Technical Note

Robotic Abdominal Wall Repair with Endoscopic Adductor Lengthening: A Minimally Invasive Approach for Core Muscle Injuries

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Abstract: Groin pain is a common complaint in sports medicine practices but can be a challenge to accurately diagnose given the expanse of differentials. In the athlete, groin pain may be caused by a core muscle injury, also known as sports hernia or athletic pubalgia. These injuries most frequently occur in young males who participate in explosive and rotationally demanding activities such as soccer, football, and ice hockey, which generate large forces across the trunk and hip joint. These injuries are becoming more frequently diagnosed, in part, due to the utilization of diagnostic modalities, such as dynamic ultrasound and magnetic resonance imaging (MRI) and sensitive physical examination tests, such as the cross-body sit-up and squeeze test. When conservative management fails, surgical intervention is a good option for the athletes who desire to return to play. Surgical options include both open and laparoscopic techniques to repair abdominopelvic defects with or without attention to adductor pathology. The purpose of this article is to present a technique for minimally invasive robotic abdominal wall repair with endoscopic adductor lengthening for core muscle injuries.

Introduction

Groin pain is a common complaint in sports medicine practices and may be difficult to diagnose because of its multifactorial etiology.[1,2] Because of the complex abdominopelvic anatomy, the differential diagnosis is broad and may include gastrointestinal, urologic, or gynecologic pathologies, as well as a range of orthopaedic differentials, such as femoroacetabular impingement, osteoarthritis, adductor contracture, osteitis pubis, and fracture.[1,3] There also exist more ambiguous groin pathologies, such as core muscle injuries (CMI).[4] Also known as a sports hernia or athletic pubalgia, CMI most commonly occurs among young male athletes and leads to reduced play time secondary to pain.[5,6] As a result of improved diagnostic modalities and better understanding of the pathoanatomy of CMI, these injuries have become easier to diagnose.[7–9] Conservative treatment of CMI includes rest, nonsteroidal anti-inflammatory drugs, physical therapy, biologics, and corticosteroid injections.[10–12] When conservative treatment fails, surgical intervention is indicated.[13]

Surgical options for CMI are vast and include both laparoscopic and open techniques.[14] These surgical modalities aim to repair posterior abdominal wall laxity, splitting of the conjoined tendon, and tears in the rectus abdominus.[1] Coexisting pathologies, such as femoroacetabular impingement (FAI), may contribute to the development of CMI by increasing the stress through the pubis as a result of the decreased range of motion in the hip, and these patients may benefit from additional surgical

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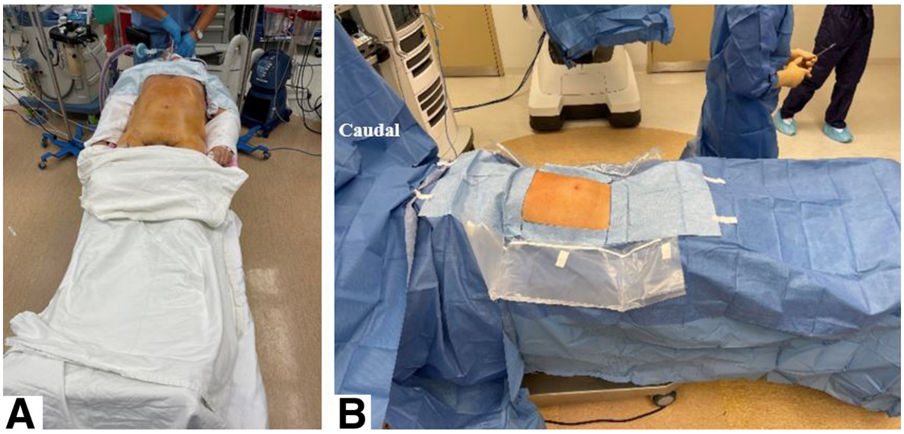

Fig 1. A) The patient is positioned supine, bony prominences well padded, arms tucked at the side. B) The abdomen is prepared and draped in the usual sterile fashion for the robotic core muscle injury repair portion of the procedure.

interventions to address these pathologies.[15] Laparoscopic repairs for CMI are classified as an extraperitoneal procedure (TEP) or transabdominal preperitoneal procedure (TAPP).[1] While these laparoscopic techniques most often include a repair with polypropylene mesh, many open techniques use a plication-based method without mesh.[1] Several open techniques have been described, including the modified Bassini and the modified Shouldice, both of which approximate the transversalis fascia to the iliopubic tract or to itself, respectively.[1] Studies have shown that correcting these abdominopelvic pathologies laparoscopically in conjunction with ipsilateral adductor lengthening leads to return to full sports-related activity in as quickly as 24 days, with a range up to 6 months.[2,16,17] As a contracted adductor tendon is commonly a deforming force on the core muscles, an open adductor lengthening has become increasingly popular.[5,18,19] Since this combined approach has been shown to be successful, surgeons have continued to improve on current techniques by decreasing incision size, reducing postoperative pain, and achieving quicker return to play time.[14] At our institution, we employ a specialized technique using a combination of the da Vinci robotic system (Intuitive, Sunnyvale, CA) for abdominopelvic mesh repair with endoscopic adductor lengthening. The purpose of this article is to present a technique for minimally invasive robotic abdominal wall repair with ipsilateral endoscopic adductor lengthening for core muscle injuries.

Approval from the Institutional Review Board was obtained prior to the initiation of this study.

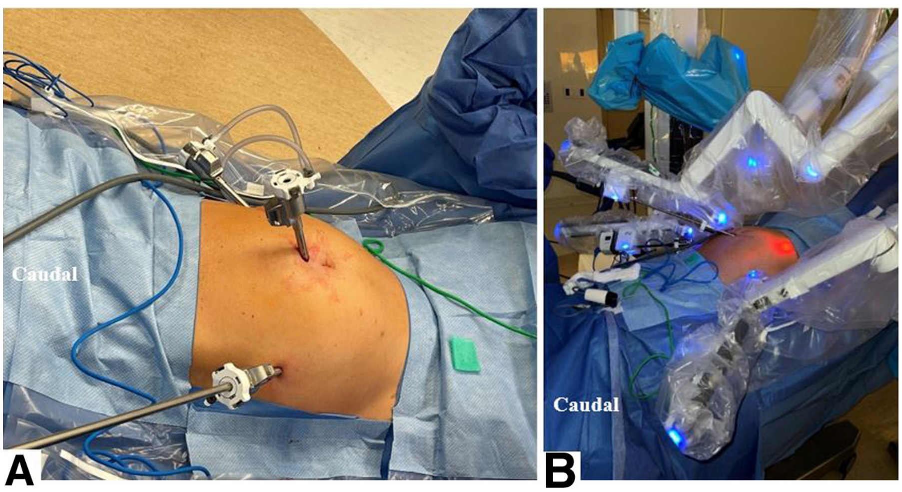

Fig 2. A) Following insufflation, the trochars are inserted first in the left upper quadrant and then under direct visualization in the midline and right upper quadrant. B) The da Vinci surgical robot is brought in from the patient's left side and docked.

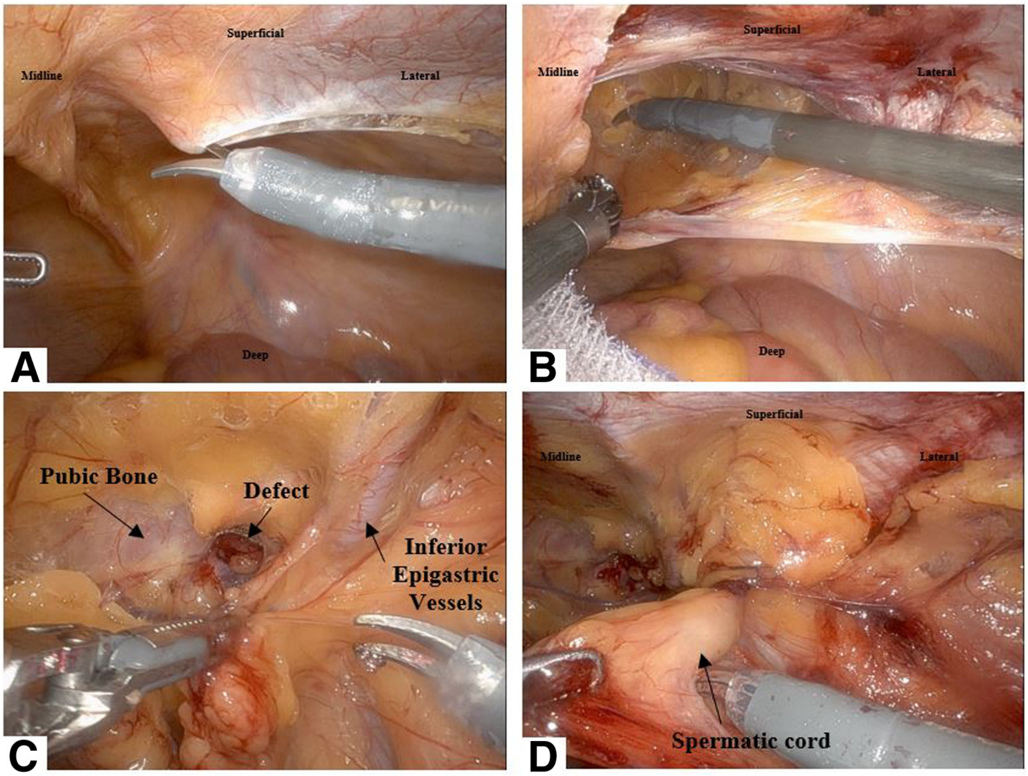

Fig 3. A) Incision of the peritoneum with electrocautery is visualized from the supraumbilical portal. B) A peritoneal flap is created with a combination of electrocautery, and blunt dissection to the level of the Coopers ligament. C) The defect is identified medial to the epigastric vessels. D) The spermatic cord is identified and circumferentially released from the peritoneum.

Surgical Technique

Surgical Technique—Robotic CMI Repair

The robotic CMI repair is performed by a general surgeon with expertise in robotic abdominal surgery. The patient is positioned supine with the arms tucked at the sides (Fig 1A). Bony prominences are well padded. The abdomen is then prepped and draped in the usual sterile fashion (Fig 1B) (Video 1). The da Vinci Systems (Intuitive, Sunnyvale, CA) surgical robot is positioned to approach from the patient's left side.

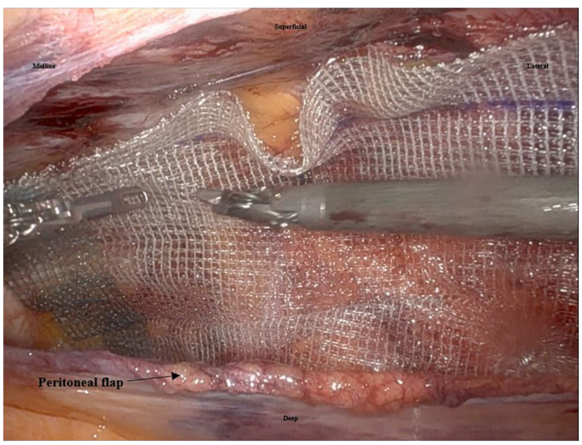

Fig 4. Visualized from the supraumbilical portal, the anatomic ProGrip mesh is appropriately positioned over the abdominal wall defect in the right lower quadrant with good medial coverage. Pressure is applied to affix the mesh to the peritoneal wall.

Following preparation and draping, the patient is placed in slight Trendelenburg. The left upper quadrant portal is made first at Palmers Point through which a Veress (Medtronic, Minneapolis, MN) needle is inserted to insufflate the abdomen to 15 mmHg. After the 8.5-mm robotic trochar is inserted into the portal at Palmers Point, the midline and right upper quadrant portals are made and 8.5-mm robotic trochars inserted under direct visualization (Fig 2A). The anatomic (right in this case) 15 × 10 cm ProGrip Laparoscopic Self-Fixating Mesh (Medtronic, Minneapolis, MN) is folded into thirds, and the border is marked with a sterile marking pen to assist with orientation once inside the abdominal cavity. The mesh and 180-day 2-0 V-Loc Wound Closure—Barbed Suture (Medtronic, Minneapolis, MN) are inserted into the abdomen prior to robotic docking. The robot is brought into the sterile field from the patient's left side, and the camera is attached to robotic arm #3 in the supraumbilical portal, the bipolar grasper to robotic arm #2 in the left lateral portal,

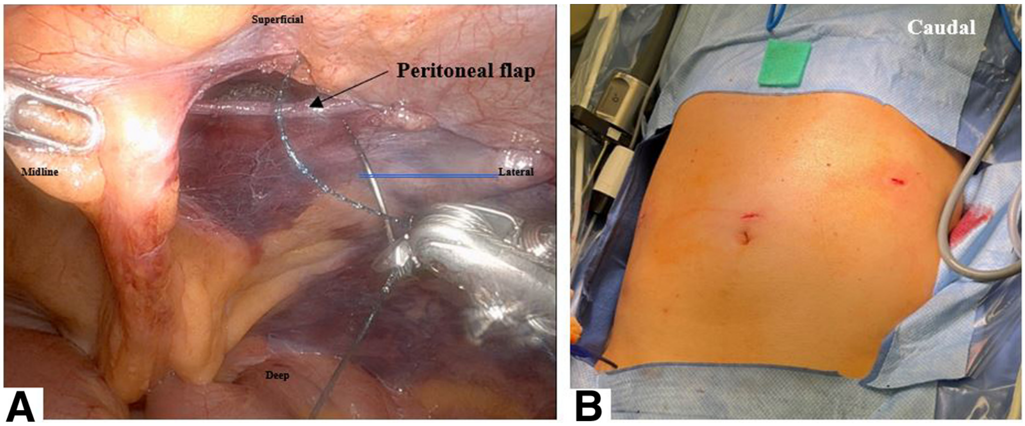

Fig 5. A) From the supraumbilical portal, the 180-day 2-0 V-Loc is used for the closure of the peritoneal flap working lateral to medial. Laparoscopic instruments and trochars are removed under direct visualization. B) The periumbilical fascia is closed followed by subcutaneous closure of the portals.

Table 1. Technical Pearls and Pitfalls of Robotic-Assisted Hernia Repair

Fold the mesh into quarters and mark one edge of mesh with a sterile marking pen prior to introduction into the abdominal cavity to ensure ease of orientation, unfolding, and application to abdominal wall.
After docking of the robot, palpate the abdomen under direct visualization to assist with orientation and identification of the start of the peritoneal flap creation.
Care should be taken to stay in the peritoneal plane, not to stray too far laterally, not to dissect too deep and to avoid epigastric perforators when developing the flap.
Identification of key structures, including the Cooper ligament, urinary bladder, ureter, epigastric vessels, and spermatic cord should be made.
Once the mesh is unfolded and appropriately positioned with good medial coverage, traction is applied to the peritoneal flap. If movement of the mesh is observed, then further mobilization of the peritoneal flap is necessary.
Care should be taken not to have exposed V-Loc in the intra-abdominal cavity following peritoneal flap closure.

Fig 6. A) Following the robotic core muscle injury repair, the patient is repositioned for adductor lengthening, remaining supine with the lower extremities placed in the frog position. B) The right inguinal region is prepped and draped in the usual sterile fashion.

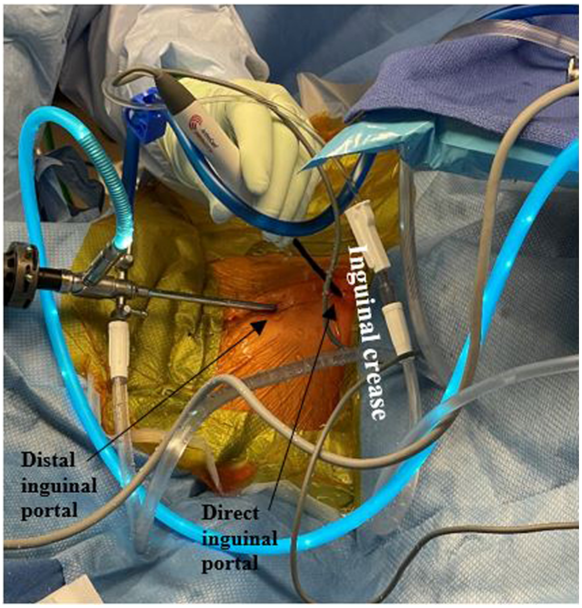

Fig 7. Following local anesthetic infiltration, the distal inguinal portal is made 4-fingerbreadths from the right inguinal crease, and a cannula-less endoscopy is positioned. Under direct visualization, the second, direct inguinal portal is made just distal to the right inguinal crease. Both portals overly the palpated adductor tendon. A radiofrequency device is positioned in the direct inguinal portal.

and the hot monopolar scissor in robotic arm #4 in the right lateral portal (Fig 2B).

Following docking, the operation is continued from the robotic console. Attention is turned to the right side of the abdomen. To create the peritoneal flap, the peritoneum is incised using electrocautery from the median umbilical ligament working laterally (Fig 3, A and B). Preperitoneal dissection is taken down to the level of the ligament of Cooper, which is identified. If there is evidence of a direct defect, it is reduced (Fig 3C). The spermatic cord structures are identified, and the peritoneum is circumferentially dissected off both the vas deferens and the spermatic cord (Fig 3D). The epigastric vessels are all protected throughout the entire operation.

Once satisfied with the high dissection of the peritoneum, the anatomic ProGrip mesh is unfolded and appropriately positioned with good medial coverage (Fig 4). Traction is applied to the peritoneal flap to confirm the mesh is properly placed and that there is adequate dissection of the peritoneum. The mesh should not move when traction is applied to the peritoneal flap and additional mobilization of the peritoneal flap is required if movement is observed. No fixation tacks are used.

Closure of the peritoneal flap is accomplished with a 2-0, 180-day V-Loc (Fig 5A). The abdomen is then deinsufflated. The periumbilical fascia is closed with 0 Vicryl (Ethicon, Raritan, NJ), and laparoscopic portals are closed with 3-0 Monocryl (Ethicon, Raritan, NJ)

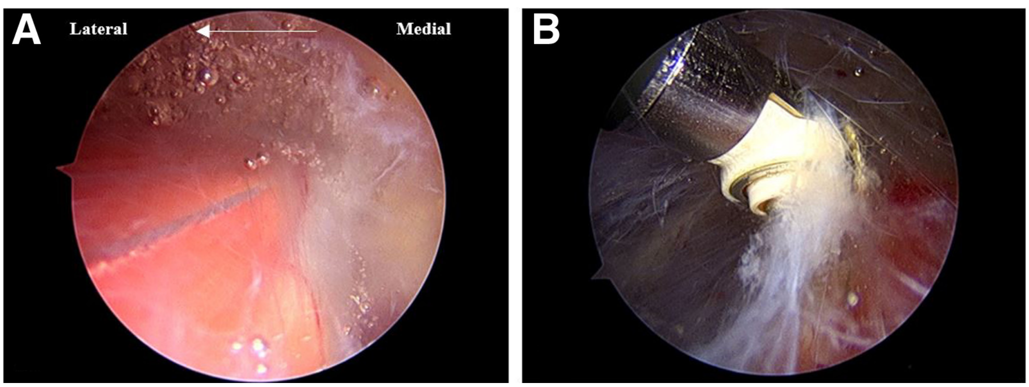

Fig 8. From the distal inguinal portal, the right adductor tendon is visualized. A) The resected bursitis and tendon sheath are observed. B) The tendon sheath is then opened with a VAPR wand.

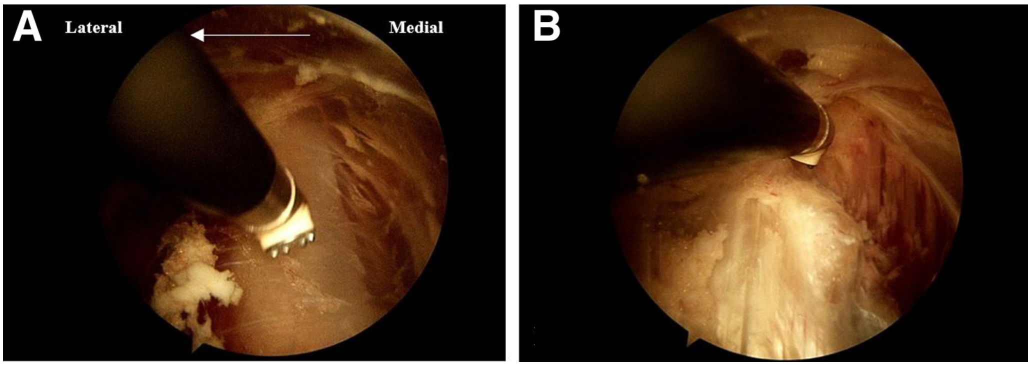

Fig 9. A) The right adductor tendon continues to be viewed from the distal inguinal portal, and the fascial opening and delineation of the tendon are achieved with the VAPR wand. B) Working most proximally, 50% of the adductor tendon is released from medial to lateral.

and surgical skin glue (Fig 5B). A sterile dressing is applied. The technical pearls and pitfalls for the robotic CMI repair are listed in Table 1.

Surgical Technique—Adductor Lengthening

The sterile drapes from the robotic CMI repair portion of the case are removed, and the patient's lower extremities are placed in the frog position (Fig 6A) with bony prominences well padded. The groin is prepped and draped in the usual sterile fashion (Fig 6B).

The adductor tendon is palpated, and local anesthetic is injected into the planned location of the incisions. Two portals are made in the groin, in line with the adductor tendon with particular care taken to avoid neurovascular structures such as the obturator nerve. The distal inguinal portal is made 4-fingerbreadths from the inguinal crease with blunt dissection. The endoscope is then positioned and under direct visualization, a spinal needle is used to localize the direct inguinal portal, which is made as close to the inguinal crease as possible overlying the adductor tendon (Fig 7).

A VAPR wand (DePuy Mitek, Inc., Raynham, MA) is positioned in the direct inguinal portal without a cannula. Erythema, tendinopathy, and contracture of the adductor longus tendon is identified (Fig 8A). A bursectomy is performed and the inflamed fascia is opened with the VAPR wand (Fig 8B). Hemostasis is achieved with electrocautery.

After the adductor longus tendon fascia is opened and the tendon is delineated both medially and laterally (Fig 9A), the Z-lengthening is performed with the VAPR wand. As proximal as possible, 50% of the tendon is taken (Fig 9B), working from medial to lateral. Great care is taken to avoid the obturator nerve.

A #1 Vicryl suture is passed through the released distal limb with an EXPRESSEW AutoCapture + Suture Passer (Depuy Synthes, Raynham, MA) (Fig 10A). The suture is carried 1.5 cm distally and sewn to the limb of the remaining healthy tendon (Fig 10B). It is tied with an arthroscopic knot pusher, and the tails are cut to appropriate length.

The remaining 50% of the proximal limb is released to complete the lengthening by again, working medially to laterally with the VAPR wand. The distally and proximally released tendons remain sutured. Debridement of nonviable tissue is performed (Fig 11).

Fluid is removed from the surgical space with gentle pressure. Portals are closed with 3-0 Monocryl suture

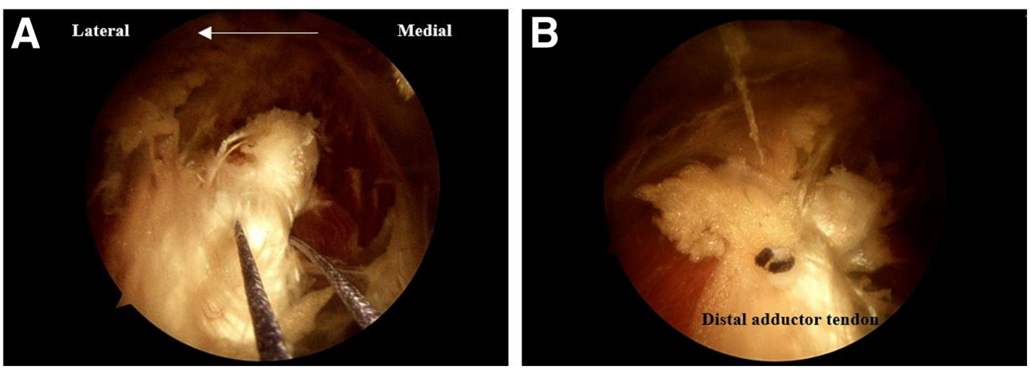

Fig 10. The EXPRESSEW AutoCapture + Suture Passer is placed in the direct inguinal portal. A) Suture is passed through the medial portion of distal limb of the now partially released right adductor tendon. B) The suture is then carried 1.5 cm distally, and then passed through the remaining healthy tendon and tied with an arthroscopic knot pusher.

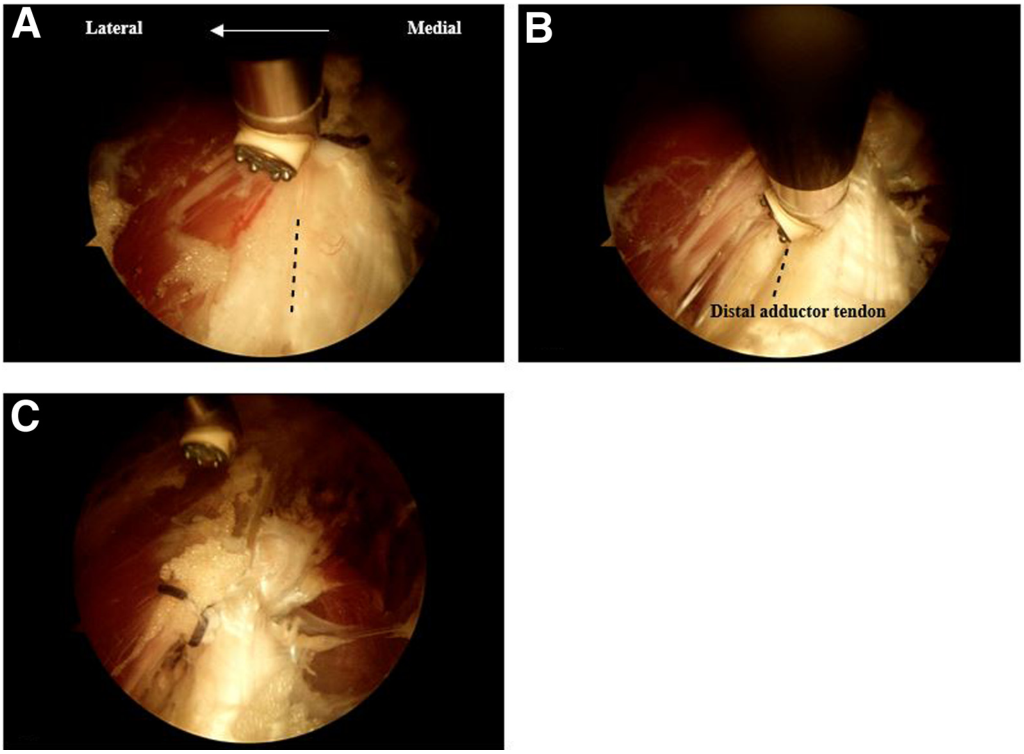

Fig 11. A) The VAPR wand working from the direct inguinal portal, is positioned in the central portion (dashed line) of the right adductor tendon, just distal to the suture. B) The remaining 50% of the tendon is released beginning from the center of the tendon and working laterally. C) Any necessary debridement is then performed.

and surgical skin glue, and a sterile dressing is applied (Fig 12). The technical pearls and pitfalls for the adductor lengthening are listed in Table 2.

Postoperative Rehabilitation

Rehabilitation is divided int 4 phases over a 6-week period. During the first 2 weeks (Phase 1), patients are to avoid hyperextension of the hip and trunk, as well as heavy lifting, with the goal of restoring active range of motion (ROM) and flexibility. To progress to moderate protection in Phase 2 (postoperative weeks 3 and 4), patients must have decreased pain and improved ROM. Goals include restoring pain-free hip and lumbar spine ROM. Full, nonpainful ROM of both hips and lumbar spine are necessary to progress to Phase 3 (weeks 4 and 5), which involves advanced exercise. Phase 4 is the return to activity phase, which patients progress to once they have achieved pain-free light sport activity.

Fig 12. Following the removal of the endoscope and VAPR wand, the excess fluid in the surgical space created by the procedure is expressed with gentle pressure prior to skin closure.

Discussion

Core muscle injury is most common in the high-level athlete performing rotational movements at maximum exertion. Because of the broad range of pathologies contributing to CMI, it can be treated with a variety of surgical techniques.[15,20] The described technique is for patients presenting with abdominal wall defects and concomitant adductor contracture, a type 3 CMI described by Kraeutler et al.[20] The primary indication for combined robotic repair and ipsilateral adductor release is persistent pain (>3 months) in an athlete who has failed conservative treatment and desires to return to play. The return to play time varies significantly within the literature and by technique with Rossidis et al.[16] reporting an average of 24 days[16] for full return

Table 2. Technical Pearls and Pitfalls of Endoscopic Adductor Longus Lengthening

The patient is placed in the frog position (flexing and abducting hips) to put the adductor tendon in tension and allow for easier placement of scope above the tendon.
The first portal should be the distal portal, 4 finger breadths from the inguinal crease to maximize visualization and access.
Adequately delineate the tendon both medially and laterally by removal of the fascia and inflamed tissues prior to lengthening to ensure complete release of the tendon and visualization for avoidance of obturator nerve, which is medial.
Work medial to lateral to take down 50% of the proximal adductor tendon with care not to leave any fibers remaining, resulting in an incomplete lengthening.
A hemostat may be used to spread the subcutaneous tissue in the portal to assist in prevention of a soft tissue bridge when reinserting the EXPRESSEW to complete the suturing of the tendon limb.
Remove as much fluid from the surgical space with gentle pressure prior to closure to prevent excessive edema.

to play following laparoscopic totally extraperitoneal mesh inguinal hernia repair and ipsilateral adductor longus tenotomy and Emblom et al.[21] reporting an average of 4.1 months following open rectus abdominis-adductor longus aponeurotic plate repair. A systematic review from 2021 reported a range of mean return to play of 0.5-6.27 months across a variety of open, transabdominal, totally extraperitoneal and combination repairs, but a comparison across the techniques could not be performed due to variation in technique and definition of return to play.[17] The possible advantages in return to play time with this minimally invasive approach warrant further investigation.

There is no consensus in the literature identifying a superior technique when it comes to the open vs laparoscopic approach, and much of the literature cites surgeon preference and experience.[17,22] The proposed advantages of robotic CMI repair and adductor lengthening include decreased blood loss, better visualization of the spermatic cord, and a faster recovery time, with some authors citing a quicker return to play.[23] Advantages of the open approach include direct visualization of the attachments of the rectus abdominus and conjoined insertion of the adductor longus on the pubis, including the ability to evaluate the contralateral side.[3]

We have presented the indications and surgical technique for a combined minimally invasive robot-assisted CMI repair and ipsilateral adductor lengthening for the treatment of CMI with persistent groin pain in the high-level athlete. Given the advancements in robotic surgery, we believe this is a useful surgical technique for the treatment of athletes desiring a less invasive surgery.

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