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HOW-I-DO-IT

Ten steps for proper peripheral nerve handling during inguinal hernia surgery

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Abstract

Introduction Post-inguinal pain after a hernia surgery is prevalent and can be quite frustrating for the surgeon and patient alike. There are several sources for possible post-operative inguinal pain after a successful hernia repair; however, in the setting where a recurrent inguinal hernia is not present, it is likely related to the nerves in the inguinal canal or pelvis. Chronic inguinal groin pain after hernia repairs have been reported in a high percentage of patients following inguinal hernia surgery despite being one of the most common procedures performed annually in the USA and worldwide.

Materials and methods We present ten of the basic concepts utilized by peripheral nerve surgeons to limit nerve injury, which can easily be applied to open inguinal hernia surgery with or without mesh, starting with the firm understanding of the inguinal anatomy to addressing the nerves, meticulous placement of the mesh and the active revision of the surrounding structures and nerve position before closure.

Conclusions Understanding the proper handling of the inguinal nerves during hernia surgery can decrease the incidence of post-operative chronic pain by employing microsurgical concepts to day-to-day surgical procedures and prevent complications in an extensive set of patients.

Keywords Inguinal pain · Peripheral nerves · Chronic pain

Introduction

Post-inguinal pain after hernia surgery is prevalent and can be quite frustrating for the surgeon and patient alike [1]. All surgical specialties tend to work in surgical silos and echo chambers, which limit our exposure to current techniques employed by other specialties that can be very applicable to our own practices. I am at fault for this as well, but as I work with different surgical specialties, I have learned a great deal from some of the most basic concepts employed in their daily practices.

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Chronic inguinal groin pain after hernia repairs has been reported in 15–50% of patients [2, 3] following inguinal hernia surgery despite being one of the most common procedures performed annually in the USA and worldwide [4]. There are several sources for possible post-operative inguinal pain after a successful hernia repair [5]; however, in the setting where a recurrent inguinal hernia is not present, it is likely related to the nerves in the inguinal canal or pelvis [5, 6]. It is critical to understand that proper handling of the inguinal nerves during the actual inguinal hernia surgery can help decrease the chance of developing post-operative pain [6, 7], especially the most severe debilitating pain. Rough and improper handling of the inguinal nerves can turn a successful inguinal hernia repair into a post-operative nightmare riddled with nerve pain [7, 8].

My handling of inguinal nerves has greatly changed from my initial general surgery training to my current practice a decade later. Ten of the basic concepts utilized by peripheral nerve surgeons to limit nerve injury, which can easily be applied to primary open inguinal hernia surgery with or without mesh, will be presented.

1. Firm understanding of the nerve anatomy in the groin
There are three nerves in the inguinal canal (ilioinguinal, iliohypogastric, and genital branch of the genitofemoral nerve) and two in the pre-peritoneal space (lateral femoral cutaneous nerve and the femoral branch of the genitofemoral nerve) [9]. While the nerves of the inguinal canal can be distorted from a larger hernia, it is critical to know where they should be located to prevent injury.
2. 2.5 × loupe magnification for dissection
The nerves can range in size from 0.5 to 2.5 mm in diameter and look remarkably like other structures including fat, tendon, and fascia.
3. The use of finer instruments
To carefully dissect around the nerves, finer instruments are needed to allow for more precise handling of the nerves. The three instruments that I utilized for this are the McIndoe forceps, tenotomy scissors, and Adson bipolar cautery. The McIndoe forceps are a vascular type of forceps that have a slightly finer tip for grasping the cord structures during the dissection, while the longer tenotomy scissors will replace the Metzenbaum scissors around the nerves. The tenotomy scissors have a fine blunt tip which is ideal to dissect around the nerves to spread the adventitia and neurolyse the nerve. The Adson bipolar is needed to carefully cauterize the small capillary network around the cord structures, if necessary, without burning the nerve. Standard use of monopolar cautery close to the nerves will result in thermal injury [10]. The vessels around the cord structures should be maintained to the best of the surgeon's ability to keep the blood flow intact to the testicle and the vas deferens; however, the small capillary network that extends from the cord structures through a loose areolar plane to the surround tissues should be carefully cauterized with the bipolar cautery to limit bleeding. These vessels branch perpendicular or tangentially from the cord structures and limit the mobility of the cords during the repair. These are the small vessels that can easily be torn if blunt dissection of the cord structures is carried out.
4. Clear and deliberate identification of the nerves during surgery
Each of the three inguinal nerves needs to be clearly identified during the case. This is important to prevent inadvertent injury to the nerves [5].
5. Bloodless field
This can be challenging in certain settings; however, any little bit of bleeding will stain the tissues and make identification of the nerves more challenging. If bleeding is noted, hemostasis needs to be done immediately and meticulously before moving on.

This is especially important at the end of the case as well, as any residual oozing from the tissues will result in additional scarring and result in adhesive neuritis of the remaining inguinal nerves [11]. Level 1 evidence comes from a previous study supporting a bloodless field [12, 13].

6. No-touch/minimal handling of the nerves
Peripheral nerves are very unforgiving if they are not carefully handled and minimally manipulated [8]. The three major tenets are as follows.

Avoid excessive traction
The nerves should not be stretched excessively. This can damage the internal structure of the nerve itself, causing perineural scarring, which can result in permanent nerve injury despite the nerve appearing to be in continuity. Determining the amount of traction that is appropriate can be a bit of an art; however, if the nerve is stretched tight like a guitar string, then it is too much. For example, the ilioinguinal nerve should remain with the cord structures when being retracted to prevent excessive stretch.
Avoid crushing the nerve
The nerves should not be grasped with forceps, hemostats, or any other device during dissection [14]. To mobilize the nerve from the surrounding tissues, the adventitia should be grasped with the McIndoe forceps to avoid crushing the nerve itself. Grabbing the nerve, even gently, will result in damage to microscopic axons within the nerve sheath. This will result in an axonotmetic injury which can result in permanent numbness or chronic pain [6].
Avoid thermal injury to the nerve
Monopolar cautery can cause significant injury to the inguinal nerves during surgical dissection and should be used away from the nerves. Bipolar cautery on a low setting (i.e., setting of 10–15) is a better option to carefully cauterize and divide tissues and small vessels around the nerves and hernia sac [15]. The current is localized between the two ends of the bipolar forceps which results in less thermal injury to the surrounding tissues. For small vessels in the area, the use of microsurgical clips can be applied to continue to allow for a bloodless dissection [16].

7. Addressing the nerves (preservation versus transection)
Surgeons' philosophical approach to the inguinal nerves varies drastically. Some will prefer to routinely transect all three branches to prevent the chance of chronic pain at the expense of inguinal sensation, whereas others may save the nerves in hopes of preserving sensation. These are the two extremes, and most surgeons are probably somewhere in between.

Should the decision be made to transect any of the nerve branches, the nerve should be transected sharply with sharp scissors or a scalpel, not by cautery [17]. The proximal nerve end needs to be divided and rotated away from the mesh to prevent it from adhering to the mesh itself. Evidence for addressing nerves follows Level I.

The ilioinguinal and iliohypogastric nerve should be transected so they fall into the deep layer of the internal oblique muscles, and the genital branch of the genitofemoral nerve should be transected at the internal ring to allow it to fall into the pre-peritoneal space.

The nerve endings should not be ligated with a clip or suture, which would surgically create a compression point on the nerve and result in pain [14, 15].

The nerve end will form a neuroma, but if it does so in the internal oblique muscle or the pre-peritoneal fat, it will have enough soft padding to prevent chronic pain [5, 6]. There are additional techniques that can be employed to cap the nerve with muscle grafts, but this is outside the scope of this discussion.

If the nerves are preserved, awareness during mesh placement is needed to prevent the long-term sequelae of the nerves adhering to the mesh or improperly placed sutures.

8. Meticulous placement of the mesh
While the focus of the surgery is to repair the hernia and prevent recurrence, consideration and awareness of the nerves during mesh placement are critical.

The ilioinguinal nerve and the genital branch of the genitofemoral nerve can become adherent to the mesh opening that is used to create the new internal ring. Even with a generous opening in the mesh for the internal ring, these nerves will tend to stick to the mesh as it begins to heal into place. In terms of the recommended size of the neo-internal ring, there is quite a bit of variability among surgeons. My approach does not use a mesh, but rather a suture only technique. However, it is important to be able to pass the tip of the index finger through the internal ring along the cord structures. Overtightening the ring may cause a venous congestion to the testicular vessels, which can be quite painful. This must be balanced with the inner ring being too loose for a recurrent indirect hernia to pass through. If a synthetic mesh is used, the surgeon should expect the cord structures at the internal ring to stick to the mesh. Trying to prevent cord structures, particularly the ilioinguinal and genitofemoral nerve, adhering to the mesh or internal ring is paramount. Potentially making a small notch in the mesh at the location of the ilioinguinal nerve or folding some of the internal oblique muscle or fascia over the edge of the mesh might provide a better gliding surface for the nerve at the internal ring. Rotating the adventitia from the cord structures over the nerves so they do not come in direct contact with the mesh can potentially help prevent a tether point of the nerves to the mesh at this level. Shrinkage of the mesh should also be taken into consideration as a potential nerve entrapment cause [18].

The iliohypogastric nerve runs over the internal oblique muscle in a horizontal direction away from the inguinal floor; however, with placement of mesh, the nerve will be sandwiched between the internal oblique muscle and the overlying mesh, which creates an opportunity for the entire length of the iliohypogastric nerve to become adherent to the deep surface of the mesh. This is a bit more challenging with mesh placement, so there needs to be some amount of adventitia covering the nerve in a bloodless plane to decrease the nerve scarring to the mesh; other options for prevention of scarring will be discussed in step 10 of this manuscript.

9. Checking the position of the cord structure and nerves prior to closure
This mainly applies to the ilioinguinal nerve after an extensive dissection, where the ilioinguinal nerve has been stretched from the hernia and rests on the mesh instead of on the cord structures. The nerve needs to have a normal oblique direction without tethering at the internal ring and without a kink or bend in the nerve. The nerve should be re-draped in the inguinal canal, so any redundancy is distributed in the canal over the cord structures. The external ring should not be overtightened on the cord structures which would result in nerve compression with healing.

10. Resorbable barrier between nerves and surrounding structures
The utilization of soft tissue barriers can help prevent the nerves from adhering to the mesh or surrounding structures [19]. Evidence from cited review falls under Level III. Despite meticulous dissection and repair, the tissues still heal with scarring. While these are not routinely used at this time for inguinal hernia repair, they are used for peripheral nerve surgery. Collagen-based and amniotic-based products seem to cause additional scarring, so I have moved away from them in the setting of peripheral nerve surgery and inguinal surgeries. A hyaluronic acid-based product designed for peripheral nerves and tendons may provide some benefit [20]. Hyaluronic acid-based products, used as fillers in facial cosmetic procedures and as lubricants in orthopedic joint injections, are biocompatible and do not leave scar tissue. Utilization of a hyaluronic acid sheet can provide a barrier between the nerves and the mesh or

surrounding tissue to help prevent nerve adhesions in the post-operative period [20].

Employing these techniques will not require much surgeon learning or add significant time to the procedure. Understanding the proper handling of the inguinal nerves during hernia surgery can decrease the incidence of post-operative chronic pain by employing microsurgical concepts.

Data availability Not applicable.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval For this type of study ethical approval is not required.

Human and animal rights This article does not contain any studies with human participants performed by any of the authors.

Informed consent For this type of study formal consent is not required.

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