Mesh Repair: The Factors to Consider When Deciding Between Open Versus Laparoscopic Repair

Sri Vallabh Reddy Gudigopuram 1, Ciri C. Raguthu 2, Harini Gajjela 3, Iljena Kela 3, Chandra L. Kakarala 4, Mohammad Hassan 5, Rishab Belavadi 6, Ibrahim Sange 7, 8

Introduction And Background
Groin hernias arise from a defect in the abdominal wall and consist of inguinal and femoral hernias [1]. The lifetime risk of acquiring a groin hernia is 27% for men and 3% for women [2]. The risk escalates with age, and the frequency of hernia repair increases from 0.25% at age 18 years to 4.2% at age 75 to 80 years [2].

Inguinal hernias could be of predominantly two types - direct or indirect based on their site of herniation to the inferior epigastric vessels (IEV) and Hesselsbach’s triangle [3]. More than 90% of all inguinal hernias occur in males. Femoral hernias are noticeably more common in females compared to males; however, less than 1% of all inguinal hernias are present in females as compared to males [4].

Keywords: General Surgery, chronic pain, recurrence rate, outcomes, laparoscopic inguinal hernia repair, open inguinal hernia repair

Categories: General Surgery, chronic pain, recurrence rate, outcomes, laparoscopic inguinal hernia repair, open inguinal hernia repair

Abstract
Inguinal hernia repair is one of the most commonly performed surgical procedures worldwide. An inguinal hernia occurs due to a defect in the abdominal wall, which allows the abdominal contents to pass through it. Although the placement of mesh over the defect is the gold standard to close the defect, there are various approaches to achieving it, out of which two of the most widely accepted techniques are laparoscopic inguinal hernia repair (LHIR) and open inguinal hernia repair (OHIR). However, the approach of choice widely fluctuates with regards to various factors such as patient history, type of hernias, and surgeons’ preference. It is imperative to understand the variations in outcomes of different approaches and how best they fit an individual patient in deciding the technique to be undertaken. This article has reviewed many studies and compared the two techniques in terms of chronic pain, the time required to return to activity, rate of recurrence, and cost-effectiveness.

Review

How to cite this article
Gudigopuram S, Raguthu C C, Gajjela H, et al. (November 16, 2021) Inguinal Hernia Mesh Repair: The Factors to Consider When Deciding Between Open Versus Laparoscopic Repair. Cureus 13(11): e19628. DOI 10.7759/cureus.19628
The types of groin hernias are defined based on their anatomic relation to the surrounding structures. Direct inguinal hernias occur due to laxity of the inguinal canal floor and present above the inguinal ligament, medial to the IEV, and within the Hesselbach’s space. Indirect inguinal hernias usually occur due to the forced opening of Processus Vaginalis by increased intraabdominal pressure and present above the inguinal ligament lateral to the IEV and outside of the Hesselbach’s triangle [3,13]. Femoral hernias occur due to weakness in the femoral canal and present below the inguinal ligament and medial to femoral vessels [13].

The establishment of mesh in the late 1960s has transformed the repair of groin hernias. Since then, multiple approaches to repair the defect have been described. They include tension-free mesh repair via the open inguinal hernia repair (OHR) and the laparoscopic inguinal hernia repair (LIHR) [3,14]. The success of an inguinal hernia repair depends on several factors such as hernia recurrence, infection rate, neuralgia, and the rate of complications [15].

### Laparoscopic inguinal hernia mesh repair

The first LIHR was introduced by Ralph Ger and colleagues in 1982 and gained popularity in late 1990. They had performed on dogs by repairing the patent processus vaginalis [16]. The laparoscopic approaches are primarily of two types - transabdominal preperitoneal repair (TAPP) and total extraperitoneal repair (TEP) [17]. In 1992, Arregui and colleagues first introduced the TAPP approach, and the placement of mesh in this approach requires access into the peritoneal cavity [18]. In 1993, McKernan and colleagues first performed the TEP approach, which requires preperitoneal dissection and mesh placement without entering the abdominal cavity [19]. As per the latest literature, the outcomes in terms of postoperative pain, overall complications, and recurrence rates were similar in both TAPP and TEP. Hence, the choice of technique depends upon the surgeon’s skill, preference, and experience [20,21]. The overall advantages of the laparoscopic approach are as follows [3,22,23].

- Repair of recurrent inguinal hernias.
- Minimal post-operative and chronic pain.
- Earlier return to daily life activities.
- Repair of bilateral inguinal hernias without an increase in morbidity.

The laparoscopic approach is very beneficial in the repair of recurrent inguinal hernias that have been previously repaired with a traditional open anterior approach as the laparoscopic posterior approach avoids the significant scar tissue and allows the surgeon to approach from a previously untouched space [3,20]. LIHR has shown a decrease in chronic pain and the time required to return to full activity when performed in recurrent inguinal hernia patients [23]. Pisanu et al. conducted a meta-analysis in 2015, which included seven studies comparing laparoscopic and open (Lichtenstein) approaches. A total of 647 patients with recurrent inguinal hernias were randomized to undergo either technique. Among them, 335 underwent the Laparoscopic (TAPP/TEP) technique and 314 open (Lichtenstein) technique. The analysis revealed that 9.2% of patients in the laparoscopic group and 21.5% in the open group complained of chronic pain. At the same time, the patients in the laparoscopic group required 13.9 days and patients in the open group 18.4 days to return to work. These findings concluded that laparoscopic repair reduces chronic pain and the time required to return to work [24].

Bilateral inguinal hernias can occur in approximately 8% to 30% of patients in whom LIHR has proved beneficial in decreasing the recurrence and the risk of complications associated with it [20,25]. A study conducted in 2013 evaluated and compared the treatment outcomes of the bilateral inguinal hernia repair by a laparoscopic (TEP) approach and open (Lichtenstein) approach techniques. A total of 325 patients with bilateral inguinal hernias hospitalized at that institution between 2006 and 2011 were analyzed based on their records. Among them, 234 cases underwent a laparoscopic approach, and 91 patients underwent an open approach. The analysis showed complications in 2.5% of the cases in the laparoscopic group and 27.4% cases in the open group. The study stated that the laparoscopic approach had a 10-fold decrease in complications and morbidity than the open repair and concluded that laparoscopic repair is the gold standard for bilateral inguinal hernias [26].

LIHR also boasts an optimistic postoperative course by decreasing the incidence of post-surgical chronic pain and the time required to return to work [27,28]. Eklund et al. performed a randomized multi-center study with a five-year follow-up were performed in 2010 on a group of adult men with primary inguinal hernia. The study compared the frequency of chronic postoperative pain categorized into mild, moderate, or severe after the laparoscopic (TEP) repair and open (Lichtenstein) repair. Of 1,570 out of 1,512 randomized patients, 665 underwent TEP, and 705 underwent an open repair. With the results of 1.9% in the TEP group and 5.5% in the open group with moderate to severe pain after five years, the study concluded that laparoscopic hernia repair had been associated with less chronic pain than an open hernia repair [28]. The above-mentioned study also assessed the short-term complications, reoperations, postoperative pain, and time to resumption to normal activity after primary inguinal hernia repair in both laparoscopic and open groups. It concluded that the laparoscopic (TEP) group returned to normal activities earlier than the open.
However, LIHR has some limitations with regards to the recurrence rate as it was significantly higher after laparoscopic repair than open repair in primary hernias [30]. A randomized study was done on men above 18 years of age with an inguinal hernia at 14 veterans’ affairs (VA) medical centers. The primary outcome of the study was a recurrence of inguinal hernia at a two-year follow-up. A total of 2,164 patients were randomized, out of whom 1,983 underwent surgery, and a two-year follow-up was completed in 1,696 patients. Among them, 862 underwent laparoscopic approach and 854 underwent open approach. The study concluded that the recurrence was more common in the laparoscopic group (10.1%) than in the open group (4.9%) [30]. These studies on LIHR are summarized in Table 1.

Another drawback of laparoscopic repair is the lengthy operative time that the surgeon usually requires to carry out the procedure [24]. The use of general anesthesia as a part of laparoscopic surgery restricts patients with cardiac or pulmonary co-morbidities from undergoing the procedure relative to the open approach, which can be performed under local anesthesia [3,23]. A prospective randomized study performed in 2003 studied 25 patients in the open group and 25 patients in the TEP group. The study had revealed that the laparoscopic (TEP) repair took 75.72 +/- 31.6 min, which was significantly longer than the open repair, which took 54 +/- 15 min to perform the procedure [31]. However, in the analysis between TAPP and TEP, the TEP technique had a longer operative time due to its smaller intraoperative field and increased risk of bleeding while dissecting the pre-peritoneal space. For this reason, the learning curve is much higher for the TEP technique than the TAPP technique. But, at the same time, the TAPP approach is associated with abdominal organ injury due to its wide intraoperative field [32]. Hence, commonly the laparoscopic procedures are associated with an increased risk of complications such as hemorrhage, bowel, bladder, and vascular injuries [33].

According to a review of the latest research studies, certain outcomes such as recurrence were likely influenced by subjective factors such as experience and the skills of the operating surgeon [34]. Compared to the open approach, the learning curve for the laparoscopic repairs is around 50-100 cases, which is more cumbersome to master [27]. In terms of operating time in the TEP approach, a surgeon needs a minimum of 50 cases to reach the plateau and 60 cases or more to limit the complications, recurrence, and conversion rate [35]. A population-based retrospective cohort study performed in Canada identified 95,301 adults using linked administrative databases who underwent primary inguinal hernia repair (85.4% open approach vs.
Lichtenstein was -3.3, and TEP vs. Lichtenstein was -3.6. Therefore, they concluded that the Lichtenstein postoperative chronic pain, the TAPP and TEP had an RR=0.36 and 0.36, respectively, vs. the Lichtenstein laparoscopic patients had less postoperative pain according to the visual analog scale. In terms of Lichtenstein repair, 1,296 underwent TAPP, and 3,012 underwent TEP repair. The analysis revealed that the approaches. The study included thirty-five trials consisting of 7,777 patients. Among them, 3,496 underwent meta-analysis of Randomized control trials were conducted in 2021 to evaluate the effective inguinal hernia concerning chronic postoperative pain and the time required to return to work. The same findings can be paired with a study performed by Schneider et al., which aimed to analyze and compare the costs of laparoscopic repair and open Lichtenstein repair. They reviewed multiple cases performed by four trainees from three different hospitals to the same number of procedures performed by the open hernia repair because of its usefulness in any patient with any hernia. It also had a short learning curve and reliable outcomes with a low recurrence rate than other open tissue repair techniques. Many studies were performed to prove the effectiveness of Lichtenstein over other tissue repairs. One such study was done in 2002, which gathered information from electronic databases. It had conducted 62 relevant comparisons in 58 trials which included 11,174 participants. Among them, 6,901 had individual patient data, 2,390 had supplementary aggregated data, and 1,883 had published data. The analysis showed that 88 in 4,426 of the mesh repair vs. 167 in 3,795 of the non-mesh repair had a hernia recurrence, and 120 in 2,368 in the mesh group vs. 215 in 1,998 in the non-mesh group had persistent pain concluding that mesh repair is associated with a low recurrence rate and less persistent pain than the non-mesh repair. However, the use of mesh repair was not widespread until 1984, when Lichtenstein first coined the term "tension-free" repair. Since then, the Lichtenstein open mesh repair has been the most widely accepted open hernia repair because of its usefulness in any patient with any hernia. OIHR also has benefits in terms of operative time, use of local anesthesia, and cost-effectiveness. Dhankar et al. performed a prospective randomized trial to compare the outcomes of LIHR and OIHR in terms of anesthesia and cost-effectiveness. The study recruited 72 patients, among whom 56 patients were randomized to the LIHR group and 56 to the OIHR group. After performing a per-protocol analysis, the study concluded that the OIHR had a shorter operating time and lower cost to anesthetics. It stated that open repair would be the best option to perform in developing nations, as long-term patients' comfort was equal. The same findings can be paired with a study performed by Schneider et al., which aimed to analyze and compare the costs of laparoscopic repair and open Lichtenstein repair. They reviewed multiple cases performed at two hospitals and concluded that the laparoscopic procedure would cost 852 US dollars more than the open Lichtenstein repair. But, when compared to laparoscopic repair (TAPP and TEP), the open Lichtenstein repair has a drawback concerning chronic postoperative pain and the time required to return to work. A systematic review and meta-analysis of Randomized control trials were conducted in 2021 to evaluate the effective inguinal hernia approaches. The study included thirty-five trials consisting of 7,777 patients. Among them, 3,496 underwent Lichtenstein repair, 1,296 underwent TAPP, and 3,012 underwent TEP repair. The analysis revealed that the laparoscopic patients had less postoperative pain according to the visual analog scale. In terms of postoperative chronic pain, the TAPP and TEP had an RR=0.36 and 0.36, respectively, vs. the Lichtenstein repair. Regarding the time required to return to work, the weighted mean difference among TAPP vs. Lichtenstein was -3.3, and TEP vs. Lichtenstein was -3.6. Therefore, they concluded that the Lichtenstein...
was inferior to laparoscopic among the outcomes mentioned above [50]. As mentioned previously, hernia recurrence is a chronic complication, and it is the main determining factor for a successful hernia repair, and the rate of recurrence is also a beneficial outcome in judging a technique [51]. Sevinc et al. conducted a prospective randomized study in 2019 to compare the postoperative outcomes of the LIHR and the OIHR. It included 302 patients with an inguinal hernia, 147 underwent TEP repair, and 155 underwent OIHR. After a mean follow-up for 40.95 months, the recurrence rate was similar in both groups [52]. Although the open approach has some drawbacks in terms of chronic pain and recovery time, the overall complication rate was almost equal to the laparoscopic approach [53]. Kargar et al. performed a randomized study that aimed to compare the short-term complications of LIHR and Lichtenstein repair. The study included 120 patients who underwent inguinal hernia repair, among whom 60 were randomized to LIHR and 60 into OIHR. The subjects were followed for six weeks and assessed for hematoma/seroma, urinary retention, and wound infection during the hospital stay. The study showed that the differences in these outcomes among the two groups were not statistically significant and hence concluded that both approaches have no difference in the rate of these complications [54]. The articles on OIHR are summarized in Table 2.

| STUDY | DESIGN | SUBJECTS | STUDY OBJECTIVES | RESULTS | CONCLUSION |
|-------|--------|----------|------------------|---------|------------|
| Dhankar et al. (2014) [48] | Prospective randomized trial | 72 patients with inguinal hernia. | To compare the open approach and laparoscopic approach in terms of anesthesia, operative time, and cost. | The open approach had a shorter operating time, usage of local anesthetic in the open approach is associated with lesser cost, and patients in both groups had the same level of comfort in the long term. | Due to the low cost of anesthetics, same long-term comfort of patients it is recommended that open repair would be best in resource-scarce countries. |
| Aiolfi et al. (2021) [50] | Meta-analysis | Thirty-five trials consisted of a total of 7,777 patients with inguinal hernia. | Evaluate and compare the laparoscopic and open approaches | The chronic pain and TRRDA were less in the LIHR group than the OIHR group. | The Lichtenstein approach was inferior to the laparoscopic approach. |
| Sevinc et al. (2019) [52] | Prospective randomized study | 302 adult patients with inguinal hernia. | To compare postoperative outcomes in Open and Laparoscopic approaches. | After a mean follow-up of 40.95 months, both groups had a similar recurrence rate. | The open approach and laparoscopic approach had the same recurrence rate. |
| Kargar et al. (2015) [54] | Randomized trial | 120 patients with inguinal hernia. | To compare short-term complications of the open approach and the Laparoscopic approach. | After a follow-up of 6-weeks, the rate of hematoma/seroma, urinary retention, wound infections were not statistically significant. | There is no difference in the rate of immediate complications between the open approach and the laparoscopic approach. |

**TABLE 2: Summary of included studies regarding the outcomes of open inguinal hernia repair.**

LIHR, Laparoscopic Inguinal Hernia Repair; OIHR, Open Inguinal Hernia Repair; TRRDA, Time Required to Return to Daily Activities.

Therefore, when performed by training residents, the outcomes of the OIHR are almost equal to the experienced surgeon. The technique’s feasibility, easy learning curve, and cost-effectiveness make it the most widely accepted approach to repair a hernia [44].

**Limitations**

The article discusses only the generalized overview of the outcomes mentioned above. It does not acknowledge the specific factors as to why those outcomes occur. Another major limitation is that it included studies of inguinal hernia only on men but did not include female patients and pediatric patients.

**Conclusions**

Today every conventional technique is shifting towards a modern, minimally invasive technique with Inguinal hernia repair being one of them. In this article, we have referred to multiple studies to describe the fate of outcomes such as postoperative pain, chronic pain, the time required to return to normal activities, and complications with regards to the open approach and the laparoscopic approach. This article gives a
Other relationships or activities that could appear to have influenced the submitted work. The authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

**References**

1. Shakil A, Aparicio K, Barta E, Munoz K: Inguinal hernias: diagnosis and management. Am Fam Physician. 2020, 102:487-92.
2. Itani KM, Fitzgibbons R: Approach to groin hernias. JAMA Surg. 2019, 154:551-2. 10.1001/jamasurg.2018.5564
3. Bax T, Sheppard BC, Crass RA: Surgical options in the management of groin hernias. Am Fam Physician. 1999, 59:145-56.
4. Rutkow IM, Robbins AW: Demographic, classificatory, and socioeconomic aspects of hernia repair in the United States. Surg Clin North Am. 1993, 73:413-26. 10.1016/s0039-6109(16)4027-5
5. Lau H, Fang C, Yuen WK, Patil NG: Risk factors for inguinal hernia in adult males: a case-control study. Surgery. 2007, 141:262-6. 10.1016/j.surg.2006.04.014
6. LeBlanc KE, LeBlanc LL, LeBlanc KA: Inguinal hernias: diagnosis and management. Am Fam Physician. 2013, 87:844-8.
7. van den Berg JC, de Valois JC, Go PM, Rosenbusch G: Detection of groin hernia with physical examination, ultrasound, and MRI compared with laparoscopic findings. Invest Radiol. 1999, 34:739-45. 10.1097/00004424-199912000-00002
8. Alam A, Nice C, Uberti R: The accuracy of ultrasound in the diagnosis of clinically occult groin hernias in adults. Eur Radiol. 2005, 15:2457-61. 10.1007/s00330-005-2825-7
9. Robinson A, Light D, Kasim A, Nice C: A systematic review and meta-analysis of the role of radiology in the diagnosis of inguinal hernia. Surg Endosc. 2013, 27:11-8. 10.1007/s00464-012-2412-3
10. Miller J, Cho J, Michael MJ, Saouaf R, Towfigh S: Open approach: a preliminary report. JAMA Surg. 2014, 149:1077-80. 10.1001/jamasurg.2014.484
11. Fitzgibbons RJ Jr, Giobbie-Hurder A, Gibbs JQ, et al.: Watchful waiting vs repair of inguinal hernia in minimally symptomatic men: a randomized clinical trial. JAMA. 2006, 295:285-92. 10.1001/jama.2006.218
12. Fitzgibbons RJ Jr, Forse RA: Clinical practice. Groin hernias in adults. N Engl J Med. 2015, 372:576-63. 10.1056/NEJMc1404068
13. Nyhus LM, Klein MS, Rogers FB: Inguinal hernia. Curr Probl Surg. 1991, 28:401-50. 10.1016/0011-3840(91)90028-n
14. Awad SS, Fagan SP: Current approaches to inguinal hernia repair. Am J Surg. 2004, 188:98-165. 10.1016/j.amjsurg.2004.09.007
15. Gram-Hanssen A, Tolstrup A, Zetner D, Rosenberg J: Inguinal hernia. N Engl J Med. 1990, 323:937-43. 10.1056/NEJM199008023230701
16. Stoppa RE: The treatment of complicated groin and incisional hernias. World J Surg. 1989, 59:143-56. 10.1007/BF00591232
17. Stoppa RE: The treatment of complicated groin and incisional hernias. World J Surg. 1989, 59:143-56. 10.1007/BF00591232
18. Arregui ME, Davis CJ, Yueh O, Nagan RF: Laparoscopic mesh repair of inguinal hernia using a preperitoneal approach: a preliminary report. Surg Laparosc Endosc. 1992, 2:55-8.
19. McKernan JB, Law LS: Laparoscopic repair of inguinal hernia using a totally extraperitoneal prosthetic approach. Surg Endosc. 1993, 7:26-8. 10.1007/BF00591232
20. Scrace A, Melillo P, Pignata G, Di Salvo E, Revaz M, Merola G, Grecia L.: Which is the best laparoscopic approach for inguinal hernia repair: TEP or TAPP? A systematic review of the literature with a network meta-analysis. Surg Endosc. 2012, 26:2855-66. 10.1007/s00464-012-2852-5
21. Ortenzi M, Williams S, Solanki M, Haji A: Laparoscopic repair of inguinal hernia: retrospective comparison of TEP and TAPP procedures in a tertiary referral center. Minerva Chir. 2020, 75:279-85. 10.23736/s0026-4733.20.08518-1
versus Lichtenstein operation for primary inguinal hernia repair - A systematic review and meta-analysis of
Scheuermann U, Niebisch S, Lyros O, Jansen-Winkeln B, Gockel I: 2019, 49:38-41.
10.1016/j.ijsu.2013.03.012
Gopal SV, Warrier A: 2003, 13:261-7.
Lichtenstein herniorrhaphy: cost comparison at teaching hospitals
Schneider BE, Castillo JM, Villegas L, Scott DJ, Jones DB:
10.1007/s00464-012-2585-3
Dhankhar DS, Sharma N, Mishra T, Kaur N, Singh S, Gupta S:
multi-centre study about Lichtenstein technique
Merola G, Cavallaro G, Iorio O, et al.: patch repair for primary inguinal hernias
controlled trials
EU Hernia Trialists Collaboration: 2019, 157:188-93.
Lichtenstein IL, Shulman AG, Amid PK, Montllor MM:
10.1001/archsurg.1962.01300210059012
Patiño JF, García-Herreros LG, Zundel N:
Flament JB, Phillips EH (ed): Springer, New York, NY; 2021.
Bendavid R:
Inguinal Hernia: Four Open Approaches
Timişescu L, Turcu F, Munteanu R, Godea C, Drăghici L, Ginghina O, Iordache V: Treatment of bilateral
inguinal hernia -- minimally invasive versus open surgery procedure. Chirurgia (Bucur). 2013, 108:56-61.
HerniaSurge Group: International guidelines for groin hernia management . Hernia. 2018, 22:1-165.
Ekulund A, Montgomery A, Berghvist L, Rudberg C: Chronic pain 5 years after randomized comparison of
laparoscopic and Lichtenstein inguinal hernia repair. Br J Surg. 2010, 97:600-8. 10.1002/bjs.6904
Ekulund A, Rudberg C, Smedberg S, Enander VK, Leijonmarck CE, Osterberg J, Montgomery A: Short-term
results of a randomized clinical trial comparing Lichtenstein open repair with totally extraperitoneal
laparoscopic inguinal hernia repair. Br J Surg. 2006, 93:1060-8. 10.1002/bjs.5405
Neumayer L, Giobbie-Hurder A, Jonasson O, et al.: Open mesh versus laparoscopic mesh repair of inguinal hernia.
N Engl J Med. 2004, 350:1819-27. 10.1056/NEJMoa040093
Lal P, Kajla RK, Chander J, Saha R, Ramteke VK: Randomized controlled study of laparoscopic total
extraperitoneal versus open Lichtenstein inguinal hernia repair. Surg Endosc. 2005, 17:850-6.
10.1007/s00464-002-8757-6
Tulin A, Slavu I, Braga V, Mihaila D, Alecu L: TAAP vs. TEP in inguinal hernia repair - what is the evidence?
A single center experience. Chirurgia (Bucur). 2019, 114:67-72. 10.21614/chirurgia.114.1.67
Johansson B, Hallerback B, Glise H, Anesten B, Smedberg S, Roman J: Laparoscopic mesh versus open
preperitoneal mesh versus conventional technique for inguinal hernia repair: a randomized multicentre trial
(SCUR Hernia Repair Study). Ann Surg. 1999, 230:225-31. 10.1097/00000658-199908000-00013
El-Dhubaib Y, Corless D, Emmeti C, Deakin M, Slavin J: Laparoscopic versus open repair of inguinal hernia:
a longitudinal cohort study. Surg Endosc. 2013, 27:956-45. 10.1007/s00464-012-2585-3.
Goksoy B, Azamat IF, Yilmaz G, Sert OZ, Onur E: The learning curve of laparoscopic inguinal hernia repair: a
comparison of three inexperienced surgeons. Wideoechir Inne Tech Maloinwazyjne. 2021, 16:536-46.
10.5114/wiitm.2020.100831
Ramjit JK, Dossa F, Stukel TA, Urbach DR, Fu L, Baxter NN: Reoperation for inguinal hernia recurrence in
Ontario: a population-based study. Hernia. 2019, 23:647-54. 10.1007/s10029-018-1822-0
Tetik C, Arregui ME, Dulucq JL, et al.: Complications and recurrences associated with laparoscopic repair of
groin hernias. A multi-institutional retrospective analysis. Surg Endosc. 1994, 8:1516-22; discussion 1522-3.
10.1007/BF00188291
Towfish S: Inguinal Hernia: Four Open Approaches . Surg Clin North Am. 2018, 98:623-36. 10.1016/j.suc.2018.02.004
Woods B, Neumayer L.: Open repair of inguinal hernia: an evidence-based review. Surg Clin North Am. 2008,
88:139-55, ix-x. 10.1016/j.suc.2007.11.005
Bendavid R: The shouldice repair. Abdominal Wall Hernias. Bendavid R, Abrahamson J, Arregui ME,
Flament JB, Phillips EH (ed): Springer, New York, NY; 2021. 10.1007/978-1-4419-8574-3.53
Patiño JF, García-Herreros LG, Zundel N: Inguinal hernia repair. The nyhus posterior preperitoneal
operation. Hernia North Am. 1998, 7:1065-74. 10.1007/s00099-019-01822-0
Usher HC: Hernia repair with Marlex mesh. An analysis of 541 cases . Surg Clin North Am. 1962, 34:325-8.
10.1016/0008-4981(62)90012-1
Lichtenstein IL, Shulman AG, Amid PK, Montllor MM: The tension-free hernioplasty. Am J Surg. 1989,
157:188-95. 10.1016/0002-9440(89)90526-6
Chen DC, Morrison J: State of the art: open mesh-based inguinal hernia repair . Hernia. 2019, 23:485-92.
10.1007/s10029-019-01983-x
EU Hernia Trialists Collaboration: Repair of groin hernia with synthetic mesh: meta-analysis of randomized
controlled trials. Ann Surg. 2002, 235:322-32. 10.1097/00000658-200203000-00003
Shulman AG, Amid PK, Lichtenstein IL: A survey of non-expert surgeons using the open tension-free mesh
patch repair for primary inguinal hernias. Int Surg. 1995, 80:55-6.
Merola G, Cavallaro G, Iorio O, et al.: Learning curve in open inguinal hernia repair: a quality improvement
multicentre study about Lichtenstein technique. Hernia. 2020, 24:651-9. 10.1007/s10029-019-02064-x
Dhankhar DS, Sharma N, Mishra T, Kaur N, Singh S, Gupta S: Totally extraperitoneal repair under general
anesthesia versus Lichtenstein repair under local anesthesia for unilateral inguinal hernia: a prospective
randomized controlled trial. Surg Endosc. 2014, 28:996-1002. 10.1007/s00464-013-3269-9
Schneider BE, Castillo JM, Villegas L, Scott DJ, Jones DB: Laparoscopic totally extraperitoneal versus
Lichtenstein herniorrhaphy: cost comparison at teaching hospitals. Surg Laparosc Endosc Percutan Tech.
2005, 15:261-7. 10.1016/j.sut.2004.07.003
Aiolfi A, Cavalli M, Del Ferraro S, et al.: Treatment of inguinal hernia: systematic review and updated
network meta-analysis of randomized controlled trials [PREPRINT]. Ann Surg, 2021,
10.1097/SLA.0000000000004735
Gopal SV, Warrier A: Recurrence after groin hernia repair revisited. Int J Surg. 2013, 11:374-7.
10.1016/j.ijsu.2013.07.012
Seving B, Damburac N, Güner M, Karahan Ö: Comparison of early and long term outcomes of open
Lichtenstein repair and totally extraperitoneal herniorrhaphy for primary inguinal hernias. Turk J Med Sci.
2019, 49:38-41. 10.5906/tjms.1983-094
Schueermann U, Niebisch S, Lyros S, Jansen-Winkel B, Gockel I: Transabdominal preperitoneal (TAPP)
versus Lichtenstein operation for primary inguinal hernia repair - A systematic review and meta-analysis of
randomized controlled trials. BMC Surg. 2017, 17:55. 10.1186/s12893-017-0253-7

54. Kargar S, Shiryazdi SM, Zare M, Mirshamsi MH, Ahmadi S, Neamatzadeh H: Comparison of postoperative short-term complications after laparoscopic transabdominal preperitoneal (TAPP) versus Lichtenstein tension free inguinal hernia repair: a randomized trial study. Minerva Chir. 2015, 70:83-9.