



CIRUGÍA ESPAÑOLA

www.elsevier.es/cirugia


Special article

Chronic postoperative inguinal pain: A narrative review[☆]Raúl Medina Velázquez,^{*} Joaquín Marchena Gómez, María José Luque García

Servicio de Cirugía General y del Aparato Digestivo, Hospital Universitario de Gran Canaria Dr. Negrín, Las Palmas de Gran Canaria, Spain

ARTICLE INFO

Article history:

Received 23 October 2019

Accepted 16 March 2020

Available online 2 February 2021

Keywords:

Chronic postoperative inguinal pain

Epidemiology

Etiology

Prevention

Diagnosis

Treatment

Management

Algorithm

A B S T R A C T

Inguinodynia or chronic postoperative inguinal pain is a growing problem between patients who undergo surgical repair of an inguinal hernia. The change in results measurement proposed by many authors towards Patient Reported Outcome Measurement has underlined the importance of chronic postoperative inguinal pain, because of the great limitations in everyday life and the huge socioeconomic impact that it causes. In this article a narrative review of the available literature is performed and the most relevant aspects about epidemiology, etiology prevention, diagnosis and treatment of chronic postoperative inguinal pain are discussed. A new management algorithm is also proposed. The variability in its incidence and clinical presentation makes diagnosis of chronic postoperative inguinal pain a very challenging issue. There is no standardized therapy and an adequate etiological diagnosis is key point for a successful treatment. There are many treatment options that have to be sequentially used and adjusted to each patient and their clinical features.

© 2020 AEC. Published by Elsevier España, S.L.U. All rights reserved.

Dolor inguinal crónico posquirúrgico. Una revisión narrativa

R E S U M E N

El dolor inguinal crónico posquirúrgico constituye una complicación de incidencia variable entre los pacientes intervenidos de hernia inguinal. La tendencia actual de medición de resultados en términos de calidad de vida (patient reported outcome measurement) ha puesto de manifiesto la importancia de esta complicación, debido a las limitaciones de actividad diaria e implicaciones socioeconómicas que genera. En este artículo se realiza una revisión narrativa de la literatura disponible en las plataformas PUBMED, EMBASE y Cochrane Library y se discuten los principales aspectos concernientes a la epidemiología, etiología, prevención, diagnóstico y tratamiento del dolor inguinal crónico posquirúrgico, proponiéndose un algoritmo para su manejo. Los pacientes que padecen dolor inguinal crónico posquirúrgico presentan un amplio espectro de manifestaciones clínicas y su

Palabras clave:

Dolor inguinal crónico

posquirúrgico

Inguinodinia

Epidemiología

Etiología

Prevención

Diagnóstico

Manejo

Algoritmo

[☆] Please cite this article as: Medina Velázquez R, Marchena Gómez J, Luque García MJ. Dolor inguinal crónico posquirúrgico. Una revisión narrativa. Cir Esp. 2021;99:80–88.

^{*} Corresponding author.

E-mail address: raul.medvel@gmail.com (R. Medina Velázquez).

diagnóstico supone un auténtico desafío. No existe un tratamiento estándar y el éxito del mismo radica en un adecuado diagnóstico etiológico para poner a disposición del paciente el amplio abanico de medidas terapéuticas de las que se dispone de forma individualizada.

© 2020 AEC. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

Introduction

Inguinal hernia repair is one of the most frequently performed surgical procedures, totaling more than 20 million procedures in the world.¹ Thanks to the success of prosthetic techniques in reducing recurrence rates, there has been a change in perception among the scientific community regarding the measurement of results. Many authors advocate measuring outcomes in terms of incidence of inguinodynia or self-determined quality of life (Patient-Reported Outcome Measurement).²⁻⁴

Postoperative inguinodynia or chronic postoperative inguinal pain (CPIP) is defined as new-onset groin pain or pain with characteristics that are different from the preoperative pain, which persists more than three months after the initial surgery and which appears as a direct consequence of nerve injury or somatosensory system involvement after hernia repair.^{5,6} Patients with inguinodynia may experience significant limitations in their daily activities and quality of life.⁷ Therefore, this problem has important socioeconomic implications as it generates significant direct costs (derived from health care) and indirect costs (temporary/permanent disability, lawsuits, etc.).⁸

This article provides a narrative review of different aspects concerning the epidemiology, etiology, prevention, diagnosis and treatment of CPIP.

Methods

We conducted a review of the literature on the PUBMED, EMBASE and Cochrane Library platforms using the search strategy shown in Fig. 1. The search was carried out in December 2018. Among the articles identified, we excluded those that did not meet the objectives of this review, as well as those written in a language other than English or Spanish, subsequently carrying out the narrative review based on the texts of the articles not excluded and prioritizing for this purpose those with greater methodological quality. This process was repeated with some of the cross-references from these studies, which were added to the narrative review if they were considered relevant. The review was carried out by the first two authors independently, and the third author resolved any discrepancies. Recommendations from clinical guidelines and the results obtained from randomized controlled trials were prioritized.

Results

Out of the total of 1097 studies found with the search strategy described, in the end 71 were finally selected to become part of

this review, either because of their methodological quality or because of the relevance of their results or statements. Fig. 1 illustrates the process for selecting articles for review (Fig. 2).

Epidemiology

Very variable incidences of CPIP have been reported depending on the surgical technique studied, the definition applied in each study, and the methods of evaluation and follow-up used. These figures range from 0%-76%,^{5,7,9-11} and it is estimated that between 10% and 15.2% of patients who present this complication have moderate-severe pain or pain that affects their daily activities.^{12,13} The natural history of the pain is decreasing, and both the intensity and its impact on daily life tend to decrease over time.⁹

Etiopathogenesis

In order to understand the causes of CPIP, it is necessary to know that the clinical presentation of this complication can be highly variable, and two fundamental types of pain have been identified: neuropathic and nociceptive. In its etiopathogenesis, different components may intervene that can cause neuropathic, nociceptive pain or pain that combines characteristics of both types. Knowing how to recognize the potential etiology of pain is key to establishing appropriate treatment.

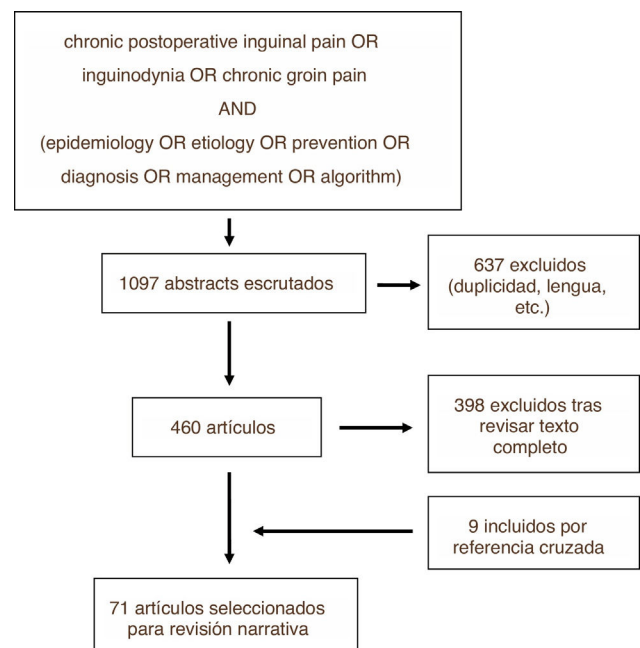


Fig. 1 – Strategy and search results.

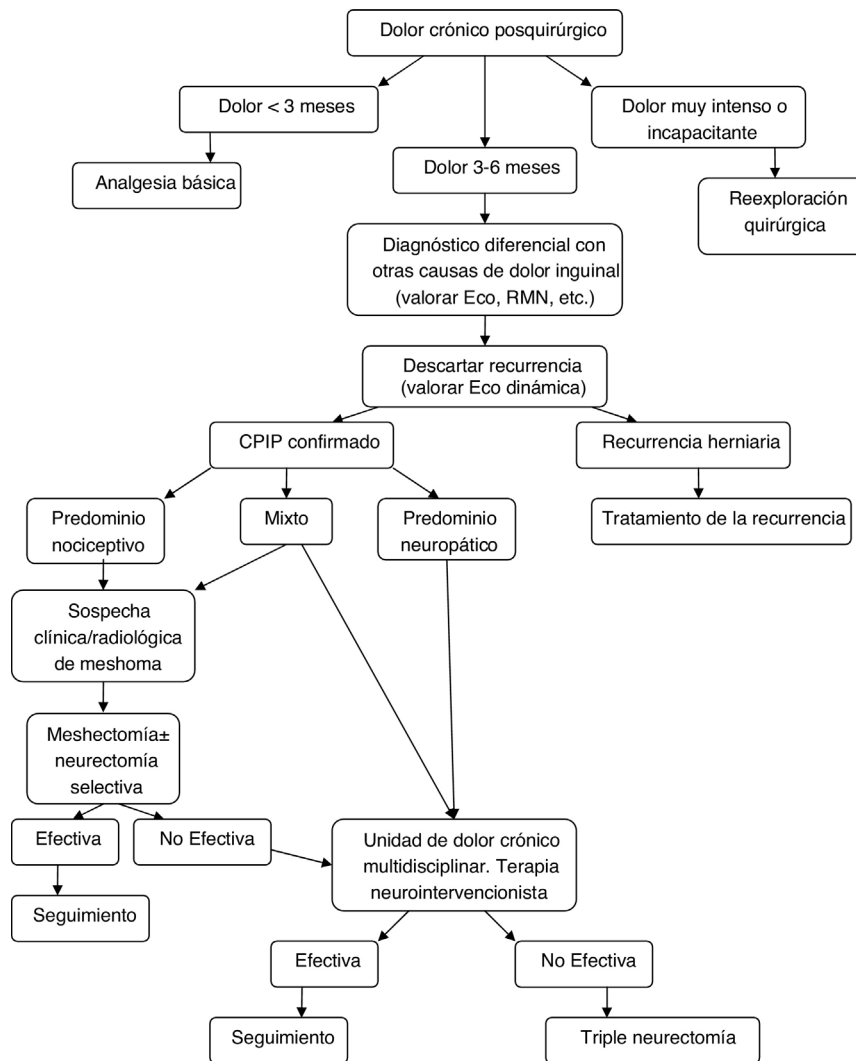


Fig. 2 – Diagnostic-therapeutic management algorithm for patients with CPIP, modified by Lange et al.¹⁵.

Neuropathic pain tends to predominate among patients with CPIP, a fact favored by the great anatomical variability that exists in the arrangement of the nerves of the inguinal region, mainly the ilioinguinal and iliohypogastric nerves and the genital branch of the genitofemoral nerve.¹⁴ This type of pain can be caused by direct nerve injury or perineural irritation, generally caused by compression, fibrosis, prosthetic material, sutures, or other fixation elements.^{15,16}

Predominantly nociceptive CPIP is generally caused by a periosteal reaction in the pubic area, due to scar tissue or by mechanical pressure generated around what is known as a 'meshoma', which is a mass formed by a retracting hernia mesh and periprosthetic fibrosis.¹⁶⁻¹⁸ Furthermore, hernia recurrences can also present in the form of predominantly nociceptive pain.^{19,20}

Other presentations of CPIP of visceral origin have been described in the form of orchialgia or dysejaculation, with a non-negligible incidence (approximately 10%).^{21,22} A proposed pathogenic mechanism is the erosion of the spermatic cord

structures by the mesh, involving autonomic innervation of the vas deferens.^{22,23}

Risk factors

Some systematic reviews of prospective studies and randomized trials have identified the endoscopic approach to inguinal hernia (transabdominal preperitoneal [TAPP]; totally extraperitoneal [TEP]) as a protective factor against the development of CPIP, compared to conventional repair techniques (prosthetic or not).^{7,24-26} In fact, the EndoHernia Society establishes a GRADE A recommendation for laparoscopic hernioplasty in order to reduce the incidence of CPIP.²⁷

There is a technical aspect that has shown to behave as a protective factor with a high level of scientific evidence; fixation of the mesh with fibrin glues instead of other fixation methods in both open and laparoscopic surgery.^{28,29}

Various risk factors have been proposed for the development of CPIP. Fränneby et al. identified the following risk

Table 1 – Risk factors for the development of post-operative chronic pain.

Preoperative	Age (young > old) Sex (♀ > ♂) Elevated intensity of pain Low level of preoperative optimism Affects daily activities Recurrent hernia Genetic predisposition (haplotype HLA DQB1*03:02)
Experimental Perioperative	High-intensity pain to stimulation with heat Inexperienced surgeon/hospital not specialized in hernias Open surgery Type of mesh (low-weight or wide-pore versus high-weight or narrow-pore) Mesh fixation (tacks or staples > fibrin glues) Neurolysis of the ilioinguinal nerve in Lichtenstein hernia repair
Postoperative	Complications in the immediate postoperative period (hematoma, infection) Elevated intensity of postoperative pain Low capacity to control pain Sensorial dysfunction along the groin
Adapted from Bjurstrom et al. ³⁶ .	

factors: age below the median, a high level of preoperative pain and the appearance of immediate postoperative complications, such as seromas/hematomas or infections.³⁰ These are, together with female gender, some of the risk factors for which the greatest consensus has been reached in the literature.^{10,11,31}

Other potential influential factors that are not so unanimous are the performance of hernioplasty due to hernia recurrence,^{9,11} the type of mesh used^{32,33} or the appearance of pain or sensory dysfunction during the immediate postoperative period.³⁴ A possible genetic influence has even been suggested.³⁵

Table 1 summarizes the different risk factors identified in the literature for the development of CPIP.³⁶

Prevention

To prevent this complication, some authors have proposed the 'watchful waiting' strategy for selected patients with inguinal hernia. This strategy has shown a low incidence of complications like incarceration or strangulation in patients with asymptomatic or minimally symptomatic hernias in the short to medium term, with no major differences in terms of pain or quality of life compared to surgically treated patients. However, in the long term, a large part of these patients opt for surgical treatment due to symptomatic progression.^{37,38} In addition, the morbidity and mortality associated with surgical treatment of incarcerated or strangulated inguinal hernia must be considered.³⁹ The HerniaSurge group recognizes that observation can be safe and reasonable in correctly selected asymptomatic patients; they recommend assessing the time of intervention according to socio-occupational circumstances and the surgical risk of each patient.⁶

Several intraoperative measures have been proposed to prevent CPIP, especially regarding the management of the

Table 2 – Intraoperative measures to prevent the appearance of CPIP proposed by Amid et al.

Measures	Avoid indiscriminate incision of subcutaneous cell tissue Avoid extensive division/resection of cremasteric fibers Avoid extensive dissection/raising of the ilioinguinal nerve from its bed Reconstruct superficial inguinal ring that is too narrow Avoid placing sutures on the inferior edge of the internal oblique muscle (entrapment of the iliohypogastric nerve) Systematic identification and preservation of nerve structures
----------	---

Source: Amid et al.¹⁶.

inguinal nerve structures. Table 2 shows the measures proposed by Amid, although not all of them are supported by consistent scientific evidence.¹⁶ Below, some of the proposed measures are listed with the level of evidence that supports them as well as the related recommendations made by the most recent clinical guidelines.

First of all, the need for systematic nerve identification during surgery has been raised and even whether their division or preservation is preferable once identified. The most relevant study in this regard is the Alfieri et al. prospective, multicenter cohort study that reported a significantly lower incidence of chronic pain in patients in whom the ilioinguinal, iliohypogastric and genital branch of the genitofemoral nerve were identified.⁴⁰ This result was also corroborated by a subsequent systematic review.⁴¹ The HerniaSurge group has established a strong recommendation for the simple recognition of the nerve pathway, without complete dissection.⁶

As for prophylactic neurectomy, selective ilioinguinal nerve neurectomy has been the most widely studied. Three meta-analyses (two based on randomized clinical trials) address this issue with contradictory results and significant heterogeneity. Furthermore, some of them report a higher incidence of paresthesia-dysesthesia in the region, which makes it impossible to establish a recommendation in favor of this prophylactic maneuver.⁴¹⁻⁴³ Apart from the ilioinguinal nerve, the available literature for prophylactic neurectomy of the iliohypogastric or the genital branch of the genitofemoral nerve does not allow any recommendation to be established.⁶

Another aspect studied is the so-called 'pragmatic neurectomy'. This involves performing neurectomy in those cases in which the nerve has been injured or is at risk of entrapment by the mesh or any fixative element. Smeds et al. report a significantly lower incidence of chronic pain after 3 months among the patients in whom this maneuver was performed.⁴⁴ Despite the fact that there are other cohort studies (without a control group) with contradictory conclusions,⁴⁵ the latest guidelines on inguinal hernia management establish a strong recommendation in favor of pragmatic neurectomy.⁶

There are other known potential sources of predominantly nociceptive pain as a consequence of periosteal reaction. Several studies suggest that sutures that include the pubic

periosteum for prosthetic fixation can trigger CPIP,^{6,18} and a strong recommendation is established to avoid this type of sutures.⁶

To prevent orchialgia, the latest guidelines strongly recommend minimizing manipulation and trauma to the spermatic cord, even though there is no solid scientific evidence to support it.⁶

Some perioperative analgesia strategies to avoid CPIP have also been evaluated. The preoperative administration of gabapentin or pregabalin is a promising measure, although it has hardly been studied.^{46,47}

Diagnosis

Any type of pain is a symptom that is highly subjective, both on the part of the patient (depending on their pain threshold, profession, daily activities, triggers, etc) as well as the surgeon when evaluating it. Therefore, when facing a patient with CPIP, we should not fall into the development of prejudices, transference, or countertransference.

First of all, we have to take into account the possibility that the pain is from a cause other than the surgery. The patient may have a pathology other than inguinal hernia that could be the cause of pain even before the operation. Only then will we be able to make an adequate differential diagnosis with other entities, for example musculoskeletal (enthesitis of the adductors, osteitis pubis, etc), genitourinary tract, peripheral nervous system (lumbar radiculopathy, obturator or pudendal nerve entrapment syndromes, etc), or other pathologies. Its mere suspicion may indicate the need for other complementary tests, such as ultrasound, MRI or even neurophysiological tests (electromyogram).^{19,48,49}

Therefore, an exhaustive anamnesis and a thorough physical examination by an experienced surgeon are the keys to the differential diagnosis in a patient with suspected CPIP. It is these characteristics that will allow us, in the first place, to rule out other underlying pathologies and extract crucial data to guide the etiological diagnosis.¹⁵

Once another underlying pathology unrelated to the hernia or its treatment has been excluded, the next step is to rule out a recurrence. In addition to the clinical history and physical examination, complementary tests can be used, fundamentally dynamic ultrasound of the inguinal region, although some authors also defend the utility of herniography.^{15,50}

From there, the characteristics of the pain will make it possible to differentiate between predominantly neuropathic or nociceptive pain, as well as the possible association with orchialgia or other accompanying symptoms. There is no clear distinction in many cases, and the etiological diagnosis can be further complicated in the presence of neuroplasticity phenomena, pairing of somatic and vegetative nerve fibers, and centralization of pain. To all this, we must add the influence of genetic, cognitive and socioeconomic circumstances.

Patients with neuropathic pain usually report features of burning or lancinating pain, radiating to the genital region or the medial side of the thigh, combined with symptoms such as hypo-/hyperesthesia, allodynia, or hyperalgesia. In contrast, nociceptive pain is better localized pain, usually continuous and described as a 'tightness' or 'sensation of a foreign body',

especially frequent at the level of the pubic tubercle. Furthermore, it tends to be worse in certain positions (when crossing the legs) or relieved in others (in the supine position), especially in the presence of a 'meshoma'.^{20,36} Likewise, it is important to evaluate the presence of symptoms that suggest some type of associated autonomic dysfunction, especially in the form of sexual dysfunction or dysejaculation, whose presence can also affect treatment.²³

In cases of predominantly neuropathic pain, we can resort to diagnostic maneuvers such as nerve blocks or dermatome mapping, introduced by Álvarez et al. and subsequently validated as a useful diagnostic tool to distinguish between neuropathic and nociceptive pain, as well as to identify the affected nerve with greater probability.^{51,52} The main utility of dynamic ultrasound lies in its ability to rule out the presence of a clinically non-evident recurrence, although some publications highlight its ability to diagnose the presence of a 'meshoma'.^{19,20} MRI could also be useful to orient the origin of pain.⁵³

Treatment

Despite the advances made, the treatment of patients with CPIP continues to represent a challenge. The lack of consensus when defining whether a treatment is effective or not makes it difficult to interpret and compare the results of the different treatments. Therefore, results must be interpreted with caution. Currently, the recommendations continue to be based on case series and expert consensus statements.^{6,36}

In the absence of universal treatment, each patient must be proposed an individualized therapeutic plan, adapted to the clinical characteristics and intraoperative findings, in the case of opting for surgical treatment. For this reason, both the clinical evaluation and the treatment must be conducted by an expert surgeon (the term 'herniologist' has been created to designate this figure).^{5,15,16,36} In any case, multimodal treatment and management strategies must be established by multidisciplinary chronic pain units.

Except in cases of pain of great intensity that is extremely disabling from the beginning, conservative treatment is the initial therapy, beginning with the administration of analgesia, topical therapy and non-pharmacological treatments, such as physiotherapy and cognitive-behavioral therapy.⁵⁴

As for pharmacological treatment, there are few studies that evaluate its effectiveness in patients with CPIP specifically, but it seems reasonable to extrapolate its proven efficacy in patients with other types of neuropathic pain, such as postherpetic neuralgia or diabetic neuropathy.⁵⁵ In the latest recommendations on the treatment of neuropathic pain, the International Association for the Study of Pain recommends tricyclic antidepressants (amitriptyline/clomipramine), serotonin-norepinephrine reuptake inhibitors (venlafaxine), and voltage-gated calcium channel blockers (gabapentin/pregabalin) as the first line of treatment.⁵⁶ Meanwhile, topical capsaicin or lidocaine are second choices due to their reduced efficacy and potential adverse effects.^{57,58} Non-steroidal anti-inflammatory drugs (NSAIDs) or even corticosteroids are used for the treatment of nociceptive pain, with varying degrees of efficacy. However, their spectrum of adverse effects limits their prolonged use.³⁶

Neurointerventional treatments are also considered part of conservative multimodal treatment and may be useful in selected patients. However, the scientific evidence supporting these methods comes mainly from small series.

Nerve blocks with local anesthetic of the ilioinguinal or iliohypogastric nerve are a measure already mentioned as a diagnostic maneuver, but they can also be used for therapeutic purposes. Genitofemoral nerve block can also be performed, although it is more complex.⁵⁹ The help of ultrasound or the use of neurostimulators allows this maneuver to be performed with greater precision, reducing adverse effects and the quantity infiltrated. However, the studies evaluating its efficacy are contradictory.^{60,61} In any case, based on the results of a recent clinical trial, it appears that surgical treatment with selective neurectomy is more effective than nerve block.⁶²

Neuroablation (radiofrequency, cryoablation) are another alternative, especially in cases where nerve blocks manage to relieve pain for a limited time.³⁶ However, the scientific evidence supporting these techniques is limited, according to a recent systematic review on pulsed radiofrequency neuroablation.⁶³

The latest neurointerventional alternative is peripheral or central neuromodulation. Although the mechanism by which it achieves its benefits is not known,⁶⁴ all the published series present favorable results in terms of pain relief, quality of life and reduction of analgesic consumption.^{65,66} Despite its effectiveness, the complexity of the treatment, its cost, and its limited availability mean that potential candidates must undergo a strict selection process. In it, psychosocial factors (motivation, social and family support, ability to follow the recommendations, etc), as well as the response to a preliminary test,⁶⁴ must be evaluated. All of this can act as a bias when interpreting the promising results.

The reasonable time to extend conservative treatment measures depending on the response to the different options is 3–6 months,¹⁵ although some authors propose extending it up to one year.^{5,67} Subsequently, a surgical treatment may be necessary, for which we have different alternatives. To maximize the success of any intervention, it is essential for the surgeon to have extensive knowledge of the inguinal and retroperitoneal anatomy.⁶⁸

Neurectomy is the surgical treatment of choice for patients with predominantly neuropathic CPIP. Favorable results have been published for both selective⁶⁹ and triple neurectomy, either by the open inguinal¹⁶ or retroperitoneal endoscopic⁷⁰ approaches. To date, only the Chen et al. prospective study has evaluated the efficacy of triple neurectomy, reporting subjective improvement in pain relief in the 20 patients who underwent endoscopic triple retroperitoneal neurectomy.⁶⁷

There are no studies that compare selective and triple neurectomy. Critics of the selective technique allude to the anatomical variability of the nerve disposition, the important network of connections in the area, and the difficulty to identify (both clinically and intraoperatively) which nerve is responsible for the symptoms as reasons to advocate for triple neurectomy.^{15,71} It is recommended that the nerves be cut proximal to the old surgical field and that the nerve stumps be ligated after division and be 'buried' in the surrounding muscle

to prevent the formation of neuromas or their regeneration.^{5,36,71} Some guidelines continue to leave the choice between triple or selective neurectomy to the discretion of the surgeon,⁶ while others opt for the triple.⁵

Although there are no comparative studies between endoscopic or open neurectomy, the retroperitoneal endoscopic approach combines the advantages of minimal invasiveness with a more proximal division of the nerve, which is more effective, especially in cases of CPIP after TEP or TAPP or a preperitoneal open approach.^{15,67,68} It is also possible to extend the neurectomy to the common trunk of the genitofemoral nerve in its retroperitoneal pathway over the anterior side of the psoas muscle using an open approach.⁷¹

Another surgical treatment option is the removal of the prosthetic material (mesh explant or 'meshectomy'), which has been shown to be safe and effective in the long term for patients with nociceptive pain in the presence of a 'meshoma'. It can be combined with a triple or selective neurectomy in patients who present mixed pain characteristics or in those cases with intraoperative evidence of nerve entrapment or injury.^{72,73} Selective neurectomy would also be associated if the position of the nerve interferes with the mesh removal. Some authors defend the usefulness of the explant alone, without associated neurectomy.²⁰ Recently, cases of laparoscopic meshectomy have been reported for patients with CPIP after laparoscopic hernioplasty with good results.⁷⁴ Mesh removal entails several risks. Apart from those inherent to surgical re-exploration of the groin (bleeding, nerve injury, testicular necrosis, etc) there is the potential risk of hernia recurrence. To minimize this, in most series some type of additional hernioplasty is used in association. For patients with CPIP after Lichtenstein hernioplasty or similar undergoing mesh removal via the anterior approach, recurrence rates of 0% have been obtained by associating an endoscopic hernioplasty, although the series were small.^{75,76}

Another factor to contemplate when choosing the best surgical alternative is the presence of orchialgia or dysejaculation. Triple neurectomy does not appear to be sufficiently effective for these patients. As there is a greater etiological involvement of the prosthetic material and the fibrous reaction that it generates on the vas deferens and its innervation,²³ mesh removal seems to be a better alternative. In refractory cases, resection of the vas deferens or orchiectomy may be necessary.^{15,23}

With the information above and the appearance of studies after the latest therapeutic algorithm by Lange et al. that support it,^{20,73,77} we the authors believe that a more prominent role should be given to mesh explants (alone or associated with neurectomy) within the surgical treatment of CPIP, always based on the characteristics of pain and intraoperative findings. Fig. 2 shows a new diagnostic-therapeutic algorithm, adding these modifications to the algorithm proposed by Lange et al.¹⁵

Conflict of interests

The authors have no conflict of interests to declare.

Acknowledgements

The authors would like to thank Dr Gonzalo Gómez Guerra for his mentoring and transmission of knowledge in the field of abdominal wall surgery.

REFERENCES

- Kingsnorth A, LeBlanc K. Hernias: inguinal and incisional. *Lancet*. 2003;362:1561-71.
- Muysoms FE, Deerenberg EB, Peeters E, Agresta F, Berrevoet F, Campanelli G, et al. Recommendations for reporting outcome results in abdominal wall repair: results of a Consensus meeting in Palermo, Italy, 28-30 June 2012. *Hernia*. 2013;17:423-33.
- Muysoms FE, Vanlander A, Ceulemans R, Kyle-Leinhase I, Michiels M, Jacobs I, et al. A prospective, multicenter, observational study on quality of life after laparoscopic inguinal hernia repair with ProGrip laparoscopic, self-fixating mesh according to the European Registry for Abdominal Wall Hernias Quality of Life Instrument. *Surgery*. 2016;160:1344-57.
- Gabriel SE, Normand S-LT. Getting the methods right—the foundation of patient-centered outcomes research. *N Engl J Med*. 2012;30:787-90.
- Alferi S, Amid PK, Campanelli G, Izard G, Kehlet H, Wijsmuller AR, et al. International guidelines for prevention and management of post-operative chronic pain following inguinal hernia surgery. *Hernia*. 2011;15:239-49.
- HerniaSurge Group. International guidelines for groin hernia management. *Hernia*. 2018;22:1-165.
- Nienhuijs S, Staal E, Strobbe L, Rosman C, Groenewoud H, Bleichrodt R. Chronic pain after mesh repair of inguinal hernia: a systematic review. *Am J Surg*. 2007;194:394-400.
- Parsons B, Schaefer C, Mann R, Sadosky A, Daniel S, Nalamachu S, et al. Economic and humanistic burden of post-trauma and post-surgical neuropathic pain among adults in the United States. *J Pain Res*. 2013;6:459-69.
- Aasvang EK, Bay-Nielsen M, Kehlet H. Pain and functional impairment 6 years after inguinal herniorrhaphy. *Hernia*. 2006;10:316-21.
- Bay-Nielsen M, Perkins FM, Kehlet H. Danish Hernia Database. Pain and functional impairment 1 year after inguinal herniorrhaphy: a nationwide questionnaire study. *Ann Surg*. 2001;233:1-7.
- Aasvang E, Kehlet H. Chronic postoperative pain: the case of inguinal herniorrhaphy. *Br J Anaesth*. 2005;95:69-76.
- Simons MP, Aufenacker T, Bay-Nielsen M, Bouillot JL, Campanelli G, Conze J, et al. European Hernia Society guidelines on the treatment of inguinal hernia in adult patients. *Hernia*. 2009;13:343-403.
- Lundström K-J, Holmberg H, Montgomery A, Nordin P. Patient-reported rates of chronic pain and recurrence after groin hernia repair. *Br J Surg*. 2018;105:106-12.
- Rab M, Ebmer A, Dellon AL. Anatomic variability of the ilioinguinal and genitofemoral nerve: implications for the treatment of groin pain. *Plast Reconstr Surg*. 2001;108:1618-23.
- Lange JFM, Kaufmann R, Wijsmuller AR, Pierie JPEN, Ploeg RJ, Chen DC, et al. An international consensus algorithm for management of chronic postoperative inguinal pain. *Hernia*. 2015;19:33-43.
- Amid PK. Causes, prevention, and surgical treatment of postherniorrhaphy neuropathic inguinodynia: triple neurectomy with proximal end implantation. *Hernia*. 2004;8:343-9.
- Amid PK. Radiologic images of meshoma: a new phenomenon causing chronic pain after prosthetic repair of abdominal wall hernias. *Arch Surg*. 2004;139:1297-8.
- Loos MJA, Roumen RMH, Scheltinga MRM. Classifying post-herniorrhaphy pain syndromes following elective inguinal hernia repair. *World J Surg*. 2007;31:1760-5. discussion 1766-1767.
- Ferzli GS, Edwards E, Al-Khoury G, Hardin R. Postherniorrhaphy groin pain and how to avoid it. *Surg Clin North Am*. 2008;88:203-16. x-xi.
- Zwaans WAR, Perquin CW, Loos MJA, Roumen RMH, Scheltinga MRM. Mesh removal and selective neurectomy for persistent groin pain following lichtenstein repair. *World J Surg*. 2017;41:701-12.
- Li J, Ji Z, Cheng T. Lightweight versus heavyweight in inguinal hernia repair: a meta-analysis. *Hernia*. 2012;16:529-39.
- Tolver MA, Rosenberg J. Pain during sexual activity before and after laparoscopic inguinal hernia repair. *Surg Endosc*. 2015;29:3722-5.
- Iakovlev V, Koch A, Petersen K, Morrison J, Grischkan D, Oprea V, et al. A pathology of mesh and time: dysejaculation, sexual pain, and orchialgia resulting from polypropylene mesh erosion into the spermatic cord. *Ann Surg*. 2018;267:569-75.
- Bittner R, Sauerland S, Schmedt C-G. Comparison of endoscopic techniques vs Shouldice and other open nonmesh techniques for inguinal hernia repair: a meta-analysis of randomized controlled trials. *Surg Endosc*. 2005;19:605-15.
- McCormack K, Scott NW, Go PM, Ross S, Grant AM. EU Hernia Trialists Collaboration. Laparoscopic techniques versus open techniques for inguinal hernia repair. *Cochrane Database Syst Rev*. 2003CD001785.
- Schmedt CG, Sauerland S, Bittner R. Comparison of endoscopic procedures vs Lichtenstein and other open mesh techniques for inguinal hernia repair: a meta-analysis of randomized controlled trials. *Surg Endosc*. 2005;19:188-99.
- Bittner R, Arregui ME, Bisgaard T, Dudai M, Ferzli GS, Fitzgibbons RJ, et al. Guidelines for laparoscopic (TAPP) and endoscopic (TEP) treatment of inguinal hernia [International Endohernia Society (IEHS)]. *Surg Endosc*. 2011;25:2773-843.
- Sun P, Cheng X, Deng S, Hu Q, Sun Y, Zheng Q. Mesh fixation with glue versus suture for chronic pain and recurrence in Lichtenstein inguinal hernioplasty. *Cochrane Database Syst Rev*. 2017. 07;2:CD010814.
- Antoniou SA, Köhler G, Antoniou GA, Muysoms FE, Pointner R, Granderath F-A. Meta-analysis of randomized trials comparing nonpenetrating vs mechanical mesh fixation in laparoscopic inguinal hernia repair. *Am J Surg*. 2016;211:239-49.
- Fränneby U, Sandblom G, Nordin P, Nyrén O, Gunnarsson U. Risk factors for long-term pain after hernia surgery. *Ann Surg*. 2006;244:212-9.
- Kalliomäki M-L, Meyerson J, Gunnarsson U, Gordh T, Sandblom G. Long-term pain after inguinal hernia repair in a population-based cohort: risk factors and interference with daily activities. *Eur J Pain*. 2008;12:214-25.
- Currie A, Andrew H, Tonsi A, Hurley PR, Taribagil S. Lightweight versus heavyweight mesh in laparoscopic inguinal hernia repair: a meta-analysis. *Surg Endosc*. 2012;26:2126-33.
- Sajid MS, Kalra L, Parampalli U, Sains PS, Baig MK. A systematic review and meta-analysis evaluating the effectiveness of lightweight mesh against heavyweight mesh in influencing the incidence of chronic groin pain

- following laparoscopic inguinal hernia repair. *Am J Surg*. 2013;205:726-36.
34. Aasvang EK, Gmaehle E, Hansen JB, Gmaehle B, Forman JL, Schwarz J, et al. Predictive risk factors for persistent postherniotomy pain. *Anesthesiology*. 2010;112:957-69.
 35. Dominguez CA, Kalliomäki M, Gunnarsson U, Moen A, Sandblom G, Kockum I, et al. The DQB1 *03:02 HLA haplotype is associated with increased risk of chronic pain after inguinal hernia surgery and lumbar disc herniation. *Pain*. 2013;154:427-33.
 36. Bjurström MF, Nicol AL, Amid PK, Chen DC. Pain control following inguinal herniorrhaphy: current perspectives. *J Pain Res*. 2014;7:277-90.
 37. Fitzgibbons RJ, Ramanan B, Arya S, Turner SA, Li X, Gibbs JO, et al. Long-term results of a randomized controlled trial of a nonoperative strategy (watchful waiting) for men with minimally symptomatic inguinal hernias. *Ann Surg*. 2013;258:508-15.
 38. Chung L, Norrie J, O'Dwyer PJ. Long-term follow-up of patients with a painless inguinal hernia from a randomized clinical trial. *Br J Surg*. 2011;98:596-9.
 39. van den Heuvel B, Dwars BJ, Klassen DR, Bonjer HJ. Is surgical repair of an asymptomatic groin hernia appropriate? A review. *Hernia*. 2011;15:251-9.
 40. Alfieri S, Rotondi F, Di Giorgio A, Fumagalli U, Salzano A, Di Miceli D, et al. Influence of preservation versus division of ilioinguinal, iliohypogastric, and genital nerves during open mesh herniorrhaphy: prospective multicentric study of chronic pain. *Ann Surg*. 2006;243:553-8.
 41. Wijsmuller AR, van Veen RN, Bosch JL, Lange JFM, Kleinrensink GJ, Jeekel J, et al. Nerve management during open hernia repair. *Br J Surg*. 2007;94:17-22.
 42. Johnner A, Faulds J, Wiseman SM. Planned ilioinguinal nerve excision for prevention of chronic pain after inguinal hernia repair: a meta-analysis. *Surgery*. 2011;150:534-41.
 43. Hsu W, Chen C-S, Lee H-C, Liang H-H, Kuo L-J, Wei P-L, et al. Preservation versus division of ilioinguinal nerve on open mesh repair of inguinal hernia: a meta-analysis of randomized controlled trials. *World J Surg*. 2012;36:2311-9.
 44. Smeds S, Löfström L, Eriksson O. Influence of nerve identification and the resection of nerves 'at risk' on postoperative pain in open inguinal hernia repair. *Hernia*. 2010;14:265-70.
 45. Reinhold WMJ, Nehls J, Eggert A. Nerve management and chronic pain after open inguinal hernia repair: a prospective two phase study. *Ann Surg*. 2011;254:163-8.
 46. Sen H, Sizlan A, Yanarateş O, Senol MG, Inangil G, Sücüllü I, et al. The effects of gabapentin on acute and chronic pain after inguinal herniorrhaphy. *Eur J Anaesthesiol*. 2009;26:772-6.
 47. Clarke H, Bonin RP, Orser BA, Englesakis M, Wijeyesundara DN, Katz J. The prevention of chronic postsurgical pain using gabapentin and pregabalin: a combined systematic review and meta-analysis. *Anesth Analg*. 2012;115:428-42.
 48. Nguyen DK, Amid PK, Chen DC. Groin pain after inguinal hernia repair. *Adv Surg*. 2016;50:203-20.
 49. Moreno-Egea A. Neuralgia del obturador: manejo clínico y descripción de una nueva forma de abordaje combinado para la valoración integral de su trayecto. Revisión de la bibliografía Rev Hispanoam Hernia. 2015;3:147-54.
 50. Robinson A, Light D, Kasim A, Nice C. A systematic review and meta-analysis of the role of radiology in the diagnosis of occult inguinal hernia. *Surg Endosc*. 2013;27:11-8.
 51. Álvarez R. Dermatome mapping: preoperative and postoperative assessment. In: Jacob B, Chen D, Ramshaw B, Towfigh S, editors. *The SAGES Manual of Groin Pain*. Cham: Springer; 2016; p. 277-92.
 52. Bjurström MF, Álvarez R, Nicol AL, Olmstead R, Amid PK, Chen DC. Quantitative validation of sensory mapping in persistent postherniorrhaphy inguinal pain patients undergoing triple neurectomy. *Hernia J Hernias Abdom Wall Surg*. 2017;21:207-14.
 53. Leander P, Ekberg O, Sjöberg S, Kesek P. MR imaging following herniography in patients with unclear groin pain. *Eur Radiol*. 2000;10:1691-6.
 54. Bushnell MC, Ceko M, Low LA. Cognitive and emotional control of pain and its disruption in chronic pain. *Nat Rev Neurosci*. 2013;14:502-11.
 55. Zeng L, Alongkronrusmee D, van Rijn RM. An integrated perspective on diabetic, alcoholic, and drug-induced neuropathy, etiology, and treatment in the US. *J Pain Res*. 2017;10:219-28.
 56. Finnerup NB, Attal N, Haroutounian S, McNicol E, Baron R, Dworkin RH, et al. Pharmacotherapy for neuropathic pain in adults: a systematic review and meta-analysis. *Lancet Neurol*. 2015;14:162-73.
 57. Bischoff JM, Ringsted TK, Petersen M, Sommer C, Uçeyler N, Werner MU. A capsaicin (8%) patch in the treatment of severe persistent inguinal postherniorrhaphy pain: a randomized, double-blind, placebo-controlled trial. *PLoS One*. 2014;9:e109144.
 58. Bischoff JM, Petersen M, Uçeyler N, Sommer C, Kehlet H, Werner MU. Lidocaine patch (5%) in treatment of persistent inguinal postherniorrhaphy pain: a randomized, double-blind, placebo-controlled, crossover trial. *Anesthesiology*. 2013;119:1444-52.
 59. Parris D, Fischbein N, Mackey S, Carroll I. A novel CT-guided transposas approach to diagnostic genitofemoral nerve block and ablation. *Pain Med Malden Mass*. 2010;11:785-9.
 60. Thomassen I, van Suijlekom JA, van de Gaag A, Ponten JEH, Nienhuijs SW. Ultrasound-guided ilioinguinal/iliohypogastric nerve blocks for chronic pain after inguinal hernia repair. *Hernia J Hernias Abdom Wall Surg*. 2013;17:329-32.
 61. Bischoff JM, Koscielniak-Nielsen ZJ, Kehlet H, Werner MU. Ultrasound-guided ilioinguinal/iliohypogastric nerve blocks for persistent inguinal postherniorrhaphy pain: a randomized, double-blind, placebo-controlled, crossover trial. *Anesth Analg*. 2012;114:1323-9.
 62. Verhagen T, Loos MJA, Scheltinga MRM, Roumen RMH. The GroinPain trial: a randomized controlled trial of injection therapy versus neurectomy for postherniorrhaphy inguinal neuralgia. *Ann Surg*. 2017;26.
 63. Werner MU, Bischoff JM, Rathmell JP, Kehlet H. Pulsed radiofrequency in the treatment of persistent pain after inguinal herniotomy: a systematic review. *Reg Anesth Pain Med*. 2012;37:340-3.
 64. Slavin KV. Peripheral nerve stimulation for neuropathic pain. *Neurother J Am Soc Exp Neurother*. 2008;5:100-6.
 65. Stinson LW, Roderer GT, Cross NE, Davis BE. Peripheral subcutaneous electrostimulation for control of intractable post-operative inguinal pain: a case report series. *Neuromodulation J Int Neuromodulation Soc*. 2001;4:99-104.
 66. Rauchwerger JJ, Giordano J, Rozen D, Kent JL, Greenspan J, Closson C-WF. On the therapeutic viability of peripheral nerve stimulation for ilioinguinal neuralgia: putative mechanisms and possible utility. *Pain Pract Off J World Inst Pain*. 2008;8:138-43.
 67. Chen DC, Hiatt JR, Amid PK. Operative management of refractory neuropathic inguinodynia by a laparoscopic retroperitoneal approach. *JAMA Surg*. 2013;148:962-7.
 68. Reinhold W, Schroeder AD, Schroeder M, Berger C, Rohr M, Wehrenberg U. Retroperitoneal anatomy of the iliohypogastric, ilioinguinal, genitofemoral, and lateral femoral cutaneous nerve: consequences for prevention and treatment of chronic inguinodynia. *Hernia*. 2015;19:539-48.
 69. Loos MJ, Scheltinga MR, Roumen RM. Tailored neurectomy for treatment of postherniorrhaphy inguinal neuralgia. *Surgery*. 2010;147:275-81.

70. Giger U, Wente MN, Büchler MW, Krähenbühl S, Lerut J, Krähenbühl L. Endoscopic retroperitoneal neurectomy for chronic pain after groin surgery. *Br J Surg.* 2009;96:1076-81.
71. Amid PK, Chen DC. Surgical treatment of chronic groin and testicular pain after laparoscopic and open preperitoneal inguinal hernia repair. *J Am Coll Surg.* 2011;213:531-6.
72. Bischoff JM, Enghuus C, Werner MU, Kehlet H. Long-term follow-up after mesh removal and selective neurectomy for persistent inguinal postherniorrhaphy pain. *Hernia.* 2013;17:339-45.
73. Zwaans WAR, Verhagen T, Roumen RMH, Scheltinga MRM. Factors Determining outcome after surgery for chronic groin pain following a Lichtenstein hernia repair. *World J Surg.* 2015;39:2652-62.
74. Slooter GD, Zwaans WAR, Perquin CW, Roumen RMH, Scheltinga MRM. Laparoscopic mesh removal for otherwise intractable inguinal pain following endoscopic hernia repair is feasible, safe and may be effective in selected patients. *Surg Endosc.* 2018;32:1613-9.
75. Rosen MJ, Novitsky YW, Cobb WS, Kercher KW, Heniford BT. Combined open and laparoscopic approach to chronic pain following open inguinal hernia repair. *Hernia.* 2006;10:20-4.
76. Keller JE, Stefanidis D, Dolce CJ, Iannitti DA, Kercher KW, Heniford BT. Combined open and laparoscopic approach to chronic pain after inguinal hernia repair. *Am Surg.* 2008;74:695-700. discussion 700-701.
77. Campanelli G, Bertocchi V, Cavalli M, Bombini G, Biondi A, Tentorio T, et al. Surgical treatment of chronic pain after inguinal hernia repair. *Hernia J Hernias Abdom Wall Surg.* 2013;17:347-53.