Chapter 3

Robotic Inguinal Hernia Repair

Sarrina Shraga, Erin Chang, David Radvinsky and Gainosuke Sugiyama*

SUNY Downstate College of Medicine, USA

***Corresponding Author:** Gainosuke Sugiyama, SUNY Downstate College of Medicine, USA, Email: gsugiyamamd@gmail.com

First Published **May 20, 2017**

Introduction

Inguinal hernia is one of the oldest surgical pathologies. Dating back to the ancient times, it has been described in texts as far back as the Mesopotamian Era. While many methods were tried including twisting of the hernia sac and possible cauterizing of the hernia sac, it was Galen, a Roman physician between 130-200, who performed ligation of the hernia sac during orchiectomies with resection of the spermatic cord. This became the primary method of hernia repair until the 19th century with expansion of knowledge of the inguinal anatomy. With the advent of aseptic procedural technique and anesthesia, operative techniques flourished. An Italian surgeon, Dr. Eduardo Bassini published a method of primary repair for direct hernias in 1890, which began a series of adaptations worldwide, leading to the Dr. Earle Shouldice's four layer repair [1]. The repair was an improvement to the previous methods, however, there persisted a high rate of recurrence due to the tension. Releasing incisions along with autologous transfers of tissue are described as in an attempt for a resolution. An effective tension free method was developed by Dr. Irving Lichtenstein with the use of prolene mesh as a bridge between the ligament. In this repair Lichtenstein sutured the prosthetic loosely in place to recreate the canal [1]. In 1987 Dr. Gilbert described a sutureless method of repair using one prosthetic mesh to

insert into the internal ring and another mesh to lay flat along the canal [2]. Drs. Robbins and Rutkow, in 1993, further modernized this sutureless method into what is commonly known as the "plug" and "patch" or Rutkow hernia repair [3]. This sutureless repair leads to tension free repair using prosthetic material.

With the increasing popularity of laparoscopic surgery, minimally invasive inguinal hernia repair became of interest in the 80'and 90's. The first documented laparoscopic inguinal hernia repair was done in 1979 by Dr. Fletcher where he performed this repair primarily without a mesh. During the 1990's, two approaches to laparoscopic inguinal hernia repair were popularized; the Trans Abdominal Pre- Peritoneal (TAPP) repair and the Total Extra Peritoneal (TEP) repair [1]. Both approaches utilize knowledge of the posterior anatomy and can be done with incorporation of mesh or primary repair. The laparoscopic repairs have been found to have equal success rates when compared to open repair [4].

The TAPP repair was further adapted into a robotic surgical approach. The use of robotic surgery for this approach allows the surgeon a three dimensional vision and more degrees of freedom in range of motion. Though robotic surgery has many advantages, it is not the technique of choice by many practicing general surgeons. The usage of robotic platform is relatively recent and there is a scarcity of data on its utility and outcome at this time. At this point in time, it's another minimally invasive tool that can

lead to performing minimally invasive inguinal hernia repair.

Approach to a Patient with Inguinal Hernia

Patients with inguinal hernias most commonly complain of a bulge in the groin which may or may not be associated with pain. After attaining a history, the physical exam for this patient should include palpation of the inguinal canal. The external ring is digitally palpated with gentle pressure using redundant skin of the scrotum, and patient is asked to participate in a valsalva maneuver. In the setting of an inguinal hernia, direct or indirect, a palpable bulge will be identified[5].

Men and women have a lifetime risk of inguinal hernia, 27% and 3% respectively [6]. In a large scale randomized control study observing asymptomatic and minimally symptomatic inguinal hernia, it was determined that watchful waiting is a safe alternative to surgical management in men. In women, however, all hernias should be repaired due to the higher incidence of femoral hernias [30].

In the setting of a primary unilateral hernia, endoscopic or open Lichtenstein repair is recommended. Large scale analysis of open compared to endoscopic repair shows inconclusive data on the difference between

recurrence rate and the presence of chronic pain. This variability is likely due to the heterogeneity of endoscopic repairs, and surgeon experience [8].The choice of endoscopic technique is operator dependent. The outcomes for both TAPP and TEP laparoscopic repair are similar; either technique is acceptable for managing primary inguinal hernia [8]. Another suitable endoscopic technique in this setting is utilizing robotic assisted laparoscopic repair. This is an emerging technique with increasing popularity. The TAPP approach is used for robotic repair. Bilateral primary inguinal hernia is best approached endoscopically if the patient is a candidate . Endoscopic repair has been shown to be the optimal treatment of bilateral inguinal hernia repair [7]. A large scale randomized control trial showed no changes in recurrence rate compared to open approach, with improved cost effectiveness and decreased operative time [9]. While no change in quality of life was noted comparing an open Lichtenstein repair to an endoscopic repair of BHR, there was decreased incidence in reports of chronic pain. There have been concerns regarding the use of mesh in TEP and TAPP repair and its relation to male infertility in the setting of BHR. Evidence does not support this correlation [10].

Patients presenting with recurrent hernias after open repair, endoscopic repair is recommended. Endoscopic repair (TEP or TAPP) is associated with decreased post-

operative pain, shorter recovery time and decreased incidence of chronic pain and reoperation [10]. However, increased operative time and similar rates or recurrence is observed [8]. Similarly, in patients with previous laparoscopic repairs with recurrent hernias, open repairs are recommended [10].

Candidates for robotic hernia repair are healthy, young patients who are able to tolerate pneumoperitoneum. Robotic hernia repairs are most commonly recommended for patients with bilateral or recurrent hernias with previously open repairs. Few contraindications to a robotic repair are grossly contaminated abdominal cavity, and inability to tolerate pneumoperitoneum. In addition, few relative contraindications are previous laparoscopic repairs, ascites, peritoneal dialysis, and large intra scrotal hernias [12].

Though most patients present in the office setting, some present in a more urgent manner with an irreducible bulge. Complicated hernias, such as hernias presenting with incarceration or strangulation, or hernias with obstructive symptoms such as nausea, vomiting, obstipation and constipation require acute intervention. There is limited evidence in endoscopic repair of incarcerated or strangulated hernias. The data available is predominantly based on single surgeon experiences [8].

Technique

Laparoscopic inguinal hernia repair can be done using two approaches: totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP). The TEP repair is done entirely in the preperitoneal space; a balloon dissector is used to develop the space [1]. A mesh is placed in this space without entry into the peritoneum. The TAPP repair is done with entry into the peritoneum and use of the posterior anatomy to incise the peritoneum and dissect the preperitoneal space. The mesh is placed in the same space as in TEP repair. The TAPP repair is completed when the peritoneum is closed for a layered repair [1]. Robotic assisted repair has been described using both of these approaches [11]. The room set-up up for the robotic assisted TAPP repair can vary based on patient positioning. One option is to place the patient in lithotomy position in moderate trendelenburg, docking the robotic platform in between the legs (Figure 1). A second option is to place the patient in supine position, utilizing side docking method, robot can be docked on either side of the patient (Figure 2) [12].

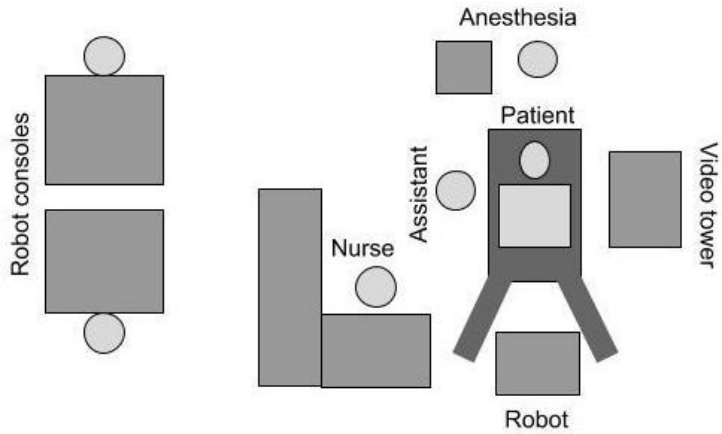

Figure 1: OR setup for lithotomy position.

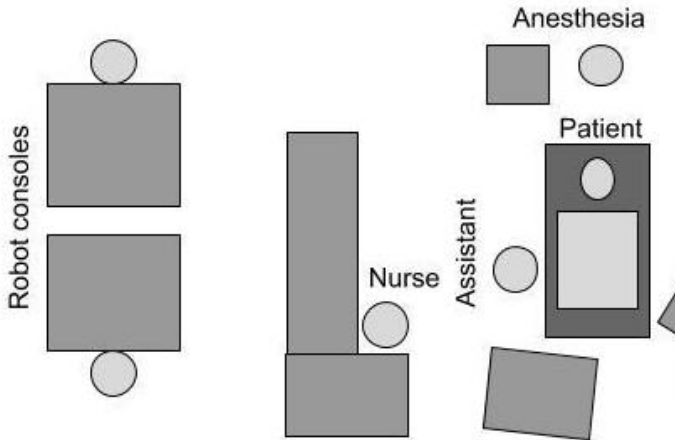

Figure 2: OR setup for supine position.

The procedure is performed using three ports: one in the umbilicus and two ports on either side. The umbilicus is used for entry into the abdomen and initial port placement. Direct visualization allows the surgeon to be sure port placement is correct. The additional trocars are placed 10cm lateral to the umbilicus or at approximately the midclavicular line on the left and right side. It is surgeon preference to place these ports in line with the umbilical port or 2-3cm superior to it [12,13]. This placement allows for optimal triangularization of the groin and greatest mobility for the robotic arms. The robotic platform is docked once all ports are in place. Commonly R1 is fitted with a monopolar/heated shear and R2 with a bipolar grasper/needle driver.

Before beginning the dissection it is important to note surgical landmarks. For inguinal hernia repair first the medial umbilical ligament is identified then with help of the assistant the anterior superior iliac spine (ASIS) is identified. Using electrodissection an incision is made in the peritoneum from the anterior iliac spine to the medial umbilical ligament [12,13]. The preperitoneal fat is dissected bluntly to create a superior and inferior peritoneal flap. The dissection is continued medially to Cooper's ligament. This is an important landmark to then identify the Triangle of Doom found laterally (Figure 3). The vas deferens/spermatic cord or round ligament are then identified; these structures are adjacent (or even adherent) to the hernia sac. Once all anatomic structures are identified

the hernia sac is dissected off the cord. In difficult cases the sac can be resected instead; this is done by ligating the sac at narrowest point and later suturing the peritoneal defect [12,13].

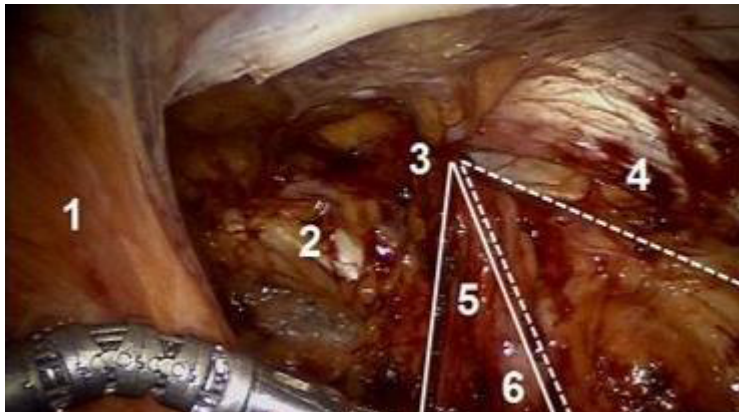

Figure 3: Image from Dominguez et al. review article (12) of the Right inguinal region: 1) supravesical fossa, 2) Cooper's ligament, 3) inferior epigastric vessels, 4) transverse arch, 5) vas deferens, 6) cord elements with gonadal vessels, and 7) peritoneal flap; Solid triangle is triangle of Doom, Dashed triangle is Triangle of pain.

The mesh can be placed once the hernia sac is fully dissected and reduced. The mesh should be 10x15cm to adequately cover defect with overlap [14]. Choice of mesh is operator dependent. One option is a polypropylene mesh with either tacs or anchoring sutures [12]. Another option is a self-fixating mesh, this avoids additional time spent securing the mesh. This self-fixating mesh can be be cut in a "keyhole" pattern to allow spermatic cord and

vas deferens to lay in their natural anatomic location [13]. After mesh is in placed, the peritoneal flaps are sutured with a running stitch. , For patients with bilateral hernias this same technique is repeated for the opposite side. An alternate method described in urology literature is using a single incision across the median umbilical ligaments to repair both hernias [14]. This technique is not commonly used in general surgery practice as it adds increased preperitoneal dissection and a more difficult peritoneal defect to close [12].

Outcomes

When planning management of an inguinal hernia it is important to assess outcomes of all possible interventions. Success rates and complications rates along with individualized care should guide which surgical approach to choose. Currently, though advanced endoscopic options are available for managing inguinal hernia only 41-48% of surgeons are choosing this kind of repair [16-18] Surveyed general surgeons site lack of training, uncertainty in outcome benefit and high cost as reasons to avoid minimally invasive repair; however, there is substantial evidence that much of this is misconception [18].

One of the most feared postoperative complications of inguinal hernia repair is chronic groin pain persisting over 3 months. A 2003 Cochrane review of open and laparoscopic approaches found lower rates of persistent pain

and numbness following laparoscopic repair [4]. When comparing both laparoscopic techniques (TAPP and TEP) a 2005 Cochrane found no significant difference in pain rates between the repairs, though they noted insufficient data [19]. However, a more recent (2013) randomized control trial found postoperative pain rate is significantly higher following TAPP repair [20].

Laparoscopic surgery requires training, there is a learning curve to achieving success. The anatomy is complex and there is more exposure to vascular and visceral organs. Increased difficulty of this approach may have an effect on operative times; a 2003 Cochrane review found that laparoscopic inguinal hernia repair takes an average 15 minutes longer than open repair [4]. This same review found significantly high rates of visceral and vascular injury following laparoscopic repair. Operative time and complication rates decrease with operator proficiency [21,22]Though the learning curve is steep, with presence of an experienced laparoscopic surgeon and appropriate training, newer operators can avoid high conversion rates and postoperative complications [21,23].

There is scarce data on exact trends about use of robotic assisted hernia repair because it is a newer technique; however, there is increased use of the robotic surgery in the US and worldwide. From 2007, the number of robotic assisted surgeries has tripled worldwide and the number of robotic systems installed has grown by 75% in the US

alone [24]. Yet still only a small number of surgeons are using this technique for inguinal hernia repair. Barriers in standardizing robotic surgery for inguinal hernia repair are the same as those for any other new technique: need for high quality data on outcome benefit, learning curve and cost [25].

Robotic assisted inguinal hernia repair has comparable outcomes to laparoscopic repair. When an inguinal hernia is noted during robotic prostatectomy the surgeon can choose to correct it using the robotic platform in the same procedure. In a large retrospective review these patients, who had an inguinal hernia repaired with use of robot during prostatectomy, showed no increase in length of hospital stay and complication rate [15]. This 2013 study proved that robotic assisted inguinal hernia repair is feasible. As this technique became more integrated, several single institution reviews have been published looking at outcomes. All of these small retrospective studies show similar results that robotic assisted inguinal hernia repair has similar complication rate and recurrence rate to laparoscopic approach [13,26-28]. Though there is some retrospective evidence of success a large randomized trial is needed to confirm these findings.

Robotic surgery like laparoscopic surgery also has a learning curve. However, with the added degrees of freedom robotic surgery allows for faster and easier performance of surgical tasks when compared to laparoscopy

[29]. Studies show conflicting data when comparing operating times between the two techniques; this is likely a reflections of the learning curve as these studies from single institutions with one surgeon [27,28]. Though robotic surgery requires mastery of a specific skill set, currently the European Association of Endoscopic Surgeons (EAES) reached a consensus that robotic surgery is superior to laparoscopic in "confined spaces" such as the pelvis and groin [25].

Conclusion

Inguinal hernia repair has changed significantly throughout history. We have come a long way from initial attempts at eradicating the hernia sac to open surgical repair with prosthetic mesh. With the advancement and increased utilization of minimally invasive surgery, the inguinal hernia repair entered a new era in the 1990's. Currently we are beyond laparoscopic approaches; we are implementing use of robotic assisted surgery for inguinal hernia repair. The robotic assisted platform allows the surgeon better visualization and easier manipulation of tissues. These advantages to robotic assisted repair are making it a more commonly used platform but we are still at the beginnings of implementing this technique. These rapid advancements of endoscopic technique have led to gaps in standardized guidelines. Current data justifies safety and utility of robotic assisted inguinal hernia repair, but there is need for larger trials, long terms follow up, and randomized controlled studies to provide stronger

evidence to bring this approach to the forefront of hernia management.

References

1. Matthews R Douglas, Leigh Neumayer. Inguinal Hernia in the 21st Century: An Evidence-Based Review. Current Problems in Surgery. 2008; 45: 261-312.
2. Gilbert Arthur I. Sutureless Repair of Inguinal Hernia. The American Journal of Surgery. 1992; 163: 331-35.
3. Robbins, Alan W, Ira M Rutkow. The Mesh-Plug Hernioplasty. Surgical Clinics of North America. 1993; 73: 501-512.
4. Mccormack Kirsty, Neil Scott, Peter Mnyh Go, et al. Laparoscopic Techniques versus Open Techniques for Inguinal Hernia Repair. Cochrane Database of Systematic Reviews. 2003.
5. Solomon Caren G, Robert J Fitzgibbons, R Armour Forse. Groin Hernias in Adults. New England Journal of Medicine. 2015; 372: 756-763.
6. Gould Jon. Laparoscopic versus Open Inguinal Hernia Repair. Surgical Clinics of North America. 2008; 88: 1073-1081.
7. Chung L, J Norrie, P J O'dwyer. Long-term Follow-up of Patients with a Painless Inguinal Hernia from a Randomized Clinical Trial. British Journal of Surgery. 2010; 98: 596-599.
8. Miserez M, Peeters E, Aufenacker T, Bouillot JL, Campanelli G, et al. Update with Level 1 Studies of the European Hernia Society Guidelines on the Treatment of Inguinal Hernia in Adult Patients. Hernia. 2014; 18: 151-163.
9. Leigh Neumayer, Anita Giobbie-Hurder, Olga Jonasson, Robert Fitzgibbons, Dorothy Dunlop, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med. 2004; 350: 1819-1827.
10. Köckerling F, Bittner R, Kuthe A, Stechemesser B, Lorenz R, et al. Laparo-endoscopic versus Open Recurrent Inguinal Hernia Repair: Should We Follow the Guidelines? Surgical Endoscopy. 2016.
11. Cestari A, AC Galli, MN Sangalli. Totally Extraperitoneal (TEP) Bilateral Hernioplasty Using the Single SiteÂ® Robotic Da Vinci Platform (DV-SS TEP): Description of the Technique and Preliminary Results. Hernia. 2016.
12. Dominguez JE Escobar, Anthony Gonzalez, Charan Donkor. Robotic Inguinal Hernia Repair. Journal of Surgical Oncology. 2015; 112: 310-314.
13. Arcerito M, Changchien E, Bernal O, Konkoly-

Hernia

Thege A, Moon J. Robotic Inguinal Hernia Repair: Technique and Experience. American Surgeon. 2016; 82: 1014-1017.

14. Bittner R, Arregui ME, Bisgaard T, Dudai M, Ferzli GS, et al. Guidelines for Laparoscopic (TAPP) and Endoscopic (TEP) Treatment of Inguinal Hernia [International Endohernia Society (IEHS)]. Surgical Endoscopy. 2011; 25: 2773-2843.
15. Lee Daniel K, Daniel P Montgomery, James R Porter. Concurrent Transperitoneal Repair for Incidentally Detected Inguinal Hernias During Robotically Assisted Radical Prostatectomy. Urology. 2013; 82: 1320-1322.
16. Benjamin Zendejas, Tatiana Ramirez, Trahern Jones, Admire Kuchena, Jaime Martinez, et al. Trends in the Utilization of Inguinal Hernia Repair Techniques: A Population-based Study. The American Journal of Surgery. 2012; 203: 313-317.
17. Ãberg S, K Andresen, J Rosenberg. Surgical Approach for Recurrent Inguinal Hernias: A Nationwide Cohort Study. Hernia. 2016; 20: 777-782.
18. Trevisonno M, Kaneva P, Watanabe Y, Fried GM, Feldman LS, et al. Current Practices of Laparoscopic Inguinal Hernia Repair: A Population-based Analysis. Hernia. 2015; 19: 725-733.

19. Wake Beverly L, Kirsty Mccormack, Cynthia Fraser, Juan Perez, Luke Vale, et al. Transabdominal Pre-peritoneal (TAPP) vs Totally Extraperitoneal (TEP) Laparoscopic Techniques for Inguinal Hernia Repair. Cochrane Database of Systematic Reviews. 2005.
20. Virinder Kumar Bansal, Mahesh C Misra, Divya Babu, Jonathan Victor, Subodh Kumar, et al. A Prospective, Randomized Comparison of Long-term Outcomes: Chronic Groin Pain and Quality of Life following Totally Extraperitoneal (TEP) and Transabdominal Preperitoneal (TAPP) Laparoscopic Inguinal Hernia Repair. Surgical Endoscopy. 2013; 27: 2373-2382.
21. Yoon Young Choi, Zisun Kim, Kyung Yul Hur. Learning Curve for Laparoscopic Totally Extraperitoneal Repair of Inguinal Hernia. Canadian Journal of Surgery. 2012; 55: 33-36.
22. Schouten N, van Dalen T, Smakman N, Elias SG, van de Water C, et al. Is There an End of the â learning Curve â of Endoscopic Totally Extraperitoneal (TEP) Hernia Repair? Surgical Endoscopy. 2012; 27: 789-794.
23. Lal Pawanindra, R K Kajla, J Chander, V K Ramteke. Laparoscopic Total Extraperitoneal (TEP) Inguinal Hernia Repair: Overcoming the Learning Curve. Surgical Endoscopy. 2004; 18: 642-645.

24. Barbash, Gabriel I, Sherry A. Glied. New Technology and Health Care Costs â The Case of Robot-Assisted Surgery. New England Journal of Medicine. 2010; 363: 701-704.

25. Szold, Amir, Roberto Bergamaschi, Ivo Broeders, Jenny Dankelman, et al. European Association of Endoscopic Surgeons (EAES) Consensus Statement on the Use of Robotics in General Surgery. Surgical Endoscopy. 2014; 29: 253-288.

26. Dominguez, Jose E Escobar, Michael Gonzalez Ramos, Rupa Seetharamaiah, Jorge Rabaza, et al. Feasibility of Robotic Inguinal Hernia Repair, a Single-institution Experience." Surgical Endoscopy. 2015; 30: 4042-4048.

27. Waite, Kimberly E, Mark A Herman, Patrick J Doyle. Comparison of Robotic versus Laparoscopic Transabdominal Preperitoneal (TAPP) Inguinal Hernia Repair.Journal of Robotic Surgery. 2016; 10: 239-244.

28. Kudsi, Omar Yusef, Justin C Mccarty, Nivedh Paluvoi, Allan S Mabardy. Transition from Laparoscopic Totally Extraperitoneal Inguinal Hernia Repair to Robotic Transabdominal Preperitoneal Inguinal Hernia Repair: A Retrospective Review of a Single Surgeons Experience. World Journal of Surgery. 2017.

29. Yohannes, Paulos, Paul Rotariu, Peter Pinto, Arthur D Smith, et al. Comparison of Robotic versus Laparoscopic Skills: Is There a Difference in the Learning Curve? Urology. 2002; 60: 39-45.

30. Ramanan B, Maloley BJ, Fitzgibbons RJ. Inguinal hernia: follow or repair?. Adv Surg. 2014; 48: 1-11.