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TECHNICAL NOTE – NEUROSURGICAL TECHNIQUES

Robot-assisted triple neurectomy for iatrogenic inguinal pain: a technical note

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Abstract

Background Painful neuromas are a relatively common complication of hernia and abdominal wall surgery.

Objective Surgical neurectomy has the potential to to provide durable relief for chronic pain; however, current surgical approaches are not without morbidity or anatomical challenges. We sought a surgical alternative.

Methods In the treatment of a case of incapacitating inguinal pain, we performed an anterior transperitoneal approach using a surgical robot.

Results This approach was facile and provided elegant anatomical visualization.

Conclusion This case describes the first known robot-assisted laparoscopic triple neurectomy and details a simplified, transperitoneal approach.

Keywords Robotic · Neurectomy · Pain · Ilioinguinal · Iliohypogastric · Genitofemoral

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Background and importance

Chronic groin pain is a relatively common consequence of inguinal hernia repairs. The reported frequency of postoperative pain varies by the methodology of research, varying from 0 to 53 % [22]. Systematic reviews of higher quality studies have reported chronic pain which limits daily activities to be present in 25 % of patients, with approximately 10–12 % of patients reporting moderate to severe chronic pain [1, 2, 21].

Numerous theories have tried to account for the high incidence of pain; however, it is most plausible that a majority of cases result from local nerve trauma within the abdominal wall [1, 22], which has been histologically confirmed on surgical exploration [4]. This postoperative pain is most commonly associated with clinical indicators of peripheral nerve injury, such as decreased sensation, dysesthesias, mechanical allodynia, and thermal sensitivity [18]. While there is frequently a gradual reduction in such reported pain over time [5, 14, 28], a small but significant population suffers with incapacitating pain that persists. When conservative management fails to provide relief, the most commonly accepted surgical option is that of neurectomy [2]. When the pain syndrome cannot be reliably attributed to a single nerve source, neurectomy of the ilioinguinal, iliohypogastric and the genitofemoral nerves, the so-called "triple neurectomy," has been advocated [13, 27].

For a case of chronic incapacitating post-herniorrhaphy nerve pain, we performed a robot-assisted laparoscopic triple neurectomy. Use of a surgical robot facilitated a minimally invasive anterior transperitoneal technique, which has not been commonly utilized. This approach optimized anatomical visualization and minimized additional tissue trauma. To our knowledge, this is the first reported case utilizing a surgical robot to perform a "triple neurectomy" for inguinal neuralgia.

Technique

A 50-year-old woman was referred to our clinic for chronic unilateral groin pain that started abruptly after inguinal hernia surgery, having failed 18 months of intense nonoperative treatment. She reported being incapacitated by excruciating neuropathic pain that kept her confined to her home, resting in bed the majority of the day. Diagnostic blocks failed to isolate a single nerve source for her pain, and she was offered neurectomies of the genitofemoral, ilioinguinal and iliohypogastric nerves. Because of her predilection for chronic pain, we elected to pursue a robotically assisted laparoscopic triple neurectomy to minimize surgical invasiveness. An anterior approach was used to avoid the intercostal sensory and motor plexuses that would be encountered via a lateral, retroperitoneal approach.

The patient was positioned in a mid-lateral decubitus position to allow gravity to assist with mobilization of the peritoneal viscera to the contralateral side. Port placement (as shown in Fig. 1) included a 5 mm port in bilateral lower quadrants, a 10 mm port in the periumbilical region, and a 5 mm port in the right upper quadrant. The da Vinci Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA) was used with the camera at the periumbilical port, and two arms at the right upper and lower quadrant ports. A surgical assistant operated at the contralateral lower quadrant port for retraction. Dual 3D consoles provided operative views to both surgeons.

After safe laparoscopic port creation and adequate insufflation, the operating table was rotated to increase gravity-assisted intestinal retraction. Using the robot, the viscera were swept laterally and the posterior peritoneal membrane was mobilized to access the retroperitoneum (Video 1). The genitofemoral nerve was encountered first, being visualized along the ventral surface of the psoas muscle. The nerve was followed caudally to its distal entrance into the inguinal canal, and then rostrally to its emergence from the psoas muscle, to confirm the nerve's identity as the genitofemoral and, of near equal importance, to ensure incorporation of all its branches in the planned neurectomy. In this case, in addition to the typical distal bifurcation, a more proximally situated medial branch of the genitofemoral nerve was also identified (Fig. 2). Overlying the proximal genitofemoral nerve, the ureter could be clearly visualized and differentiated from the nerve, due to its periodic peristaltic activity. Stimulation of the genitofemoral nerve produced no appreciable muscular contraction. Next, emerging immediately lateral to the psoas, the lateral femoral cutaneous nerve was identified. This nerve courses inferolaterally over the ventral surface of the quadratus lumborum muscle (Fig. 3). Finally, on the lateral border of the quadratus lumborum, and lying on the ventral surface of the posterior aponeurosis of the transversus abdominis, a conjoined nerve containing both the ilioinguinal and iliohypogastric nerves was identified. This nerve bifurcated prior to entering the abdominal wall (Fig. 4), presumably providing late origins of the iliohypogastric and ilioinguinal nerves. Although a common L1 nerve is a frequent anatomical variation [11, 29], the subdiaphragmatic and retrohepatic recesses were exhaustively explored for other nerves. Stimulation of this L1 common ilioinguinal and iliohypogastric nerve trunk gave a weak motor response in the anterior abdominal wall, confirming that the nerve identified was not the subcostal nerve.

After adequate visual and electrodiagnostic confirmation of the genitofemoral and the conjoined ilioinguinal and iliohypogastric nerves (Fig. 5), each were crushed at three positions proximally, then coagulated and divided distally. A 2-cm segment was harvested for pathology, reducing

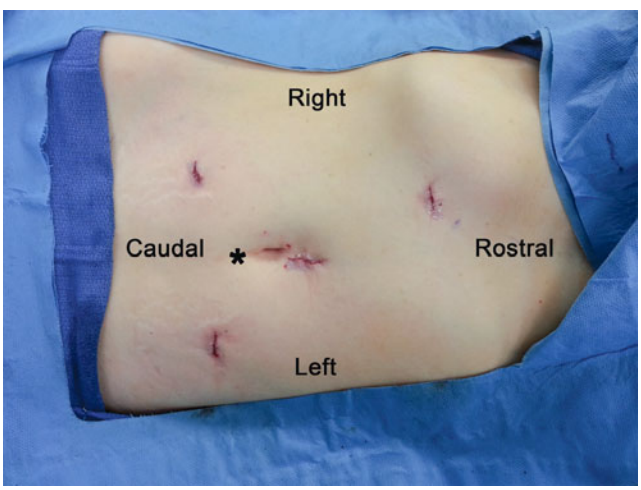

Fig. 1 Laparoscopic port placement. The patient was placed in a partial lateral decubitus position during port placement; rostral, caudal, right and left are labeled for orientation. A 10 mm camera port was placed rostral to the umbilicus, as the patient had a prior laparoscopic procedure (*asterisk*). The right inferior quadrant port and the right sub-hepatic port were utilized for the robot arms. The left inferior quadrant port was used by the surgical assistant. *Used with permission from Barrow Neurological Institute*

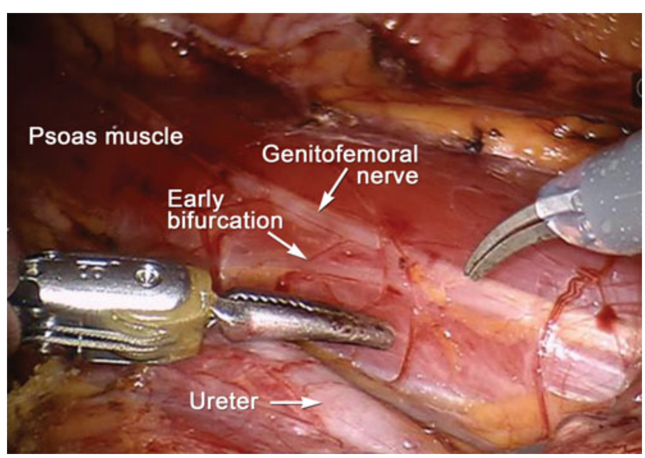

Fig. 2 Identification of the bifurcation of the genitofemoral nerve on the ventral surface of the psoas. Note the adjacent location of the ureter and similar appearance. Screen capture from surgical video. *Used with permission from Barrow Neurological Institute*

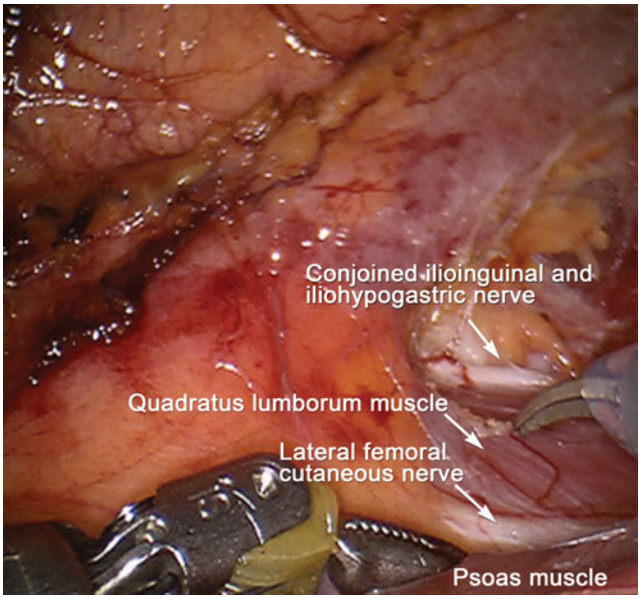

Fig. 3 Lateral femoral cutaneous nerve is lateral to the psoas muscle and ventral to the quadratus lumborum muscle; the conjoined ilioinguinal and iliohypogastric nerve is lateral to the quadratus lumborum muscle and anteromedial to the transversus abdominis muscle prior to its entry into the muscular layers of the abdominal wall. Screen capture from surgical video. *Used with permission from Barrow Neurological Institute*

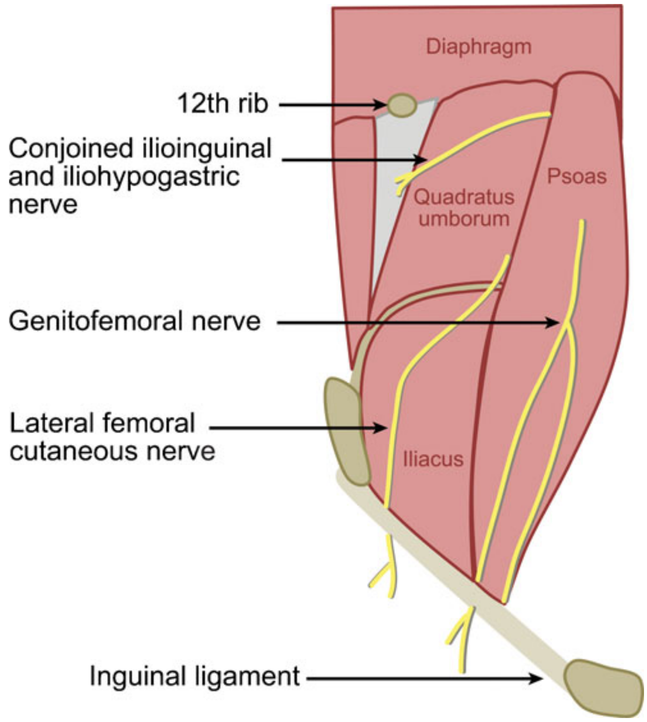

Fig. 5 Artistic rendering of the anatomy seen during surgery. *Used with permission from Barrow Neurological Institute*

the likelihood of spontaneous regeneration. After wound closure, the total operative time was 78 min. There was no blood in the suction canister at the end of the case.

Immediately after surgery, the patient awoke with anesthesia in the expected regions. She subsequently described being able to close her legs without pain, which had been a significant limitation for her. She was discharged home the following day. The day after surgery, she was able to take a walk for pleasure, an event she had been unable to do since her hernia repair.

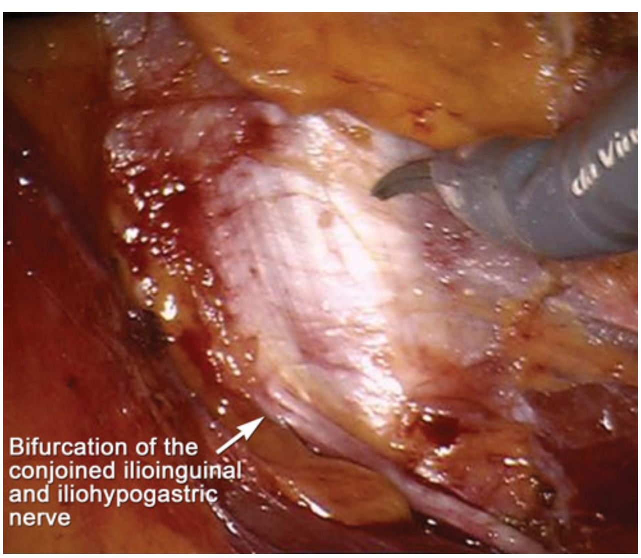

Fig. 4 Bifurcation of the conjoined ilioinguinal and iliohypogastric at the entrance of the nerve into the muscular layers of the abdominal wall. Screen capture from surgical video. *Used with permission from Barrow Neurological Institute*

Discussion

The robot-assisted laparoscopic triple neurectomy provided panoramic visualization with wide access to important visceral and neural structures, and yielded an acceptable postoperative

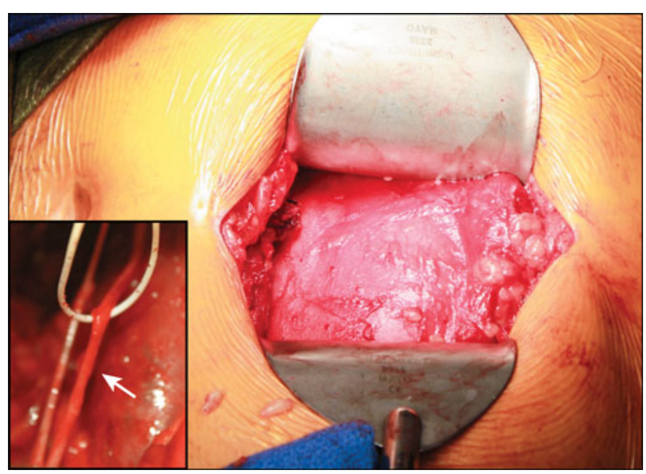

Fig. 6 Traditional anterolateral incision for retroperitoneal triple neurectomy, performed previously by the senior author. Genitofemoral nerve (*arrow*). *Used with permission from Barrow Neurological Institute*

result. Our initial operative time compares favorably with those associated with a laparoscopic retroperitoneal approach [25]. The technical point of this paper is to describe a novel surgical approach to this commonly performed procedure.

Two surgical approaches are commonly utilized for neurectomy of the ilioinguinal, iliohypogastric and/or genitofemoral nerves: an approach within the anterior abdominal wall, either through re-exploration or proximal nerve identification lateral to the original incision [4, 7, 26]; or a retroperitoneal approach [19, 25]. Accurate identification of the terminal inguinal and genital nerves in the inguinal canal may be challenging [7], particularly with postoperative scarring. In fact, it appears that lack of identification of these variable nerves, even by experienced surgeons, may frequently be the root cause of inguinal neuralgia [3]. Due to the tedium and risks of re-exploring the distal inguinal canal, particularly when multiple terminal branches of the ilioinguinal, iliohypogastric and genital nerves frequently exist [23], some authors advocate for retroperitoneal division of the proximal genitofemoral nerve [19]. When chronic groin pain is not isolated to the ilioinguinal and iliohypogastric distributions, performing a triple neurectomy retroperitoneally avoids both an anterior abdominal wall incision and a separate flank approach.

Traditional or “open” lateral or anterolateral retroperitoneal approaches commonly require a relatively large incision through the muscular abdominal wall (Fig. 6), which potentially makes recovery more painful and prolonged. Additionally, the nerve branches supplying the abdominal wall musculature and sensation to the lateral and anterior abdomen traverse this region. Because these nerves penetrate between layers of the abdominal musculature, they are relatively immobile and susceptible to injury [8], even with endoscopic or minimally invasive retractors. The consequences of injury to these nerves include flank bulge from motor paresis and intercostal neuralgia, which has been shown to occur occasionally in lateral endoscopic spinal surgery [9, 17] and minimally invasive anterolateral spine surgery [6].

Prior reports of laparoscopic ilioinguinal, iliohypogastric and genitofemoral neurectomies have utilized a completely retroperitoneal approach through a lateral flank approach [12, 20, 25]. We chose a traditional anterior laparoscopic portal set-up approach for multiple reasons. First, for the access surgeon, there is greater familiarity with the intraperitoneal landscape. Second, the midline camera port provides better visualization than lateral retroperitoneal ports in two key areas: the lateral subdiaphragmatic recess and the medial border of the psoas. In both locations, variant branches may arise and incomplete division may lead to suboptimal clinical results. Anatomical variation within the retroperitoneal space is considerable [11], as attested by the patient described herein. Third, the anterior port positions avoid potential injury to the major motor branch of the subcostal nerve, as well as the lateral cutaneous branches of the thoracic ventral rami. These nerves are plexiform in the lateral wall [24] and injury to small branches is a significant risk; in a patient with a history of neuroma formation, this poses an unwelcome complication. Lastly, we were able to visualize and protect adjacent visceral structures prior to nerve dissection; for example, the ureter is adjacent to and crosses ventrally to the genitofemoral nerve in the retroperitoneal space, which places the ureter at risk when approaching the genitofemoral nerve posterolaterally.

Two additional technical notes are worthy of consideration. The surgical robot provided essential surgical facility for dissecting through the posterior peritoneal membrane and into the subdiaphragmatic recess. Meticulous nerve handling is harder to achieve with standard laparoscopic tools. Second, we have incorporated a proximal crush into our neurectomies. Any division of a nerve creates neuroma formation; the goal of a surgical neurectomy is to provide a circumstance where pain fibers are dispersed [10]. A proximal crush injury creates a longitudinal zone of injury that may reduce recurrence of a painful neuroma. An anterior, transperitoneal approach affords wide surgical visualization of the retroperitoneum. In fact, it was the originally described route for genitofemoral neurectomy [15, 16] until supplanted by flank approaches that avoid the prior incision and the potential of hernia development. We found the approach to be anatomically intuitive, with less perceived risk to visceral and neural structures.

Conclusion

Robot-assisted, transperitoneal laparoscopic triple neurectomy can provide a facile approach for neurectomies of the ilioinguinal, iliohypogastric and genitofemoral nerves.

Conflicts of interest None.

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