

OPEN, LAPAROSCOPIC OR ROBOTIC APPROACH: WHICH IS THE BEST SURGICAL TECHNIQUE FOR INGUINAL HERNIA REPAIR? AN INTEGRATIVE REVIEW

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Abstract: Introduction: the inguinal hernia occurs due to weakness of the abdominal wall, allowing tissue to protrude through vulnerable areas, such as the inguinal canal. It can be congenital, being more common in children, or acquired, prevalent in adults exposed to factors such as physical exertion and aging. The high prevalence of this condition highlights the importance of studying different surgical techniques, such as open, laparoscopic and robotic approaches. Inguinal hernia surgery has evolved from traditional methods, such as those of Bassini and Shouldice, to modern techniques such as tension-free repair with Lichtenstein mesh and, more recently, laparoscopic and robotic approaches. These innovations have reduced invasiveness, providing less pain and faster recovery. However, the choice of the ideal technique still depends on the patient's profile and the surgeon's experience, making understanding these options crucial for clinical success. **Methods:** This integrative review analyzed articles published between 2019 and 2024 in the BVS, PUBMED, and MEDLINE databases, using keywords related to surgical techniques for inguinal hernia. Of the 980 studies identified, after exclusions by specific criteria, 150 were reviewed and 29 included in the final analysis, comparing the open, laparoscopic, and robotic approaches. **Results:** The open approach is indicated for primary, large, or recurrent hernias; open repair involves a direct incision in the inguinal region. Techniques include hernioplasty with tensioning (Bassini) and without tensioning (Lichtenstein). It is simple, requires less equipment, and can be performed under local anesthesia, but recovery is slower and more painful, with a higher risk of complications. The laparoscopic approach became popular in the late 20th century, offering minimally invasive repair with less pain and faster recovery than open hernioplasty. TAPP and

TEP techniques are common, with TAPP being more accessible due to its broad anatomical view. Laparoscopy requires general anesthesia, is more expensive, and has a longer learning curve. The recent technology offered by the robotic approach is ideal for complex cases, combining the precision of robotics with the benefits of laparoscopy. It offers 3D vision and greater control, but its high cost and prolonged learning curve limit its use, and it is reserved for challenging situations.

Discussion: The comparison of techniques for inguinal hernia repair (open, laparoscopic, and robotic) involves aspects such as time, complications, cost, and recovery. The open technique is the most widely used, accessible, and economical, ideal for large hernias and emergencies, but has a slower recovery and greater morbidity. Laparoscopy offers less pain and faster recovery, and is preferred in specialized centers, but requires more skill and equipment. Robotic surgery is precise and suitable for complex cases, but is expensive and has a longer operative time. The choice of technique must consider the patient's profile, the surgeon's experience, and the available resources. **Conclusion:** The choice of technique for inguinal hernia repair must balance safety, efficacy, and cost, considering clinical factors and available resources. The open technique is widely used and cost-effective, but has greater morbidity and recovery time. Laparoscopy offers rapid recovery and good aesthetic results, but requires greater surgical dexterity. Robotic surgery is precise and indicated for complex cases, but is expensive and restricted to specialized centers. Further studies are needed to evaluate robotic surgery.

INTRODUCTION

An inguinal hernia occurs where the aponeurosis and fascia are not completely surrounded by striated muscle, allowing organs or tissues to protrude through a weak point in the abdominal wall [1]. The inguinal region has natural points of weakness, such as the inguinal canal, which serves as a passage for the spermatic cord in men and the round ligament in women. In children, these hernias are often congenital due to failure of the inguinal canal to close after birth [2]. In adults, factors such as excessive physical exertion, obesity, chronic coughing, and aging can weaken the abdominal wall, leading to the development of inguinal hernias [3].

The study and knowledge about the effectiveness of the different surgical techniques for inguinal hernias are crucial to optimize clinical outcomes and provide the best possible care to patients. Each technique—open, laparoscopic, and robotic—has its own advantages and disadvantages, and understanding these differences helps to customize treatment based on the specific needs of each patient [5]. Furthermore, understanding hernias, their causes, and treatments is essential due to their high prevalence and potential for post-repair complications. The high prevalence of inguinal hernias, evidenced by data from DATASUS, which recorded the performance of 2,671,347 hernioplasties in Brazil between 2008 and 2018, makes it essential to know the different surgical techniques for the treatment of this condition [6]. In the United States, approximately 600,000 hernias are repaired annually, and according to The Lancet it is the most common surgical pathology worldwide [6,7]. Ongoing research and analysis of available techniques help ensure that the most effective methods are applied, reducing complications and improving outcomes for a large number of individuals.

Reflecting the progress made throughout the history of surgery, open hernioplasty is marked by significant advances that have transformed the treatment of this condition. In 1871, Eduardo Bassini, an Italian surgeon, introduced an innovative technique that involved suturing the muscle tissue around the hernia site to close the opening [7]. This method was a landmark at the time, as it provided a systematic and structured way to repair hernias, resulting in improved success rates compared to previous methods.

In the 1950s, Earle Shouldice further refined this approach with a multilayer suture technique to reinforce the abdominal wall, offering improved recurrence results and becoming the gold standard for hernia treatment [7].

The evolution continued in the 1970s with tension-free repair, introduced by Stock and Usher and popularized by Irving Lichtenstein. This technique uses a synthetic mesh to cover and reinforce the hernia area without tensioning the surrounding tissues, which has significantly reduced recurrence rates. Furthermore, the tension-free repair technique is easy to teach and reproduce, facilitating its global adoption and becoming the dominant approach for open inguinal hernia repair [7].

Laparoscopy represented a revolution in the treatment of inguinal hernias. The technique was first described by Ger in 1991, who innovated by applying the laparoscopic method for the repair of inguinal hernias. The first laparoscopic techniques for inguinal hernia repair, such as Transabdominal Preperitoneal (TAPP) and Totally Extraperitoneal (TEP), allowed a wide view of the inguinal area and repair using mesh, without the need for large incisions [8]. This resulted in decreased postoperative pain, faster recovery and earlier return to normal activities and work. These advantages have made laparoscopy an

attractive option, especially for patients with bilateral or recurrent hernias [8]. Robotic surgery, although relatively recent compared to laparoscopic surgery, represents the newest frontier in the evolution of techniques for inguinal hernia repair [9]. Its beginnings can be traced back to the urological literature, but it was Dominguez et al. in 2015 who first described it in the general surgery literature [9]. The robotic platform, by providing greater precision, ergonomics and three-dimensional visualization, overcomes the technical limitations of previous approaches; however, it has disadvantages such as an increased learning curve for the surgeon and the high cost of the procedure [9]. The ideal operative approach for inguinal hernia is still a matter of debate. The current study is relevant in that it provides a comprehensive evaluation of the available evidence, allowing the identification of the circumstances in which each approach is most effective [10]. This type of analysis is crucial to guide clinical practice and contribute to the standardization of surgical indications, ensuring better outcomes for patients [10].

METHODS

This is an integrative review conducted based on queries in the following virtual databases: Virtual Health Library (BVS), PUBMED and MEDLINE. As inclusion criteria, articles published between 2019 and 2024, in English, were selected. The search was performed using the following keywords in English: “open inguinal hernia repair”, “laparoscopic inguinal hernia repair”, “robotic inguinal hernia repair”, “surgical technique inguinal hernia” and “inguinal hernia surgery outcomes”. The selection of articles occurred in three stages. Initially, 380 articles were identified. Of these, studies with repetitive themes, inconclusive data, experimental trials, dissertations, theses and conference abstracts were excluded, resulting in 150

articles. These 150 articles were fully reviewed and 29 studies were included in the final analysis, after excluding publications with redundant or repetitive results, inconclusive analyses or with low clinical relevance. From this refinement, the extracted data were reorganized to construct the review and comparison between surgical approaches.

RESULTS

OPEN APPROACH: FUNDAMENTALS AND CHARACTERISTICS

The open approach for inguinal hernia repair involves an incision in the inguinal region, allowing direct access to the hernia for repair. It is especially indicated in patients with primary, large, or recurrent hernias, and is preferred in situations where laparoscopic or robotic techniques are not feasible [11]. There are two main techniques in this approach: (1) Tension Hernioplasty (Bassini, McVay), which are traditional methods that use suturing of anatomical structures, such as muscles and aponeuroses, to reinforce the abdominal wall, and (2) Tension-Free Hernioplasty (Lichtenstein), which uses a polypropylene mesh fixed without tension, reducing postoperative pain and recurrence rates. Currently, the open Lichtenstein technique is widely used more than Tension Hernioplasty [11].

Among the advantages of open hernioplasty, the long clinical experience, the high success rate and the need for less technical complexity and equipment compared to minimally invasive approaches stand out [12]. In addition, the surgery can be performed under local or regional anesthesia, being a viable option for patients with contraindications to general anesthesia. The learning curve for surgeons is shorter compared to laparoscopic and robotic techniques [12]. On the other hand, postoperative recovery tends to be

longer, with more intense pain in the first few weeks. The larger incision increases the risk of surgical wound infection, and there is a greater likelihood of chronic pain and sensory changes due to possible nerve injuries [13]. In addition, the time away from normal activities is generally longer compared to minimally invasive techniques. Total recovery ranges from 2 to 6 weeks, with a risk of complications such as seromas, hematomas, and surgical wound infections [13].

LAPAROSCOPIC APPROACH: FUNDAMENTALS AND CHARACTERISTICS

Laparoscopic inguinal hernia repair is a minimally invasive surgical technique that has become popular since the 1990s due to its benefits, such as less tissue trauma and accelerated recovery [14]. Unlike the open approach, laparoscopic surgery uses small incisions through which trocars are inserted to pass surgical instruments and a camera that provides high-definition internal visualization. This technique is especially indicated for patients with bilateral hernias, recurrent hernias after open surgery, or in cases where rapid postoperative recovery is a priority [14].

There are two main techniques in the laparoscopic approach: The Transabdominal Preperitoneal Technique (TAPP) and the Totally Extraperitoneal Technique (TEP). In TAPP, access is made through the abdominal cavity, with dissection of the peritoneum to reach the preperitoneal space, where the hernia is repaired and the reinforcement mesh is positioned [15]. TEP allows direct access to the preperitoneal space without the need to enter the abdominal cavity, which reduces the risk of intra-abdominal complications [15].

The TAPP (Transabdominal Pre-Peritoneal) technique is widely used in laparoscopic inguinal hernia repair due to its more favorable learning curve. In this approach, the

transabdominal approach provides a broader and more familiar anatomical view, facilitating dissection and understanding of the structures involved [16]. In comparison, the TEP (Totally Extra-Peritoneal) technique requires a more restricted extra-peritoneal access, which makes it technically more complex, especially for less experienced surgeons. This difference in ease of execution makes TAPP a preferred choice, especially in centers where laparoscopy is still developing [16].

In addition, the versatility and visibility provided by TAPP are important factors in its popularity [17]. The technique offers a clear and comprehensive view of the inguinal structures, allowing accurate identification of occult or bilateral hernias. Although TEP has the advantage of avoiding the peritoneal cavity and reducing the risk of intra-abdominal complications, TAPP allows for broader surgical maneuvers, being useful in cases with complications or when it is necessary to approach other structures. Due to its greater dissemination in training and surgical practice, TAPP has consolidated itself as the predominant technique in many centers, creating a cycle of increasing adoption [17].

Among the main advantages of using both techniques, TAPP and TEP, are less postoperative pain, due to less tissue trauma, and faster recovery, allowing an early return to normal activities, usually within 1 to 2 weeks [17]. In addition, the risk of surgical wound infection is reduced, since the incisions are smaller. Another positive point is the broad and detailed visualization of the anatomy during surgery, which is advantageous in cases of complex or bilateral hernias. The technique allows the treatment of bilateral hernias with the same access, offering an efficient solution in cases of this type [17].

However, laparoscopy has some disadvantages, such as greater technical complexity and a longer learning curve for surgeons, in

addition to requiring general anesthesia, which can be a limitation for patients with severe comorbidities.

The cost also tends to be higher, due to the need for specialized equipment and disposable materials [18]. In addition, there is a high risk of intra-abdominal complications, such as visceral and vascular injuries, especially in the TAPP technique [18].

In technical terms, accurate identification and preservation of anatomical structures, such as vessels and nerves, are essential to avoid complications and ensure a good surgical result [18]. Correct use of the reinforcement mesh and its adequate fixation are also essential to reduce recurrence rates[18].

ROBOTIC APPROACH: FUNDAMENTALS AND CHARACTERISTICS

The robotic approach to inguinal hernia repair is an evolution of minimally invasive techniques that combines the precision and control offered by robotic technology with the benefits of laparoscopy [19]. In this method, a robotic system controlled by the surgeon performs precise movements with articulated instruments, providing greater dexterity in restricted spaces and an enlarged internal visualization in 3D. This technique is especially indicated for patients with complex, recurrent or bilateral hernias, and is particularly advantageous in situations that require surgical precision, such as in obese patients or when preservation of anatomical structures is essential [19].

Among the main advantages of robotic surgery are the superior precision of movements, which minimizes the risk of injury to nerves and vessels, and the three-dimensional vision with greater magnification, which improves the perception of anatomy. In addition, the robotic system offers greater comfort to the surgeon, benefiting more

complex procedures [19]. The technique also provides less tissue trauma, resulting in less postoperative pain and faster recovery. On the other hand, disadvantages include high cost, longer learning curve, and limited availability of the technology. Nevertheless, with a lower incidence of chronic pain and complications, the robotic approach stands out as an advanced and effective option for inguinal hernia surgeries, especially in challenging cases [19].

DISCUSSION

To compare the three surgical approaches for inguinal hernia repair (open, laparoscopic, and robotic), several factors are analyzed, including surgical time, complications, cost, and postoperative recovery [19]. The open approach remains the most widely used in regions with fewer resources or for patients with large inguinal hernias and in emergency cases [20]. However, it presents greater morbidity in terms of pain and recovery time. The open technique is the most traditional and widely used. Known for its simplicity, it requires a shorter learning curve and is accessible to most surgeons. It is generally a less expensive technique, both in terms of equipment cost and operative time, and can be performed under local or regional anesthesia, which is especially advantageous for patients with comorbidities [20]. Laparoscopy, in turn, is increasingly the preferred technique in specialized centers due to its shorter hospital stay and recovery time, in addition to presenting superior aesthetic results [20]. However, it requires greater technical skill and experience from the surgeon. Robotic surgery, although it offers advantages such as better ergonomics and precision, is still restricted to centers of excellence due to its high cost. The application of this technique is generally indicated in complex cases where precision is essential, such as in patients with recurrences or with difficult anatomies [20].

The debate about the superiority between the approaches depends on factors such as the availability of resources, surgeon experience, and specific patient characteristics [20]. However, the trend is that laparoscopy will remain the standard for most cases, while robotic surgery may expand as costs decrease and the technology becomes more widely available [20].

Evidence suggests that the routine use of mesh for most inguinal hernias is important. Open mesh-based repairs are probably easier to learn and teach than laparoscopic repairs. Although there is justifiable concern that laparoscopic inguinal hernia repairs may be associated with an increased rate of recurrence, this may not be true for experienced laparoscopic hernia surgeons [21]. For primary unilateral inguinal hernias, laparoscopic techniques are associated with faster recovery and perhaps less long-term pain and numbness.

The direct costs of laparoscopic repairs are higher than those of open repairs, but this cost may be more than offset from a societal perspective by a faster return to normal activities and work. For recurrent bilateral inguinal hernias, the laparoscopic approach appears to have clearer benefits and may be the technique of choice [21].

The RIVAL (Robotic Inguinal vs Transabdominal Laparoscopic Inguinal Hernia Repair) study is currently the only prospective randomized clinical trial directly comparing robotic versus minimally invasive laparoscopic inguinal hernia repair [22]. Initial clinical outcomes demonstrated similarities between the groups in terms of postoperative pain, quality of life, mobility, cosmesis, wound morbidity, and complications [22].

The study suggests that for surgeons who are already proficient in laparoscopic surgery (a traditional minimally invasive technique), there is no justification for using robotic

surgery for uncomplicated unilateral inguinal hernia repair [22]. The reason for this is that robotic surgery offered no clear advantages over laparoscopic surgery, while it was more expensive, time-consuming, and caused more frustration for the surgeon [22].

Therefore, a close analysis of the three operative methodologies is crucial for the modern surgical field. The choice between open, laparoscopic and robotic techniques must be based on a careful analysis of the patient's needs, the complexity of the case and the available resources [23]. The open approach remains an excellent option for simple cases and in contexts with limited resources, while laparoscopy stands out in young, active patients or those with bilateral hernias, due to faster recovery and better aesthetic results. Robotic surgery, in turn, can be considered in complex scenarios or for surgeons seeking greater precision in more challenging procedures, although its high cost and prolonged operative time limit its application in cases of simple inguinal hernias [23].

In summary, all three techniques have their place in the correction of inguinal hernias, and the decision must be personalized, considering the patient's profile, the surgeon's experience and the available infrastructure. The ideal approach is the one that balances efficacy, safety and cost-benefit for each specific situation [23].

When considering the best surgical technique, it is essential to evaluate the individual context of the patient, including their clinical conditions, the type of hernia, and the level of expertise of the surgical team [24]. The literature indicates that, while the open technique remains a solid choice, especially in cases of unilateral hernia and in high-risk patients, minimally invasive approaches tend to offer better results in terms of recovery and quality of life. The robotic technique, although promising, still lacks

robust evidence of clinical benefits that justify its widespread adoption, except in specialized centers [24]. Therefore, the choice of the ideal technique must be guided by an individualized analysis, considering clinical factors, available resources, and patient preferences, always seeking a balance between safety, efficacy, and cost-benefit [25]. Future studies, especially large-scale randomized clinical trials, are needed to provide more conclusive evidence on the comparative advantages of robotic surgery over other techniques [25].

CONCLUSION

Therefore, the choice of the ideal technique must be guided by an individualized analysis, considering clinical factors, available resources and patient preferences, always seeking a balance between safety, efficacy and cost-benefit [26]. Future studies, especially large-scale randomized clinical trials, are needed to provide more conclusive evidence on the comparative advantages of robotic surgery in relation to other techniques [26]. The open approach continues to be the most widely used in regions with fewer resources or for patients with large inguinal hernias and in emergency cases. However, it presents greater morbidity in terms of pain and recovery time [27]. Laparoscopy, in turn, is increasingly the preferred technique in specialized centers due to the shorter hospitalization and recovery time, in addition to presenting superior aesthetic results. However, it requires greater technical skill and experience from the surgeon compared to open approach hernioplasty [27]. Robotic surgery, although it offers advantages such as better ergonomics and precision, is still restricted to centers of excellence due to its high cost [28]. The application of this technique is generally indicated in complex cases where precision is essential, such as in patients with recurrences or with difficult anatomies [29].

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