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In Brief

Current strategies for the management of inguinal hernia: What are the available approaches and the key considerations?

Bryan K. Richmond, MD, MBA[a,*], Crystal Totten, MD[b], John Scott Roth, MD[c], Jonathon Tsai, MD[d], Vashisht Madabhushi, MD[e]

Inguinal hernia repair is one of the most commonly performed operations throughout the world. In addition to the 700,000 repairs performed in the United States alone, more than 20 million patients are treated for inguinal hernia each year. The lifetime risk of developing a groin hernia is estimated at 27%-43% in men and 3%-6% in women, most of which will ultimately require repair. After the publication of landmark anatomic treatises by giants such as Dr Astley Cooper and others in the early 1800s, surgeons began performing more anatomically sound tissue repairs (Bassini, Shouldice, McVay) with far better results than the repairs of prior years. Of these, the Shouldice repair has been the most extensively studied and has yielded the best overall results, albeit results that have been challenging to reproduce outside of the Shouldice Clinic. With the development of synthetic mesh in the 1950s, it was realized that its use could effectively reduce recurrence rates. Its routine use by Lichtenstein combined with the simplicity and reproducibility of his landmark technique makes this repair the gold standard for open repairs today. Other iterations of open mesh repairs followed, which included the once popular "plug and patch technique," the bilayer (Gilbert) technique, and open preperitoneal mesh approaches. However, the Lichtenstein repair using a simple flat piece of mesh remains the gold standard and has recently been endorsed as such by expert consensus. Preformed hernia prostheses such as the plug and patch technique and the Gilbert repair are no longer recommended due to their

From the [a]Division of General Surgery, The William J. Maier Endowed Chair of Research, West Virginia University – Charleston Division, Charleston, WV; [b]Division of Gastrointestinal and Minimally Invasive Surgery, Department of Surgery, University of Kentucky, Lexington, KY; [c]Division of Gastrointestinal and Minimally Invasive Surgery, Department of Surgery, Center for Advanced Training and Simulation, University of Kentucky, Lexington, KY; [d]Charleston Area Medical Center, West Virginia University – Charleston Division, Charleston, WV; and [e]Department of Surgery, University of Kentucky, Lexington, KY

* Address reprint requests to: Bryan K. Richmond, MD, MBA, Division of General Surgery, The William J. Maier Endowed Chair of Research, West Virginia University – Charleston Division, 3110 MacCorkle Ave. SE, Room 3023, Charleston, WV 25304.

E-mail address: brichmond@hsc.wvu.edu (B.K. Richmond).

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greater bulk and the necessity of violation of both the anterior and preperitoneal planes for their correct placement.

With the advent of laparoscopy, surgeons gained another tool by which inguinal hernia could be treated. Purported advantages included decreased pain and the ability to cover the entire myopectineal orifice with mesh thereby addressing any coexisting femoral defects as well. Both transabdominal preperitoneal (TAPP) and totally extraperitoneal preperitoneal (TEP) repairs are performed routinely today. With the advent of robotic surgery, an increasing number of inguinal hernia repairs (robotic TAPP [rTAPP]) are being performed via this method as well. But which approach is best? That is the focus of this monograph, but the answer is not a simple one. The existence and widespread use of so many viable approaches suggest that one "best repair" does not exist. Still, we believe that we have identified 5 key metrics that can be applied to the critical evaluation of the advantages and disadvantages of each approach (open Lichtenstein repair, laparoscopic [TAPP and TEP], and rTAPP), including (1) consideration of recurrence rates, (2) considerations regarding pain—both acute and chronic, (3) cost considerations, (4) considerations pertaining to the learning curve, and (5) consideration of special circumstances (are there any specific clinical circumstances which clearly favor one approach over another?).

One of the most critical aspects of any hernia repair is its durability, and suffice it to say that any repair that does not yield low recurrence rates is unlikely to be embraced, regardless of any of its other purported advantages. It is first important to acknowledge that certain patient factors may predispose the patient to a recurrent hernia, and knowledge of this is critically important in order to manage patient expectations. These include female sex, low surgeon volume, disorders of collagen formation, the presence of a sliding hernia, obesity, and performance of the repair under local anesthesia, to name a few.

One must view the reporting of recurrence rates in the literature with a healthy skepticism. Much of the published data are single-center retrospective case series with varying degrees of follow-up, and variable definitions of recurrence. Few randomized controlled trials are available, and consequently this remains a much needed area for future study. Mesh-based repairs remain the standard for adult inguinal repairs. The Shouldice repair, which is the gold standard for tissue-based nonmesh repairs, is still inferior to the Lichtenstein repair in terms of recurrence rates. We do acknowledge, however, the need for familiarity with tissue-based repairs in clinical circumstances, which preclude the placement of mesh, such as gross contamination of the operative field, but the routine use of mesh is considered standard unless such a contraindication exists.

In comparing the recurrence rates from various series, there appear to be no major differences among the four approaches, provided that the surgeon performing the repairs is sufficiently experienced in the referenced repair. Previously published literature has indicated that there is a learning curve associated with all inguinal hernia repair techniques, and that this curve may be steeper and more relevant in the teaching of laparoscopic repairs (TAPP and TEP). For this reason, appropriate training, mentoring, and reporting of one's outcomes is essential, and this consideration is addressed in a subsequent section. Although rTAPP lacks the benefit of the years of study that have been devoted to the Lichtenstein open repair and the laparoscopic TAPP and TEP, the early results of rTAPP have been comparable to the other more extensively studies repairs with respect to recurrence rates. This is logical since the technical aspects of the performance of the rTAPP do not differ significantly for its laparoscopic counterpart. Still, proponents of rTAPP will benefit from continuing to add to the literature on this evolving methodology. The fact that the recurrence rates are comparable between the approaches allows the experienced and well-rounded hernia surgeon to consider the other various factors associated with the available repair methods in choosing the right approach for a given patient—and without sacrificing the durability of the repair.

The problem of chronic groin pain is a significant one. The incidence of chronic groin pain, defined as pain lasting longer than 3 months postoperatively, is estimated to be anywhere from 1% to 12%, with 0.5%-6% reported as severe and debilitating. Factors that may predispose patients to the development of chronic pain include young age, high pain intensity, lower preoperative optimism, impairment of daily activities, operation for recurrence, and genetic predisposition.

In addition, rates of chronic pain are higher after procedures performed by less-experienced surgeons and in those performed outside of high-volume hernia centers.

Extensive dissection/neurolysis of the inguinal nerves should be avoided. Routine neurectomy is not recommended, but "pragmatic" resection of traumatized "at risk" nerves is recommended. Excruciating pain of a neuropathic nature should prompt immediate re-exploration to free what would be assumed to be an entrapped nerve in the hopes of preventing chronic pain. Complications such as hematoma, infection, or seroma are also correlated with an increased incidence of chronic pain.

Mesh use reduces the incidence of groin pain by facilitating a tension-free repair. Flat meshes are preferable to mesh devices. The mesh plug seems especially problematic and expert consensus recommends that its use be avoided. It appears to be that the use of lightweight mesh (LWM) over heavyweight mesh is not associated with higher rates of recurrence and may be associated with a lower sensation of foreign body, a faster recovery time, and less acute postoperative pain. No difference in the incidence of chronic groin with the use of LWM over heavyweight mesh has consistently been demonstrated. Still, the authors feel that advocating the use of LWM is warranted based on the reduction in acute pain alone, once again with no increase in recurrence rates. Mesh fixation has also been shown to affect the incidence of chronic pain and it appears that the less fixation the better. In laparoscopic/robotic repairs, recent guidelines call for minimal or no fixation in both TAPP and TEP repairs, with the exception being large direct defects in which more points of fixation are suggested. The use of tacking devices or sutures (regardless of approach—open, laparoscopic, or robotic) is correlated with greater postoperative pain than in procedures where tissue glue is used, suggesting that the latter be a preferable technique for fixation. The use of self-gripping meshes has not been correlated with a reduction in the development of groin pain. If suture or tack fixation is used, placing the fixation into the periosteum should be avoided, as doing so may increase rates of chronic pain. In TAPP and TEP repairs, lateral fixation should be avoided entirely to avoid the "triangle of pain." Acute postoperative pain should be managed aggressively. The initial oral agents should be a combination of acetaminophen and Non-steroidal anti-inflammatory drugs (NSAIDs), with oral opioids added only if necessary. Infiltration of bupivacaine is beneficial in reducing acute pain and should be placed both subcutaneously and subfascially. Failure to manage acute pain effectively may result in higher rates of chronic pain.

Of the 3 categories of repair, the most extensively studied techniques are open and laparoscopic repairs. With respect to pain, the results of several meta-analyses and systematic reviews suggest a lower incidence of chronic pain in the laparoscopic group. Robotic repairs have shown promise with results comparable to that of laparoscopy relating to acute postoperative pain, but few data exist as to whether or not the rTAPP will offer any advantage in reducing the incidence of chronic pain. The authors strongly encourage that this question be investigated via randomized controlled trials.

Any article addressing the subject of inguinal hernia must consider the cost of the various approaches and measure these costs against the ultimate benefits that a more expensive procedure purports to provide. Although it is simple to look at procedural costs related to equipment and technique, one must also consider the cost of recurrences, time off work, cost of immediate and downstream complications, and the need for long-term specialized treatment for conditions such as chronic groin pain. When these variables are included, it becomes much more difficult to ascertain the superiority of one procedure over another. We will explore the various considerations and their implication on costs in the next few paragraphs.

The Lichtenstein repair is universally agreed upon to be the least expensive repair to perform. It is performed as an outpatient, requires no specialized equipment, and uses an inexpensive polypropylene mesh. When this is compared to laparoscopic repairs, the procedure itself is significantly less expensive, owing to the lack of laparoscopic instrumentation and expensive disposables such as trocars, dissecting balloons, and tracking devices. The specific procedural cost differences are described in the expanded section.

Despite increased procedural costs, some investigators have argued that the benefits of a laparoscopic approach may serve to mitigate the increased costs associated with this method

of repair. One such benefit is decreased pain, both acute and chronic. This has been associated with a shorter return to normal activities and work, as well as alleviation of the costs of treating chronic groin pain. The benefits of a laparoscopic approach have been touted to be even greater in the case of bilateral inguinal hernia repair, once again primarily due to the decreased pain associated with this approach, and this is well supported in the literature. However, the benefits as related to cost are less clear, with conflicting results reported across several large series, with some favoring laparoscopic repair and others favoring the Lichtenstein repair. Because some of these represent opportunity costs rather than recognized expenses it is difficult to accurately compare the repairs in terms of a cost/benefit ratio. Rather, it seems best to say that, at this time and based on the available data, the issue remains controversial.

The rTAPP repair has emerged as an alternative to laparoscopic TAPP and TEP, and is increasingly being used in this setting, although it still represents the minority of repairs performed. Early results suggest equivalent results to the laparoscopic repairs, but with substantially higher costs and increased operative times. The higher costs result primarily from the higher direct costs associated with the use of the robotic platform.

In summary, inguinal hernia repairs costs vary significantly based upon surgical approach. The Lichtenstein repair is associated with the lowest initial costs, but the laparoscopic approaches may be equivalent when comparing total costs and long-term costs. Robotic inguinal hernia repair is associated with overall higher costs than both laparoscopic and open repairs with similar outcomes.

With the emergence of any new technology, the learning curve inherent to the new technology must be considered before its adoption by the surgeon. This is particularly relevant inguinal hernia repair. All of the available repairs under discussion have a learning curve associated with their application and surgeons must be familiar with the factors affecting the extent of proctored learning that is required to achieve proficiency in each type of repair. It is generally accepted that the open Lichtenstein repair is substantially easier to master than the laparoscopic or robotic repairs. This is due to its reliance on common and well-known anatomic landmarks and the absence of the need for special laparoscopic skills. Some studies have suggested that as few as 5 repairs are sufficient to achieve proficiency, although outcomes are better with high-volume surgeons regardless of procedure type.

In contrast, laparoscopic inguinal hernia repairs are generally more difficult to master. The laparoscopic repair is a posterior approach to the abdominal wall, which requires an appreciation of the anatomic landmarks from the undersurface of the abdominal wall. Additionally, the skills required to perform a laparoscopic repair differ from open surgical techniques. As a result, the learning curve is reported to be as high as 100 cases in order to have comparable recurrence rates as expert surgeons, with the first half of the cases being the most critical, although some surgeons obtain competency sooner. TEP repairs are therefore associated with a longer learning curve than the Lichtenstein repair.

With respect to patient outcomes, there is a significantly higher rate of complications with laparoscopic repairs in the initial cases when compared to later cases. A similar trend is noted in recurrence rates, with the initial cases having a recurrence rate of 8%-30% and the later cases with a rate of 0.1%-5.0%.

The learning curve for TAPP repairs appears to be shorter than the TEP repair, possibly due to the familiar transabdominal anatomy of the TAPP relative to other laparoscopic operations and the wider operative field relative to the TEP repair. However, there are far fewer studies evaluating the learning curve associated with TAPP repairs, as compared to TEP repairs.

The use of robotic technology for inguinal hernia repair has recently evolved, although there is limited evidence as to the nature of the learning curve for the procedure. The rTAPP is identical to the laparoscopic TAPP procedure, although the learning curve also requires acquisition of robotic skills. It has been demonstrated, however, that with ascension of the learning curve, rTAPP repairs demonstrate a decrease in operative time eventually equaling laparoscopic TAPP repair times. To date, there are no studies comparing the learning curve for rTAPP repairs with laparoscopic TAPP repairs. Some argue that the learning curve for rTAPP is likely to be shorter due to the advanced optics and wristed instruments associated with the robotic platform—both

of which are purported to result in improved visualization and ease of dissection and suturing In addition, because the anatomy of a TAPP repair is the same regardless of the approach, the robotic learning curve for those proficient in laparoscopic TAPP is likely to be accelerated when compared to surgeons without significant laparoscopic experience. Conversely, it is unknown whether proficiency with rTAPP confers any advantage to ascending the learning curve for traditional laparoscopic inguinal hernia repair. It is clear that further studies are required to evaluate the various learning curves associated with these procedures and the effects of the learning curve on patient outcomes.

In conclusion, the Lichtenstein repair has the shortest learning curve, whereas the TEP and TAPP require significantly more cases to achieve proficiency. There is insufficient evidence to determine where the rTAPP falls on the learning curve continuum. In addition to the advantages and disadvantages of each technique, the surgeon's specific expertise and position on the learning curve should be considered when determining the optimal approach for any inguinal hernia repair.

In any clinical situation, the choice of repair may be affected by surgeon or patient preference and experience, but there may also be clear circumstances in which one technique distinguishes itself as the procedure of choice.

The European Hernia Society guidelines and general consensus for repair of a primary inguinal hernia in men allow the surgeon to choose the most effective and safest approach. The options include open Lichtenstein, endoscopic TAPP, or TEP repair. Plug and patch repairs should be avoided due to complications associated with these repairs and the fact that both the anterior and posterior dissection planes are violated. In younger active men between the ages of 18 and 30 years, the laparoscopic approach is favored since this population gains the most benefit from early mobility and return preoperative function with endoscopic approach. Early studies of rTAPP have suggested to those approach is also reasonable and yields results that are similar to those of laparoscopic TAPP or TEP.

A review of the Danish Hernia Registry noted an increased risk of recurrence after open primary repair in women compared to laparoscopic methods, with 38% of reoperations due to femoral hernia. It is unclear if these femoral defects were either missed during the index open operation or true recurrences. Endoscopic approaches allow for visualization of the femoral space, in addition to routine mesh coverage of the entire myopectineal orifice. Consequently, this allows identification of these femoral hernias, if present, and permits repair at the index operation. Based on these data, expert consensus recommends an endoscopic TAPP or TEP repair in women with inguinal hernia.

A laparoendoscopic approach is recommended for treatment of bilateral inguinal hernias identified preoperatively by physical examination or imaging. The advantages of faster recovery, lower risk of chronic pain, and cost effectiveness are also supported as reasons for a laparoendoscopic approach. There is no clearly demonstrated advantage of the TEP versus TAPP approach for bilateral repairs that is currently supported in the literature. There is a clear advantage, however, for the TAPP approach in identifying an occult contralateral hernia, as this is evident from within the peritoneal space, and allows a diagnostic evaluation of the contralateral side without disrupting the preperitoneal space.

The European Hernia Society recommends an open approach for repair of scrotal hernias. Limited series have been described by expert robotic surgeons who report that, in expert hands the rTAPP approach is preferred over standard laparoscopic approaches, owing to greater ease in dissection, dexterity of sac manipulation, and reduction in the risk of skin complications associated with an open approach. A laparoendoscopic approach—either laparoscopic (TAPP/TEP) or rTAPP—should only be undertaken by an expert in these procedures. Otherwise, an open approach is supported by consensus guidelines.

Many patients present with unilateral or bilateral symptomatic inguinal hernias after prior midline incisions for abdominal exploration or cesarean section. For unilateral hernias, an open approach is appropriate; however, if endoscopic expertise is available, then the TAPP technique is acceptable and is preferred over TEP due to limitations in the use of balloon dissection with previous disruption of the preperitoneal plane. If bilateral hernias are present

without significant known intraabdominal adhesions, then the laparoendoscopic TAPP approach is favored after prior lower midline, either laparoscopic or robotic. Patients with inguinal hernia development after prior major pelvic operations including prostatectomy, cystectomy, or vascular interventions such as aortic-bifemoral graft or femoral-femoral grafts should be offered an open mesh technique as a preferred technique. Complex endoscopic preperitoneal repair can be technically possible in select patient situations, but should only be performed by expert laparoscopic surgeons as these reoperative cases have a steep learning curve.

Individuals identified with cardiac and pulmonary risk factors deemed unfit for general anesthesia with a symptomatic inguinal hernia should undergo an open technique with local or regional anesthesia. Consensus guidelines support same day surgery with an open Lichtenstein operation under local anesthetic for any American society of Anesthesiologists (ASA) classes III and IV individuals. Healthy elderly patients may be offered any of the repairs as other clinical circumstances dictate.

For those patients with a prior open anterior repair, the endoscopic approach during recurrent reoperation is performed in the preperitoneal layer that has not been previously dissected. Consequently, an anterior approach is preferable to a recurrence from a previous posterior (laparoscopic or robotic) repair. If a mesh plug or Gilbert repair device (PHS) was placed at the index operation then the surgeon must anticipate adhesions and mesh products in both the anterior and posterior planes. Laparoscopic and robotic approaches to recurrences after posterior repairs are available but these should only be performed by surgeons with expert experience to avoid injury to the nervous and vascular anatomy. If the primary repair was a tissue repair, then either the anterior or posterior endoscopic or open approach can be used for the recurrent repair.

Acutely symptomatic incarcerated or strangulated inguinal hernias constitute a surgical emergency. Bowel viability should be determined first by diagnostic laparoscopy with reduction of incarcerated or strangulated contents under direct visualization. Most frequently, recovery of bowel or omentum after reduction allows for progression of hernia repair simultaneously via the surgeons preferred technique, either open anterior, TEP, or TAPP repair with mesh. If the bowel is viable but transmural peritonitis is present, then the hernia sac can be ligated with a suture and an open anterior repair performed after desufflation, leaving the peritoneum intact. The decision to implant synthetic mesh vs performing a tissue repair at the time of concomitant bowel resection remains controversial and should be based on the degree of contamination encountered.