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EDITORIAL

Current trends in the diagnosis and management of post-herniorraphy chronic groin pain

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Abstract

Inguinodynia (chronic groin pain) is one of the recognised complications of the commonly performed Lichtenstein mesh inguinal hernia repair. This has major impact on quality of life in a significant proportion of patients. The pain is classified as neuropathic and non-neuropathic related to nerve damage and to the mesh, respectively. Correct diagnosis of this problem is relatively difficult. A thorough history and clinical examination are essential, as is a good knowledge of the groin nerve distribution. In spite of the common nature of the problem, the literature evidence is limited. In this paper we discuss the diagnostic tools and treatment options, both non-surgical and surgical. In addition, we discuss the criteria for surgical intervention and its optimal timing.

Key words: Hernia; Lichtenstein repair; Chronic groin pain; Inguinodynia; Neuropathic pain; Neurectomy; Nerve block

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INTRODUCTION

Mesh inguinal hernia repair is one of the most common operations performed worldwide. Inguinodynia or Chronic Groin Pain following this operation is a potential complication and its incidence can be as high as 62.9%[1]. A quarter of these patients suffer from severe impairment in carrying out their daily routines[2-4]. Courtney *et al*[5] showed the effect of chronic groin pain on physical and social functioning, thereby limiting the individual's ability to participate in any paid employment.The rate of chronic groin pain following both open and laparoscopic hernia repair is vastly underreported[6,7]. Hindmarsh *et al*[8] shown that only 1% of patients with chronic groin pain post-herniorrhaphy were referred for further treatment. The main purpose of this review is to look at the available evidence on diagnostic modalities for this chronic problem and to discuss the varied treatment options practised worldwide.

AETIOLOGY OF CHRONIC GROIN PAIN

The exact aetiology of this complex pain is unknown, although various theories have been proposed. Chronic groin pain has been classified empirically as neuropathic or non-neuropathic in origin. Neuropathic pain is con-

sidered to be due to damage to the inguinal nerves and usually develops in the sensory distribution of the injured nerve. Non-neuropathic pain is caused by either mesh-related fibrosis or post-operative fibrosis. The nerves involved are the Ilioinguinal nerve (IIN), the Iliohypogastric nerve (IHN), the genital branch of the Genito-Femoral nerve (GFN) and, rarely, the Lateral Femoral Cutaneous nerve (LFC). These nerves can be damaged either by partial or complete transection, stretching, contusion, crushing, electrical damage or by being caught in the suture used in open repair or the tacks used in laparoscopic repair. Secondary nerve damage can also occur as a result of adjacent inflammatory processes, such as granuloma, or because of excess fibrotic reaction or mesh encasement[9]. Wantz *et al*[10] showed that handling of the sensory nerves during surgery leads to chronic residual neuralgia.

Heise *et al*[11] were the first to describe non-neuropathic pain caused by rolling up of the mesh or mesh-related excess fibrosis. Similarly, another pain syndrome, termed "somatic pain", has been described secondary to damage to the pubic tubercle while anchoring the mesh[12]. A small group of patients have been shown to suffer from diffuse pain around the spermatic cord (funiculodynia), resulting in ejaculatory pain[13]. This has been described as "visceral pain" and is due to venous congestion of the spermatic cord or to mesh encasement of the cord. A combination of neuropathic, non-neuropathic, visceral and somatic pain is common, making clinical or radiological differentiation of the cause extremely difficult.

During laparoscopic repair, the IIN is at risk lateral to the internal ring and the GFN medial to the ring. The IHN is commonly damaged by tacks or staples along its entire length, making it highly vulnerable during laparoscopic mesh fixation[14-16]. Occasional damage to the LFC nerve[17,18] and the femoral nerve[19] have also been shown during laparoscopic repair Although laparoscopic repair has been shown to result in reduced chronic groin pain, exact reasons for this are unclear[20-23].

COMPLEX SYMPTOMS OF CHRONIC GROIN PAIN

The complex symptoms of post-herniorrhaphy chronic pain vary depending on the involvement of the nerve or nerves, amount of mesh-related fibrosis and damage to spermatic cord structures. The neuropathic symptoms include pain (neuralgia), burning sensation (paraesthesia), reduced sensation (hypoaesthesia) and increased sensation (hyperaesthesia). The pain may radiate to the hemiscrotum, upper leg or back.

Neuropathic pain is usually characterised by the presence of a trigger point, its episodic nature and by being aggravated by walking or sitting. It is variously described as a stabbing, burning, shooting or pricking sensation[24]. In contrast, non-neuropathic pain is a constant dull-ache over the entire groin area with no specific trigger point and is usually aggravated by strenuous exercise.Patients commonly describe it as a gnawing, tender, pulling or pounding sensation[11].

A small group of patients also report numbness over the groin or thigh, with the most common point of maximal tenderness at the pubic tubercle. These patients have inflammation of the pubic tubercle either due to stitches made on the pubic bone during open repair or application of tacks in laparoscopic repair[13]. Another range of symptoms are related to sexual dysfunction due to vas engulfment and inflammatory reaction caused by the mesh. Patients describe ejaculatory pain in the region of superficial ring or testicular or labial pain due to GFN irritation[25]. Other complaints included diminished quality of life, mood swings and depression[26,27].

DIAGNOSIS OF CHRONIC GROIN PAIN

The diagnosis of chronic groin pain begins with a comprehensive patient history and good knowledge of the anatomy of inguinal nerves. The history should include the commonly encountered risk factors for chronic groin pain which include age below median, female gender, postoperative complications, recurrent hernia repair, open repair techniques, history of preoperative pain and an interval of less than 3 years from surgery[28].

Due to the infrequent presentation of chronic groin pain, there is no clear consensus on the diagnosis of this iatrogenic problem. Neuropathic pain is usually distributed along the sensory innervations of the affected nerve(s) and can be reproduced by tapping the skin medial to the antero-superior iliac spine or over an area of local tenderness (Tinel's test). The clinical differentiation of ilioinguinal, iliohypogastric and genitofemoral neuralgia is difficult, frequently resulting in misdiagnosis and inappropriate treatment[29,30]. This is because of the overlapping sensory innervations of these three nerves, peripheral communication between their nerve twigs and, most importantly, their common roots of origin[31]. Along with these anatomical factors, fibrosis caused by the procedure and the mesh causes a degree of non-neuropathic pain in most cases, thereby making it difficult to delineate the neuropathic cause clinically.

Deysine *et al*[32] and Starling *et al*[33] used IIN block and recommended IIN neurectomy if the block relieved pain. If pain persisted after IIN block, L1-L2 plexus block was carried out and, if this relived pain, GFN neurectomy was then performed. If pain was partially relieved by both blocks, groin exploration of both nerves was then carried out. There is no consensus on how these nerve blocks should be performed and how the results should be interpreted. Bower *et al*[34] showed that after an unspecified nerve block, 13 out of 15 patients had pain relief and went on to have their IIN, IHN and/or LFC nerve excised. Again, there were no clear criteria for putting the patient through neurectomy.

Heise *et al*[11] suggested that nerve block neither predicts nor changes outcome. They suggested that if hernia is done without mesh, then nerve blocks are needed to

identify nerve involvement. However, if a mesh is present, the sensitivity of the test is poor due to lack of spread of anaesthetic agent because of mesh-related fibrosis. Though peripheral nerve blocks or paravertebral blocks have been tried, they lack the ability to differentiate the involved nerve and are only helpful temporarily as a means of relieving pain.

CT or MRI scans are helpful in identifying non-neuropathic causes of chronic groin pain by identifying mesh-related pathologies, recurrent hernias and occasionally neuromas[35,36]. A few studies have use MR Neurography to differentiate the involved nerves by studying the water content of the inguinal nerves[37]. Kim *et al*[38] carried out electromyograms on all patients, specifically looking for denervation of the pyramidalis muscle which is supplied by the IIN nerve. They showed that 91% of IIN neurectomies and 90% of combined neurectomies were successful, although there no mention of the rate of pain recurrence.

TREATMENT OPTIONS FOR CHRONIC GROIN PAIN

The treatment of chronic groin pain can be a difficult ordeal for both the patient and the clinician. Many algorithms have been put forward for management of chronic groin pain[2,39], but none of them has been proved in randomised trials. Pain related to neuropraxia (intact axon and myelin sheath), is usually temporary and may resolve itself in around 6 mo post-herniorraphy. As time progresses, chronic groin pain disappears without treatment in 30% of the patients, remains mild in 45% and in 25% of them it persists as severe pain affecting their everyday life[5].

NON-SURGICAL TREATMENT

Lifestyle modification

Chronic groin pain has been shown to be aggravated by walking, stooping or hyper-extension of the hip and relieved by recumbent position and flexion of the hip and thigh[35]. Hence, some clinicians have advised lifestyle changes, advocating sedentary lifestyle or sedentary occupations to negate the neuropathic pain caused by movement. This leads to poor quality of life and loss of productivity[5] and is not now recommended because of the availability of better medical and surgical modalities.

Analgesics

Many clinicians use pharmacologic agents to manage chronic groin pain. These include non-steroidal anti-inflammatory drugs (NSAIDs), opioids, muscle relaxants, antiepileptics and antidepressants. However, these drugs may not prove helpful in relieving all types of chronic groin pain. The anti-depressants and antiepileptics are helpful in neuropathic pain whereas opioids or NSAIDs are usually minimally effective or ineffective for neuropathies[40]. In most studies, NSAIDs were used as the first line analgesic treatment. Kim *et al*[38] used gabapentin or oral steroids as second line agents following the failure of NSAIDs. The steroids work by reducing the inflammation and oedema surrounding entrapped nerves. The efficacy of these treatment regimens has not been proven and majority of patients suffer recurrence with worse pain due to development of resistance to analgesics.

Physical and psychological therapies

Physical therapies including massage, physiotherapy and acupuncture have been tried[24]. Keller *et al*[41] used thermotherapy to temporarily negate the painful stimulus. Ferzli *et al*[42] tried Capsaicin cream applied topically as a counter-irritant to desensitize painful stimulus. These physical techniques may reduce pain temporarily but few, if any, can prevent the recurrence of pain.

Nerve blocks

Nerve blocks reversibly interfere with neuronal transmission, leading to temporary pain relief. This can, therefore, be both diagnostic and therapeutic. The ideal nerve block would specifically anaesthetise the nerve proximal to the injury but this is technically challenging. Various chemical agents used for blockade are shorter- or longer- acting local anaesthetics, steroids and glycerol as well as neurolytic solutions such as alcohol or phenol[11]. Commonly, these agents prevent neuronal transmission through nerve fibres either by blocking membrane ion channels or by denaturation of axon proteins. They can also be used with non-pharmacologic techniques like cryoanalgesia and transcutaneous electrical nerve stimulation, depending upon the response to the anaesthetic agents. All these therapeutic modalities have their own risks, therefore a positive diagnostic block should guide the further use of therapeutic blocks.

There is little published information on the success rate of nerve block as this depends on the experience of the surgeon or the anaesthetist performing the procedure. There is no consensus on approach or the type of anaesthetic agent to be used for therapeutic inguinal nerve blockade. Previously, blind injection of local anaesthetics was practiced, based on knowledge of the anatomy of the nerves. Recently Ultrasound guided blocks have been shown to be highly accurate and selective for blockade of either the IIN or the IHN, thereby increasing success rates[43]. In a case reported by Hartrick, GFN block was attempted through a trans-psoas approach using the L3-L4 vertebral space as a guide[44]. This anecdotal evidence cannot be generalised to the population and more extensive controlled trials are needed.

Alcohol or phenol injection has been tried for reducing chronic inflammation caused by mesh or post-operative fibrosis[45]. Neuro-destructive procedures, such as cryo-ablation which destroy the nerve fibres by coagulation at very low temperatures (-40℃), have been shown to give some temporary pain relief[46]. Following cryo treatment pain recurred due to axonal regeneration. Radiofrequency pulses, working by thermo-coagulating

nerves at very high temperatures, have been shown to cause temporary pain relief in ilioinguinal neuralgia[47]. Again, definite evidence for their effectiveness is lacking.

SURGICAL TREATMENT

The surgical treatment of chronic groin pain was first described by Stulz *et al*[48] in 1982. They performed IIN neurectomy on 5 patients with chronic groin pain following inguinal hernia repair, achieving a 100% success rate. However, surgical explorations and neurectomy carried out by other groups during this period were quite unsuccessful. Hameroff *et al*[49] performed IIN neurectomy on 2 patients with 100% recurrent pain after few months. Harms *et al*[30] reported similar problems, also in two patients. The first patient had 2 unsuccessful explorations, followed by successful GFN block and 3rd exploration leading to GFN neurectomy. Second patient had IIN neurectomy on 1st exploration and, due to recurrence of pain further, exploration and GFN neurectomy. Since then a number of studies have shown success rates ranging from 70%-100%[11,12, 24,27,29,30,32-34,38,41,48-59] (Table 1).

Principles of surgical treatment

Removal of the foreign body (mesh) alone has not been shown to relieve chronic groin pain. It is thought that it is due to chronic inflammation around the nerves from the mesh-induced reaction and the consequent degenerative nerve damage. Traditionally, surgical treatment of chronic groin pain includes groin exploration, mesh removal and neurectomy. Open chemical neurolysis has been tried, but does not resolve the problem of neuromas and secondary scarification[33]. Freeing the nerve alone (physical neurolysis) has been tried but with high failure rates[27,53]. Similarly simple division of the nerves without resection is not recommended. The entire length of the nerves should be excised, in order to involve all the neural connections between the nerves. Neurectomy with or without mesh excision is usually the preferred surgical treatment but there are no current consensus on which surgical approach should be chosen and which nerve should be excised. Heise *et al*[11] found that 62% of patients who had mesh removal plus neurectomy achieved excellent results in comparison with the mesh-removal-alone group where the success rate was 50%. They concluded that concurrent neurectomy affords better results than mesh removal alone. Recently radio-frequency ablation of inguinal nerves have used with the aim for ablating the painful impulses transmitted by injured nerves. Rozen *et al*[60] found that after radio-frequency ablation at T12, L1, L2 root level 4 out of 5 patients showed complete resolution of pain 4 to 9 mo later. Again, there is a lack of systematic evidence to support these findings.

The IIN can be identified lateral to the internal ring and then traced towards the external ring and resected as distally as possible. The IHN can be identified by the separation of the external oblique aponeurosis from the underlying internal oblique muscle as proximally as possible. With the IHN, dissection should include the intramuscular section, in order to look for nerve entrapped by sutures, mesh plugs or tacks. The GFN is usually identified through a retro-peritoneal (flank) approach. In a very rare case of LFC nerve involvement, decompression was performed by releasing the inguinal ligament on the anterior superior iliac spine and the lateral fibres of internal oblique aponeurosis[27].

Amid adopted an anterior approach, where the nerve could be identified within the lateral crus of the internal ring, within the internal ring or between the spermatic cord and the inguinal ligament. He showed that complete resection might not be possible with this approach, but that even partial resection is sufficient if the other 2 nerves are resected completely[54]. He devised a single stage procedure, where simultaneous IIN, IHN and GFN neurectomies were performed under local anaesthetic with proximal end implantation of these nerves. Amid also devised a technique of implantating the cut end of the IIN and IHN within the fibres of the internal oblique, reducing the risk of adherence with aponeurotic structures and thereby reducing the chance of recurrent pain[36]. For GFN, the nerve was cut under tension in order to retract the nerve into the internal ring. In a retrospective review of 225 patients who underwent surgery for neuropathic and non-neuropathic pain, 11% had traumatic neuroma, 32% had nerve entrapment by suture, staple or mesh and 57% had perineural fibrosis[36]. They showed complete improvement in 85% of their patients, while 15% of them had transient insignificant pain with no functional impairment. Four of the 225 patients showed no benefit from this triple neurectomy[36]. Krähenbühl *et al*[55] performed laparoscopic triple neurectomies using a retro-peritoneal approach and showed complete cure in three patients. Ducic *et al*[56] adopted an open inguinal approach to identify the GFN postero-lateral to the cord, traced the nerve from there all the way to the pre-peritoneum and resected under tension. They showed 100% pain relief in 4 patients treated with GFN neurectomy.

Resected tissue from neurectomy should be sent for histology to confirm the removal of the involved nerve. Most importantly, there should be an informed decision about post-neurectomy numbness in the area of corresponding nerve innervation.

Criteria for surgical treatment

Surgical treatment is required if refractory pain persists after treatment with oral analgesics and/or local nerve(s) blockades. Nerve block must have resulted in a complete or substantial decrease in pain before neurectomy can be recommended. There are no defined limits on how often nerve blocks can be carried out and the practice has varied among surgeons worldwide. Deysine *et al*[32] employed IIN block and if it was effective on first use, IIN neurectomy was then considered. No information is given on the success rate of nerve blockade from this study or the reasons for selecting successful IIN block alone as an indication for surgical treatment. Kim *et al*[38] also relied on nerve blocks alone as an indication for neurectomy. They concluded that the nerve blocks were sensitive enough if

Table 1 Studies showing neurectomy performed by open, laparoscopic or a combination of both open and laparoscopic approach

Author	Country	No. of pts	Surgical approach	Which nerve excised?	Was mesh excised?	Follow-up duration	Recurrence/ Persistent pain	Compli-cations	Remarks
Hameroff *et al*[49], 1981	USA	2	Open	IIN	N/A	NM	2/2	Nil	Only temporary pain relief following neurectomy
Stulz *et al*[48], 1982	Switzerland	5	Open	IIN	N/A	NM	No separate data for inguinal hernia patients	Nil	Out of 22 patients who underwent neurectomy, 5 had previous inguinal hernia repair. In all inguinal hernia cases, IIN was entrapped within the scarred tissue and was excised
Harms *et al*[30], 1984	USA	2	Open	GFN, IIN + GFN	N/A	18 mo (patient 1), NM in other patient	2/2	Wound infection (2)	First patient had 2 unsuccessful exploration, followed by successful GFN block and 3rd exploration with GFN neurectomy. Second patient had IIN neurectomy on 1st exploration and due to recurrence of pain further exploration and GFN neurectomy
Starling *et al*[33], 1987	USA	26	Open	IIN or GFN	N/A	NM	2/13 in IIN group and 3/13 in all GFN group patients	Nil	No differentiation possible in GFN group to establish only patients with previous hernia repair. Overall 10 out of 13 with GFN neurectomy were pain free
Starling *et al*[29], 1989	USA	31	Open	IIN or GFN	NM	NM	2/19 in IIN 4/12 in GFN	Nil	Selective nerve blocks used to identify involved nerve(s). In GFN group, no data was given to differentiate those patients who had hernia repair and those who had other abdominal operations
Bower *et al*[34], 1996	USA	15	Open	IIN, IHN, GFN or LFC	No	66 mo	3/12	Nil	Three patients had persistent pain following redo exploration. Redo explorations could not identify involved nerve in two patients and identified a recurrent hernia in the other patient
Nahabedian *et al*[51], 1997	USA	2	Open	IIN, IHN or GFN	NM	21 mo	0/2	Nil	In one of the patients, no nerve was identified intra-operatively and on the tissue excised, but pain relief was noted post-operatively
Heise *et al*[11], 1998	USA	20	Open	IIN or IHN or GFN	Yes	16 ± 3 mo	8/20	Haematoma (1), Testicular atrophy (1)	4 patients had only mesh excised and 6 patients underwent selective neurectomy based on operative findings plus mesh excision
Lee *et al*[53], 2000	USA	11	Open	IIN, IHN, GFN or LFC	Yes	10 mo	NM	Haematoma (1) and recurrent hernia (1)	History and clinical examination alone was done for pre-operative assessment. Mesh removal alone did not relieve pain in any patients. IIN was commonly excised. Majority of patients had excellent pain relief, no differentiation could be done to identify those with hernia repair
Deysine *et al*[32], 2002	USA	22	Open	IIN	No	NM	0/22	Nil	Diagnostic nerve blocks were attempted in all patients. 8 out of 30 patients responded to conservative treatment and the rest were subjected to IIN neurectomy alone. No follow-up data was available and complications were not mentioned
Ducic *et al*[56], 2004	USA	4	Open	GFN + IIN	No	9 mo	0/4	Nil	All patients had failed medical treatment. No clear information on diagnosis of nerve entrapment, One patient had previous unsuccessful GFN resection and another patient had previous failed IIN resection
Kim *et al*[38], 2005	USA	16 (33 total)	Open	IIN, IIN + IHN	NM	12-46 mo	3/33, 10% had recurrent pain, but no clear mention about hernia patients	NM for hernia patients	33 patients were operated for CGP, but only 16 had previous hernia repair. Diagnostic nerve blocks done on all patients. Of all 33 patients operated, 91% of IIN neurectomies and 90% of combined IIN + IHN neurectomies were successful

Amid *et al*[54], 2004	USA	225	Open	Triple neurectomy	Yes	6 mo	15% had transitional incisional pain with no functional impairment	Nil	Proposed 1-stage procedure of simultaneous neurectomy of all three nerves without mobilisation of spermatic cord. The nerve ends were implanted proximally into the fibres of internal oblique muscle
Murovic *et al*[50], 2005	USA	1	Open	GFN	No	NM	0/1	Nil	Ten patients with Genitofemoral neuralgia were analysed, but only one patient had previous hernia repair. Diagnostic nerve blocks were used prior to GFN neurectomy by lateral extraperitoneal approach
Ducic *et al*[27], 2008	USA	18	Open	IIN, IHN, GFN or LFC	NM	12-24 mo	3/18	Nil	Nerve blocks not routinely done. Patients selected for surgical intervention based on history and physical findings
Delikoukos *et al*[12], 2008	Greece	6	Open	IIN	Yes	28 mo	0/6	Nil	No nerve blocks were utilised. Persistent pain in spite of analgesics were indication for surgery in this study. IIN were either excised or freed from the mesh, if entrapped
Vuilleumier *et al*[24], 2009	Switzerland	43	Open	IIN + IHN	Yes	12 mo	2/43	Recurrent hernia (1)	Diagnosis of neuropathy was done using clinical findings and positive Tinel's sign. All patients had failed conservative treatment with systemic analgesics, injection of local anaesthetics and steroids, and physiotherapy. Radical neurectomy done in all cases. GFN not excised in any case
Zacest *et al*[58], 2010	USA	27	Open	IIN, GFN	Yes	35 mo	6/19 (followed-up patients)	Nil	Diagnosis was made using selective nerve blocks. Only 19 of the 27 patients responded to telephone follow-up and 67% mentioned either complete pain relief or pain lesser than before
Loos *et al*[52], 2010	Netherlands	54	Open	IIN, IHN, GFN	Yes	18 mo	24%	Haematoma (1), wound infection (1), haemorrhage (1), ischaemic orchitis (1)	Diagnostic nerve blocks were used in majority of them (78%) and some patients underwent CT or MRI (22%). Tailored neurectomy performed depending on intra-operative findings
Krähenbühl *et al*[55], 1997	Switzerland	2	Laparoscopic (Retro-peritoneal)	GFN and IIN	No	3 mo	0/2	Nil	No information given about the diagnosis of CGP and indication for laparoscopic neurectomy. Retroperitoneal neurectomy done, but no clear mention about how the nerves were identified intra-operatively
Wong *et al*[59], 2001	Canada	1	Laparoscopic (pre-peritoneal approach, under fluoroscopic guidance)	Nerve not excised	Yes (mesh and staples)	NM	0/1	Nil	Single patient report with 5 month history of groin pain following laparoscopic hernia repair. Mesh and tackers were found to entrap the IIN and were removed laparoscopically aided by fluoroscopy
Rosen *et al*[57], 2006	USA	12	Combined open and laparoscopic	IIN + IHN	Yes	6 wk	0/12	Nil	All patients had previous open hernia repair and 2 failed percutaneous nerve blocks to treat CGP. TAPP repair done initially, followed by groin exploration, mesh removal and nerve transection. Too short follow-up
Keller *et al*[41], 2008	USA	21	Combined open and laparoscopic	Triple neurectomy	Yes	6 wk	1/19 (followed up patients)	Nil	Percutaneous nerve block was unsuccessful in all patients. Initially transabdominal diagnostic laparoscopy was performed irrespective of the route of initial surgery. Mesh was placed in the opposite location to the first mesh (laparoscopic if the first was open and *vice-versa*). Too short follow-up

NM: Not mentioned; IIN: Ilioinguinal neurectomy; IHN: Iliohypogastric neurectomy; GFN: Genitofemoral neurectomy; LFC: Lateral femoral cutaneous neurectomy; CGP: Chronic groin pain; N/A: Not applicable; Triple Neurectomy: IIN + IHN + GFN neurectomy; TAPP: Trans-abdominal pre-peritoneal repair; CT: Computed tomographic; MRI: Magnetic resonance imaging.

carried out by an experienced anaesthetist. Bower *et al*[34] showed temporary pain relief in 13 of their 17 patients following unspecified nerve block. These patients went on to have IIN, IHN or LFC neurectomy depending on operative findings. Failure or recurrence of pain following at least two attempted nerve blocks is the criterion for choosing surgery followed in most units worldwide.

Loos *et al*[52] showed that previous pain treatment is a predictor of poor operative treatment result. Kehlet *et al*[61] studied factors for persistent post-surgical pain and found that a few patients suffer from central nervous system sensitisation, making them refractory to any form of treatment and poor candidates for surgical exploration. Nerve blocks and TENS are effective treatments for such patients and surgery should be avoided[52]. Currently there is no consensus on the type of assessment tool for patients needing neurectomy and, as a result, there is no definitive protocol available for selecting patients for surgical exploration.

Timing of surgical intervention

Differences in the assessment of chronic groin pain, and variations in diagnostic practice and in the length of trial period with nerve blocks, have meant that the timing of surgical intervention has been widely varied. The timing of surgical intervention should ideally be at least 6 mo after herniorraphy to give adequate time for any neuropraxia to settle and time to try medical management[62].

Surgical approach

A combined open and laparoscopic approach has been proposed by two groups[41,57]. Keller *et al*[41] used a protocol where after removal of mesh from the previous hernia repair, further mesh was placed in the opposite location to the first mesh (laparoscopic, if previously open repair and *vice versa*). Twenty of 21 patients reported significant resolution of symptoms at 6 wk follow-up. Results showed that an initial laparoscopic approach aids examination of the inguinal areas to rule out a recurrent hernia or any other inguinal pathology. At the same time if a previous laparoscopic repair was performed, the mesh was excised and triple neurectomy plus re-do repair carried out using an open approach. Conversely, if an open repair was done previously, the inguinal areas were checked initially using laparoscopy and a TAPP repair performed, followed by mesh removal plus triple neurectomy through the previous open incision. These authors also found that one patient with testicular pain and a previous plug-and-patch repair, had the vas engulfed by mesh. Removal of the plug with the vas cured his symptoms, thereby avoiding an unnecessary neurectomy which would have been performed if open approach alone was applied.

Rosen *et al*[57] took a similar approach in patients with previous open inguinal hernia repair, using initial laparoscopic evaluation and TAPP repair, followed by open exploration, removal of mesh and then IIN and IHN neurectomy. They believed that removal of GFN was not needed, as none of their patients had any ejaculatory or other sexual symptoms. In one patient with chronic orchalgia following previous plug and patch repair, the initial diagnostic laparoscopy showed plug mesh engulfing the vas deferens, and the resection of both led to permanent relief of pain. The other 11 patients showed significant improvement in their pain following neurectomy. To date, there are no randomised studies comparing the open and laparoscopic approaches for neurectomy. The majority of the available results are from individual case series and are, therefore, biased by individual surgeon's laparoscopic abilities and the small number of patients reported.

Which nerve should be excised?

A review of surgical treatment for chronic groin pain carried out by Aasvang *et al*[63] showed that the details of surgical treatments used were not evidence based and varied between different published studies. There was no clear explanation in most studies of why only one or two nerve were resected, rather than all three. Neurectomy should ideally resect the entire length of the nerve as far proximally as possible, to leave a smoothly cut end. There is still no consensus on whether only the affected or the entrapped nerve should be removed, or whether three nerves should be removed on the basis that remaining nerve branches may still transfer pain stimuli[35]. Resection of the three nerves, IIN, IHN and GFN, has been shown to permanently relive chronic groin pain at the expense of inguinal numbness.

Ilioinguinal neurectomy alone has also been shown to be an effective treatment for relieving chronic groin pain in several studies[29,32,38]. Starling *et al*[29] performed IIN neurectomy alone in 17 patients and showed complete pain relief in 15 of them. Kim *et al*[38] showed similar results, with 19 of their 21 patients showing considerable pain relief following isolated IIN neurectomy. In a retrospective review of 19 patients, Keller *et al*[41] showed that triple neurectomy was performed in 7, dual neurectomy in 9 and at least one nerve was excised in 18 patients. Of 19 patients only one had recurrent pain a year after neurectomy.

Loos *et al*[52] followed a tailored neurectomy approach where, depending on intra-operative findings of nerve involvement or mesh pathology, the nerve was excised with or without mesh. According to these authors, this protocol avoids the removal of all three nerves, as proposed by Amid, avoiding the consequent chronic numbness[56]. In a retrospective review of 68 patients who underwent tailored neurectomy, 12 patients (17.6%) needed further operation because of persistent pain. This study showed a complete pain relief in 52%, partial pain relief in 24% and pain unchanged in 24% at 1.5 years median follow-up.

Vuilleumier *et al*[24] in a prospective cohort study of neuropathic groin pain patients, defined a radical neurectomy where the inguinal canal was explored through an anterior approach and mesh, IIN and IHN were removed radically by sharp dissection, ends of the nerves being tied with prolene sutures. They showed that median pain score (VAS) decreased significantly post-operatively, with 41 (95%) reporting complete relief and 2 (5%) having partial relief from pain. There had been a median of 6 mo

work incapacity in theses patients but all of them returned to work 6 wk post-operatively. Vuilleumier *et al*[24] suggested that as GFN is a small nerve and neurectomy of GFN can cause damage to spermatic blood vessels, the procedure should not recommended. Overall, there is no consensus on which nerve should be excised for the treatment of chronic groin pain.

Dealing with neurectomized nerve ends

The transacted nerve can be ligated, cauterised or buried within the muscle fibres. Keller *et al*[41] did not ligate the cut nerve ends until bleeding occurred, because of the risk of neuroma formation at the tied end. Majority of surgeons usually tie the nerve end with absorbable suture and tuck it under the internal oblique muscle.

Mesh excision

Currently there are no long-term results available from large studies on the safety of surgical mesh removal with or without neurectomy.

Pubic periosteal reaction or osteitis

If there is pubic periosteal reaction or osteitis, then possible causative agents such as suture materials, staples or rolled up meshes should be removed. Steroid injection can be useful when used intra-operatively or post-operatively if pain persists[62].

CONCLUSION

Chronic groin pain is not uncommon. It is particularly common in patients with pre-operative pain due to hernia and in patients who are of younger age. Diagnosing chronic groin pain is difficult and needs a high level of patient co-operation. Pain severity is subjective and will remain difficult to evaluate until better scoring systems are developed. In most studies pain is measured subjectively prior to initiation of medical or surgical treatment. Occasionally, objective assessment tools like VAS are used or there is correlation with pre-operative pain scores before treatment is given. There is currently a lack of consensus on the appropriate transition from medical to surgical management of these patients.

The role of surgery in patients with chronic groin pain is controversial and due to various surgical methodologies adopted by surgeons worldwide, data are highly confusing and difficult to interpret. Moreover, the current treatment regimens for chronic groin pain have limited success and their long-term benefits and quality of life effects are still uncertain. A randomised clinical trial comparing nerve blocks *vs* surgical neurectomy is currently being undertaken[64] to obtain a definitive answer to this difficult problem.

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