Robot-Assisted Minimally Invasive Inguinal Hernioplasty: Time to Move Forward

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Abstract

Introduction: Inguinal hernia is one of the most common surgical conditions, affecting millions of people worldwide. Due to its high incidence and the serious complications associated with it, management has evolved through advanced surgical techniques such as laparoscopy and robotic surgery, optimizing outcomes and reducing postoperative risks. This article aims to present the standardization of the robotic-assisted laparoscopic inguinal herniorrhaphy technique.

Clinical case: Two clinical cases of robotic-assisted inguinal hernioplasty are described. Case 1, A 41-year-old male with a history of umbilical herniorrhaphy was diagnosed with a right medial inguinal hernia, with a 26 mm defect and a hernia sac measuring 19 × 9 mm. The total surgical time was 95 minutes. The patient was discharged 10 hours postoperatively and reported mild postoperative pain (2/10 on the visual analog scale). Case 2, A 57-year-old male with a left medial and femoral inguinal hernia underwent a 75-minute procedure. He was discharged 9 hours later and reported mild postoperative pain (2/10 on the visual analog scale).

Conclusion: Robotic surgery enabled precise and efficient hernia repair, minimizing operative time and reducing the need for instrument changes. The outcomes were favorable, with rapid recovery and no postoperative complications, demonstrating the effectiveness and safety of the robotic technique in the management of inguinal hernias.

Keywords: Robotics, Minimally Invasive Surgical Procedures, Hernia, Clinical Course, Latin America.

Introduction

Inguinal hernia is one of the most common surgical conditions encountered in clinical practice. This condition involves the protrusion of abdominal contents through a defect in the inguinal abdominal wall (1). The European Hernia Society (EHS) defines inguinal hernia as the protrusion of abdominal contents through a defect in the abdominal wall in the inguinal region. It may be classified as indirect when the contents pass through the deep inguinal ring, or direct when they protrude directly through the posterior wall of the inguinal canal (2). It has been reported that this condition affects 11 out of every 100,000 individuals between the ages of 16 and 24, and that the incidence is significantly higher in the elderly population, affecting more than 200 per 100,000 (3). Inguinal hernias are also more prevalent in men than in women, with a lifetime incidence of 25% in men compared to 3% in women, which is attributed to anatomical differences between the sexes (4).

Given the high incidence of this condition, it is important to recognize that although it is not usually a medical emergency, serious complications can arise if surgical treatment is not provided. These complications include intestinal obstruction and strangulation (5). To understand the relevance of this, a 2011 meta-analysis compared watchful waiting with surgical management of inguinal hernias and found that mortality due to these complications was significantly higher in patients under observation, reaching 4%, compared to only 0.2% in those who underwent elective surgery (6).

In this context, hernioplasty has become one of the safest and most effective surgical procedures, also helping to reduce the economic burden associated with untreated hernia complications (5). It is estimated that more than 20 million inguinal hernioplasties are performed worldwide each year (5).

Among the surgical techniques used for inguinal hernioplasty are open, laparoscopic, and robotic approaches. The open technique remains a traditional practice involving the placement of a patch or mesh in the preperitoneal space through an incision in the inguinal region, providing direct access to the abdominal wall defect (7). In contrast, the laparoscopic approach is significantly less invasive. It has been used for more than 30 years in the repair of inguinal hernias and currently accounts for approximately 25% of hernioplasties in the United States (5). This surgical method offers advantages such as reduced postoperative pain, faster recovery of daily activities, lower surgical site infection rates, and shorter work absenteeism (5).

While the laparoscopic approach offers significant advantages, the learning curve associated with this surgical technique presents a barrier to its widespread adoption in inguinal hernia repair (8). In this context, robotic surgery emerges as a promising solution, combining the minimally invasive benefits of laparoscopy with ergonomic advantages for the surgeon. This facilitates complex maneuvers—particularly intracorporeal suturing—and provides a stable, three-dimensional image under the surgeon's control.

In recent years, robot-assisted minimally invasive surgery has experienced exponential growth within general surgery. In the United States, robotic surgery now accounts for 28% of all hernia procedures (9). Although the associated costs are higher, a 2022 meta-analysis demonstrated that this technique offers several advantages, including lower conversion rates to open surgery and superior outcomes in bilateral repairs compared to laparoscopy (10).

Despite the relatively limited advantages of robotic surgery over laparoscopy in some areas, this is largely attributable to the recent introduction of robotic systems. A shorter learning curve for robotic surgery is a key factor that should be further explored to enhance the proficiency of future robotic surgeons. Robotic hernioplasty is now a reality and represents the future of minimally invasive surgery (11).

In light of the above, our objective is to present the standardization of the robotic-assisted laparoscopic inguinal herniorrhaphy technique and to discuss our initial experience in relation to the existing literature.

Materials and Methods

The Robotic Surgery Department at Clínica de Marly began its activities in 2011, initially focusing on urologic procedures, and later expanding into other specialties. This review article presents the first robotic inguinal hernioplasties performed at the institution, marking the beginning of the robotic-assisted abdominal wall surgery program.

Surgical Technique:

The selected technique was inguinal hernioplasty using a 10 × 15 centimeter (cm) anatomical mesh via a transabdominal approach. The patient was positioned in a modified lithotomy position, with legs extended and in a Trendelenburg tilt of approximately 25°. Central docking of the Da Vinci X robotic system was performed between the patient's legs.

Pneumoperitoneum was induced using a Veress needle inserted at the midline, three centimeters above the umbilical scar. A 12-millimeter (mm) trocar was placed at this location, followed by the insertion of two additional 8 mm trocars, aligned transversely with the 12 mm trocar and spaced 8 cm apart from it.

The 3D-Max mesh was introduced through the 12 mm trocar under laparoscopic vision, and positioned within the abdominal cavity but outside the working field (in the iliac fossa contralateral to the hernia site). Similarly, two 3-0 V-Loc 180 barbed sutures were introduced through the same port, with their needles anchored to the parietal peritoneum, also outside the working field but easily accessible.

These maneuvers aim to prevent interruptions during the procedure, as well as to avoid the removal of instruments or the camera to introduce the mesh or sutures. Unlike earlier models (Standard, S, or Si), the Da Vinci X and Xi systems use 8 mm trocars for all robotic arms, which allows the camera to be positioned in various locations but makes it more difficult to insert the mesh or sutures (needles) through the 8 mm trocars. In previous versions, where the camera was mounted on a 12 mm trocar, that trocar was typically used for introducing the mesh and sutures.

In more complex surgeries where an additional trocar for an assistant is needed, a 12 mm port is usually employed for this purpose. However, in our cases, no assistant trocar was used; only three trocars were utilized. In this technique, after establishing initial access and introducing the mesh and sutures under laparoscopic vision, an 8 mm trocar was inserted inside the initially placed 12 mm trocar—a method known as the trocar-in-trocar, piggyback technique, or, as we prefer to call it, the "mothership trocar."

These maneuvers are intended to improve procedural efficiency by reducing the need to remove or exchange instruments.

Instruments: Three robotic instruments were used: a monopolar scissors, a fenestrated bipolar forceps, and a needle driver, along with a 30° laparoscope.

Results

Clinical Case 1

A 41-year-old male patient with a history of umbilical herniorrhaphy presented with abdominal pain in the right inguinal region and a sensation of weakness in the left abdominal wall. Ultrasound revealed a defect in the right inguinal canal wall, medial to the inferior epigastric vessels, with a 26 mm neck and a 19 × 9 mm hernia sac containing fat, which was reducible. A diagnosis of direct inguinal hernia was made (Table 1).

During the procedure, a P-M-2 hernia was confirmed. Adhesions in the right flank and iliac fossa were dissected, and a peritoneal flap was developed from the anterior superior iliac spine to the medial umbilical ligament. Although it was a medial hernia, the peritoneum was separated from the spermatic cord structures, with the peritoneum retracted cranially and dorsally, achieving complete reduction along with the pre-hernial lipoma.

The mesh was fixed to the Cooper's ligament using a single stitch of V-Loc 3/0 suture, and the peritoneal flap was closed continuously with the same suture material (Figures 1 and 2).

Clinical Case 2

A 57-year-old male patient presented with a two-year history of pain and a sensation of heat in the left inguinal region. An ultrasound revealed a defect in the left inguinal canal wall, with a 26 mm neck and a 23 × 20 mm hernia sac containing fat, reducible, with no masses or fluid collections. A diagnosis of a left medial inguinal hernia was made (Table 1).

During the procedure, a primary medial type 2 inguinal hernia was confirmed. Dissection was performed, developing the peritoneal flap from the anterior superior iliac spine to the medial umbilical ligament. Subsequently, the peritoneum was dissected with complete reduction of the direct hernia, and an additional femoral hernia measuring approximately 1.5 × 2 cm was identified, fully dissected, and reduced.

The lipoma of the spermatic cord was also dissected and reduced, achieving a critical view of the myopectineal orifice. The mesh was fixed to Cooper's ligament with a single stitch using V-Loc 3/0 suture, and the peritoneal flap was closed continuously with the same suture material (Figure 2).

Table 1. Comparison of Clinical and Surgical Data from Robot-Assisted Inguinal Hernia Repairs

CHARACTERISTICS	CASE 1	CASE 2
Clinical features		
Age (years)	41	57
History	Previous umbilical herniorrhaphy	-
Ultrasound findings	Defect of the right inguinal canal wall with a 26 mm neck and a 19 x 9 mm hernial sac (fatty content).	Left inguinal canal wall defect with a 26 mm neck and a 23 x 20 cm hernial sac (fatty content)
Type of hernia	Right medial inguinal hernia	Direct inguinal and left femoral hernia
Surgical features		
Total time	95 minutes	75 minutes
Trocar placement time	7 minutes	5 minutes
Docking time	4 minutes	3 minutes
Console time	50 minutes	40 minutes
Complications	No	No
Immediate postoperative pain	2/10 (VAS)	2/10 (VAS)
Hospital discharge	10 hours	9 hours

*VAS: Visual Analogue Scale

Figure 1. A. Distribution of trocars used during the procedure. B. Central positioning of the Da Vinci X robotic system (central docking). C. Introduction of the mesh and V-Loc sutures through the 12 mm port.

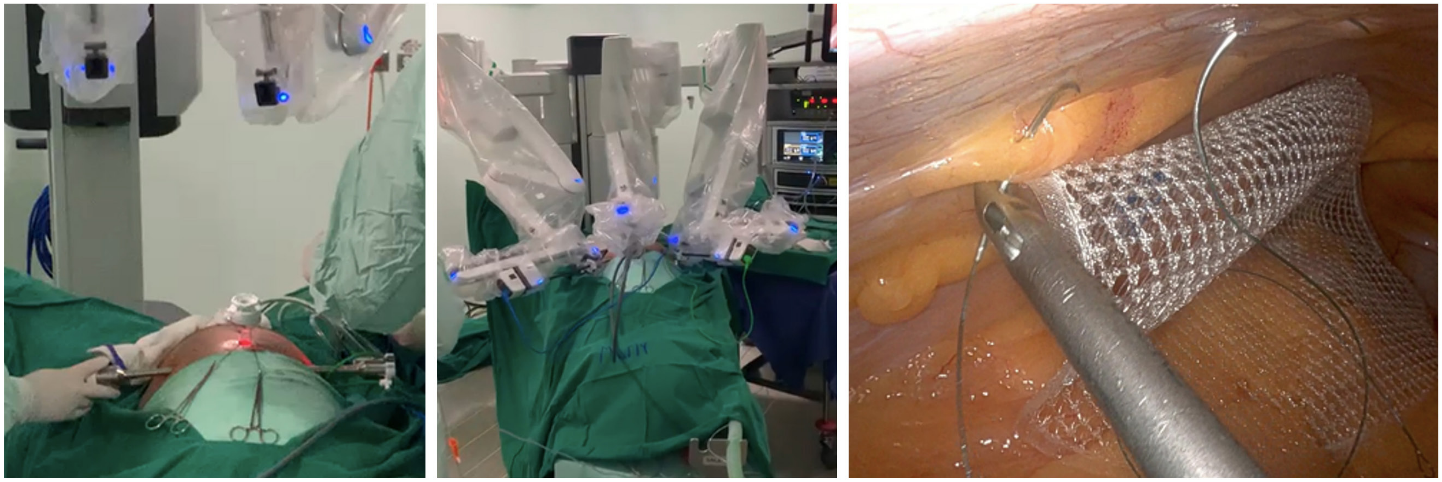
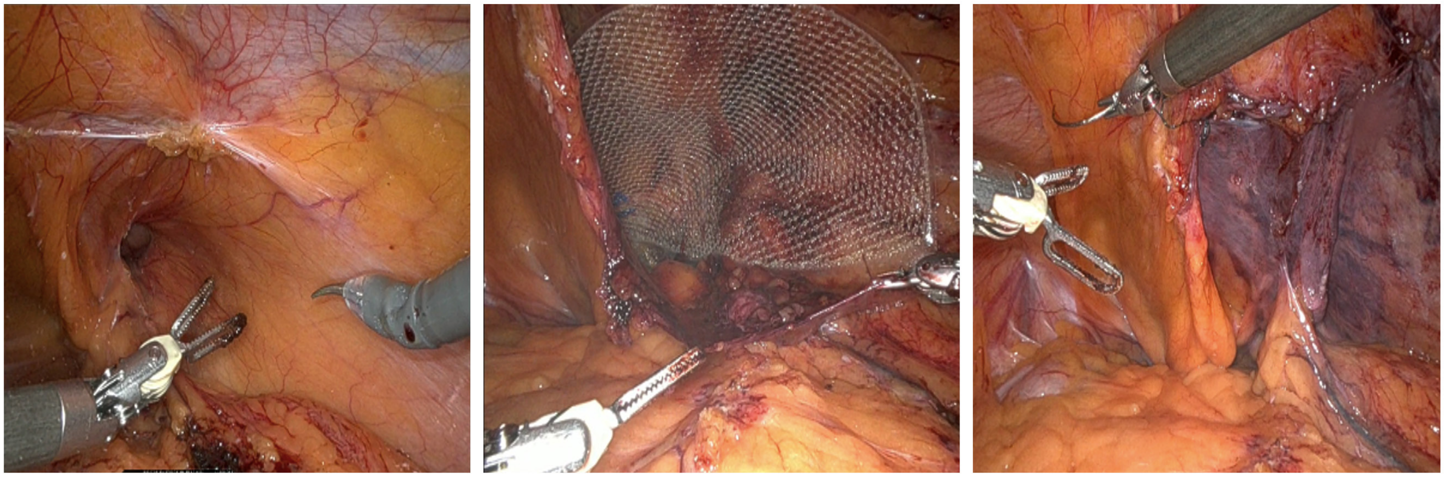


Figure 2. A. Identification of the hernia defect; B. Simple fixation stitch for the anatomical mesh; C. Closure of the peritoneal FLAP with V-Loc 3/0 suture.



Discussion

Over the past five years, the use of robot-assisted minimally invasive surgery in general surgery has experienced exponential growth, with a global estimated increase of 175% in surgical practice and up to 625% in the United States, marking a remarkable practical advancement in a relatively short period of time (9,12).

In the context of inguinal hernioplasty, in the United States, these procedures have seen a substantial rise in robotic approach, increasing from 0.7% to 28.8% of all hernia operations (13). In Colombia, there are no accurate data regarding these types of procedures assisted by robotic surgery systems.

The clinical cases presented here demonstrate the benefits of robotic surgery in inguinal hernia repair, highlighting both the precision and efficiency of the technique. The ability of robotic systems to perform precise movements and their capability to eliminate the natural tremors of the surgeon's hands are undeniable advantages. These benefits allow for more precise dissection and more delicate handling of tissues, which is crucial in procedures such as inguinal hernioplasty, where the preservation of important anatomical structures, such as blood vessels and nerves, is essential. Additionally, robotic surgery reduces the impact of the learning curve for surgeons (9).

When comparing laparoscopic hernioplasty with robotic hernioplasty, a 2022 meta-analysis (9) is particularly relevant as it shows that the outcomes of these two techniques are comparable. However, it was reported that laparoscopic surgery resulted in higher conversion rates to open surgery, whereas robotic surgery did not present this issue. However, although robotic surgery had higher associated costs, it demonstrated better performance in bilateral inguinal hernia repairs (9).

Regarding the technique, one of the challenges of robotic surgery is the need for a greater number of ports, especially for the insertion of suturing materials. However, in this case, to optimize port usage, the V-Loc suture and mesh were initially introduced through the 12 mm supraumbilical port before docking. Subsequently, a trocar-in-trocar technique was performed, coupling the camera arm to the 8 mm trocar placed within the 12 mm cannula. These maneuvers aim to make the process more efficient by reducing the need for instrument removal or exchange. An 8 mm port was superimposed for docking, allowing for a reduction in the need for an additional port. This update to the conventional technique not only optimizes the surgical field but also minimizes tissue trauma, leading to a faster recovery for patients.

In terms of operative time, our procedures had an average duration of 85 minutes, which shows a remarkable similarity to the times reported for traditional laparoscopic surgery (14). This finding is significant as it underscores that, although robotic technology is relatively new, it has already reached a level of efficiency comparable to more established techniques (15,16). However, it is important to note that the learning curve for robotic surgery is generally shorter than for laparoscopy, suggesting that, with time and experience, operative times could further improve.

The postoperative course for both patients was satisfactory, with both cases showing low scores on the Visual Analog Scale (VAS) for pain and a rapid hospital discharge. These results are consistent with the literature indicating that robotic surgery, like laparoscopy, is associated with less postoperative pain and faster recovery compared to open surgery (17). The outpatient nature of these procedures is also noteworthy, highlighting robotic surgery's capacity to facilitate early recovery and minimize hospital stay, which benefits both patients and the healthcare system long term (17,18).

One of the main barriers to robotic surgery worldwide, and specifically in our country, is its high operating cost (19). However, the institution conducted a thorough economic analysis, evaluating factors such as estimated operating room time, instruments, surgical team, and required materials.

This analysis led to the development of a service package whose cost was only 20% higher than that of a laparoscopic hernioplasty—an encouraging finding for the future of robotic surgery in Colombia.

Additionally, these procedures were performed by a female surgeon, representing the first reported cases of this kind in Colombia. We consider this achievement a remarkable step toward gender equity in medicine, particularly in fields traditionally dominated by men, such as surgery. This milestone is a testament to the growing success and presence of women in surgery and underscores the importance of promoting diversity across all areas of medicine.

The results presented in this report are merely an indication of the potential robotic surgery holds to transform surgical practice and improve patient outcomes. Therefore, it is essential to continue exploring and documenting the benefits of robotic surgery, with the aim of optimizing techniques, reducing operative times, and improving clinical outcomes in the future. The advancement of robotic technology in general surgery—and specifically in inguinal hernioplasty—is an imminent future that will undoubtedly reshape surgical practice in the years to come.

Conclusion

Robotic surgery for inguinal hernia repair not only represents a significant advancement in terms of technique and technology, but also reflects progress in female inclusion and leadership in surgery. With its precision, efficiency, and postoperative benefits, robotics is poised to play an increasingly important role in minimally invasive surgery.

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