

Chronic postoperative pain: the case of inguinal herniorrhaphy

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That surgical injury can lead to chronic pain is now well established.^{8 21 29 41 50} From these reviews and studies using a systematic collection of data, the estimated incidences of chronic pain after various procedures are: leg amputation about 60%, thoracotomy about 50%, breast surgery about 30%, cholecystectomy 10–20%, and inguinal herniorrhaphy about 10%. Predictive risk factors for chronic postoperative pain are: preoperative pain, repeat surgery, psychological vulnerability, workers compensation, a surgical approach with risk of nerve damage, moderate or severe intensity of acute postoperative pain, radiation therapy, neurotoxic chemotherapy, depression, neuroticism, and anxiety.^{29 41}

All these factors should be assessed in any study of chronic postoperative pain; however, this has rarely been the case. Thus, a detailed understanding of the relative role of the mechanisms responsible for the development of chronic postoperative pain is not available and further complicated by the many possible pathogenic mechanisms. As patients undergoing inguinal hernia repair do not have a number of the risk factors such as cancer, a severe preoperative pain state, chemotherapy or radiation therapy, or predominant psychosocial characteristics, this surgical model may be suitable for a detailed analysis of the pathogenic mechanisms involved in development of a chronic postoperative pain state. Thus, this review will focus on the study of chronic pain after inguinal hernia repair, which is one of the most common surgical procedures with an annual rate of 2800 per million population in Europe and the USA.³ Poobalan and colleagues published a review in 2001⁴⁴ where data on chronic pain after inguinal herniorrhaphy until 2000 were analysed, and found that chronic pain was observed in about 10% of patients undergoing inguinal herniorrhaphy. The conclusions and risk factors are summarized in Table 1.

This review considers, in addition to the findings by Poobalan and co-workers,⁴⁴ the literature from 2000 to April 2004, as there has been an increased focus on post-herniorrhaphy pain more recently, thereby providing a better understanding of the pathogenic mechanisms of chronic postoperative (post-herniorrhaphy) pain. A special emphasis is placed on the role of nerve damage in order to outline

strategies for prevention and treatment of chronic postoperative pain.

Methods

The term ‘chronic post-herniorrhaphy pain’ has a wide variety of interpretations in the literature. The International Association for the Study of Pain has defined chronic pain as pain lasting more than 3 months.²⁰ However, with the modern use of synthetic mesh for hernia repair, an inflammatory response may last a couple of months as a result of a reaction against the foreign material. The criteria for inclusion in this review were therefore: studies of pain more than/equal to 6 months after hernia surgery and including more than/equal to 100 patients. A search was made using the PUBMED search engine (National Centre for Biotechnology Information, US National Library of Medicine, USA), and the Ovid search engine (Ovid Technologies, Wolters Kluwer, Amsterdam, The Netherlands). We searched both databases in May 2004 and covered the period January 2000 through to April 2004. The term ‘pain’ was combined with the term ‘hernia, inguinal’. Other words associated with pain were explored, such as ‘neuropathy’, ‘discomfort’, ‘complications’, ‘consequences’, and ‘results’. The search was restricted to ‘adult 19+’ and ‘English language’. In addition, some articles published during the review process after April 2004 were included, as were articles known by the authors, but not found in the databases. References were crosschecked for literature not found in the database search. Reviews were checked for additional studies. Letters to the editor and abstracts were not included.

Data extracted from each study were: number of patients included in the original study, follow-up rate and period, frequency and severity of pain at a given time, method of pain assessment, pain descriptors, and type of surgery (mesh vs non-mesh vs laparoscopic repair). If available, data on preoperative and early postoperative pain were extracted, as were any data regarding impairments in physical, social, psychological, or sexual functions. To calculate the incidence of pain, we analysed the number of patients responding at the time of data collection. If more than one follow-up date was noted, data from the follow up closest to 1 yr were

Table 1 Factors related to development of a chronic post-herniorrhaphy pain state, based upon a literature review up to 2000⁴⁴

Pain reported in 0–53% patients.
Moderate to severe pain in about 10%.
Pain restricted daily activity in up to 25% of patients.
No conclusion on differences between laparoscopic vs open-hernia repair.
Higher risk of pain after operation for a recurrent hernia.
Less pain after mesh than non-mesh repair.
Chronic pain related to numbness in surgical area after surgery.
Chronic pain related to intensity of acute postoperative pain.

extracted, and we only included studies where the data had been collected systematically.

Exclusion criteria were: articles already included in the previous review,⁴⁴ although studies relevant to pathogenic mechanisms are quoted in the section on interpretation and future strategies; studies with less than 6 months follow up; and studies with unclear definitions of pain and its assessment.

Results

Our search yielded 111 articles, of which 62 articles were not identified beyond the abstract as they had a follow up of less than 6 months or less than 100 patients. The remaining 59 articles were studied for full critical review, and 35 articles fulfilled the inclusion criteria by evaluating postoperative pain beyond 6 months in more than/equal to 100 patients.

The studies fell into two major categories: randomized controlled trials and non-randomized studies. There was no correlation between study type and frequency of pain reported, but a significantly lower incidence of pain in single centre studies compared with multicentre studies in open surgery ($\chi^2=72$, $P<0.01$), and laparoscopic surgery ($\chi^2=15$, $P<0.05$). The incidence of pain was not correlated to study size.

Pain was the primary outcome in only 16 studies,^{3 6 10 13 17 24 25 27 30 31 39 40 42 43 51 54} and there was a significantly higher incidence of chronic pain in these studies (25 vs 7%, $\chi^2=611$, $P<0.01$) (range 0–76%), compared with studies with chronic pain as a secondary outcome. Similarly, Poobalan and co-workers⁴⁴ found a 15–53% incidence of chronic pain in four studies with pain as the primary outcome.

Time course

There was no correlation between the incidence of pain in relation to follow up. However, the literature does not contain data from a large patient cohort studied in detail and prospectively over a prolonged period. In a study¹⁰ of 120 patients, from an earlier study¹⁸ of 4076 patients, that reported severe or very severe pain 3 months after the operation, 71% still reported pain after 2.5 yr, but only 26% of the 120 patients then described the pain as severe or very severe, suggesting a ‘burn out’ effect of the pain complaints.

In a prospective randomized trial²⁶ in 102 patients comparing Shouldice’s procedure to laparoscopy, no patients complained of pain in the laparoscopic group, but 46% in the Shouldice had complaints after 1 yr, and 16% after 6 yr. However, there was no clear definition of the terms ‘pain’ or ‘complaints’, making interpretation difficult. Two other studies^{55 59} with more than 1 yr follow up, described declining pain incidences when patients were seen at 6, 12, 24, or 60 months after surgery, but again the specific time-course data on frequency and intensity were not presented from the same group of patients. In a study³⁶ of 1983 patients assigned to either laparoscopy or open-mesh hernia repair, most cases of long-term pain (about 12%) persisted from the early postoperative period, but in others it was a new phenomenon observed at a long-term visit, but without presentation of specific data. An earlier study¹¹ found an incidence of moderate or severe pain in 55% of 276 patients in the immediate postoperative period, which was reduced to 12% after 1 yr and 11% after 2 yr, but the study had a low follow-up rate of only 38%. In a recent study⁴² of 391 patients treated with hernia mesh-repair, 28% complained of mild pain, 17% of moderate pain, and 6% of severe pain at the 1-month follow up. After 6 months, the numbers were 25, 9, and 3%, and after 1 yr 18, 4, and 2%, respectively. Pain was assessed by a four-point verbal scale, but was not corrected for age or activity level.

These studies suggest that some patients improve over time, but overall there is a lack of well-designed prospective studies in well-defined groups of patients to assess and quantify the time course of chronic post-herniorrhaphy pain.

Age

Only four studies compared patient age with the occurrence of chronic pain,^{3 10 43 59} and found that the risk of chronic pain decreased with increasing age, from 39 to 58% in patients less than 40 yr to 14–17% in patients more than 65 yr. The fraction of patients with severe or very severe pain was also higher in the younger group. However, an overall interpretation of the data is hindered by the lack of data on physical activities, which may be different between the age groups, and consequently for their complaints.

Preoperative pain

Disappointingly, few studies had data on preoperative pain frequency and intensity. In a study of 300 patients,⁵⁹ 88% of patients that developed chronic pain had pain at the preoperative assessment, compared with 59% of patients without chronic pain ($P<0.001$). Another study⁴³ also found a significant predictive value ($P<0.005$) between preoperative pain, and chronic pain. A study of 323 patients⁴⁰ showed that herniorrhaphy reduced the preoperative global pain score for the patient population but that some of the patients (numbers not shown) without a history of preoperative pain developed pain at the hernia repair site 1 yr after surgery.

In contrast, a large randomized study²⁷ of 994 patients found no significant relation between the development of chronic and preoperative pain ($P=0.2$). The MRC study found that 30% of patients reported no change in pain from before to after surgery, but that 5% felt worse than before the herniorrhaphy.⁵³

Preoperative chronic pain conditions such as headache, back pain, irritable bowel syndrome, pain from scars elsewhere in the body, and peptic ulcer were found to be significantly correlated with the development of chronic pain in two studies.^{10,59} However, there is a lack of detailed information on the type of chronic preoperative pain and psychological factors, hindering proper interpretation.

In conclusion, the available data suggest that preoperative pain may increase the risk of developing chronic pain but more studies are required with a detailed analysis of the history and type of pain complained of in other parts of the body than the inguinal area.

Gender

Studies that had gender-specific data showed the highest pain incidence in women. Thus, a nationwide study³ of 1071 patients with a follow up of 81%, found a 38% incidence of chronic pain in female patients compared with 28% in males ($\chi^2=3.87$, $P<0.05$). Similarly, in a study where 15% of 224 patients undergoing mesh hernia repair were women, three of the four patients with continuous pain were women resulting in an incidence of chronic pain of 0.5% in males vs 8.8% in females.³⁴ In a retrospective study of 594 men and 56 women, 3% of males and 11% of female patients developed chronic pain.⁵¹ Contrary to these findings, a non-significant ($P=0.84$) odds ratio of 0.9 for chronic pain in females were found in a study of 994 patients.²⁷

In conclusion, these findings suggest that females are at a higher risk of developing chronic pain than males. These results are in accordance with studies after other surgical procedures, which demonstrate that females may report increased intensity of acute postoperative pain.^{28,52}

Body mass index

Two studies found no significant relation between BMI and complications.^{43,49} Four other studies measured weight as a preoperative variable but the articles did not report whether this was a predisposing factor.^{27,35,55,57}

Operation for a recurrent hernia

In most of the studies reviewed, the study population was a combination of patients undergoing herniorrhaphy for either primary or recurrent hernia, and the data on chronic pain were not specified for primary or recurrent herniorrhaphy. Only five studies compared the risk of chronic pain in these two groups. One prospective, randomized trial²⁷ and two retrospective questionnaire studies^{10,17} found no correlation between surgery for recurrent hernia and a risk of chronic

pain. In contrast, a study of 351 patients found that an operation for a recurrent hernia significantly increased the risk of chronic pain 4-fold ($P=0.005$).⁴³ Also, a detailed prospective study⁹ of 419 patients of which 21% were operated on for a recurrent hernia found a significant higher incidence of moderate or severe chronic pain 12 months after operation compared with primary herniorrhaphy (14 vs 3%, $P<0.01$).

Based on these two latter studies of high quality it may be concluded that surgery for a recurrent hernia increases the risk for development of chronic pain, probably related to a technically more difficult operation with a higher risk of nerve damage.

Employment status

Employment was found to be a risk factor for chronic pain when employed patients were compared with their retired counterparts.⁴³ However, this finding was not corrected for patient age or physical activity. An earlier study found that patients receiving workers' compensation for work-related injury had a higher risk of developing chronic pain after 6 months.⁴⁸

Open vs laparoscopic repair

Studies that fulfilled the inclusion criteria for calculation of the overall incidence of pain yielded 7658 patients that had been treated by open procedures and 7998 that had been treated by laparoscopic surgery, all of whom had been questioned or examined for pain at the time of data collection.^{3,4,6,7,10,13,17,19,23–27,30,31,34–36,39,40,42,43,47,49,51,54–57,59}

The original study size varied from 100 to 5542 patients, and the follow-up population ranged from 72 to 4845 patients.

'Discomfort' was used in some studies as a pain outcome.^{24,26,35,51,56,57} However, as there were no definitions of the term, we excluded patients with complaints of 'discomfort' alone from the above calculations.

The overall incidence of chronic pain after herniorrhaphy was 12% (18% in patients having open surgery [range 0–75.5%], and 6% in patients treated laparoscopically [range 1–16%; $P<0.01$]). The follow up and method of pain assessment, along with the study design and definition of chronic pain varies to such a degree that these numbers should be interpreted cautiously. No final conclusions should be made regarding the exact incidence of chronic groin pain in relation to the type of surgery.

Single centre trials of less than 300 patients generally reported lower rates of chronic pain compared with larger studies, except for one study.¹⁹ None of the studies that used an objective pain measurement, for instance a VAS for pain assessment, found an incidence below 5%. A study of 400 patients found an incidence of moderate or severe pain of 2% after laparoscopy compared with 10% after open surgery, but the follow-up rate was only 61%.¹³ A comparative study between total extraperitoneal (TEP) and open-mesh herniorrhaphy using a retrospective questionnaire in 560 patients showed that, after a mean follow-up period of 21 months,

22.5% of laparoscopic patients had pain/discomfort compared with 38.3% of those treated by open-mesh repair ($P < 0.01$).²⁴

The only large study⁷ ($n > 300$) with an incidence below 4% reported that 3.3% of patients experienced chronic pain after TEP compared with 9.7% after Lichtenstein's mesh procedure. Another large study⁴⁹ found an incidence of 5% of inguinal and scrotal pain 1 yr after surgery in 5542 patients, and that bilateral laparoscopic surgery did not increase the risk of chronic pain. Likewise, a significantly ($P < 0.001$) lower incidence of chronic pain after laparoscopic surgery compared with open surgery (5 vs 13.5%) was found in a randomized study of 1051 patients.²⁷ The EU Hernia Trialists Collaboration review of 2003 patients treated by laparoscopic or open-mesh repair showed that a significantly lower number of patients treated by laparoscopy developed a chronic pain state (65/1004 vs 95/999, $P < 0.05$).¹⁴ In a large ($n = 928$) nationwide study, the MRC group also found a significant ($P < 0.02$) lower number of patients with groin pain 1 yr after surgery in the laparoscopic group compared with those having open surgery.⁵³ A recent, very well-conducted, large multicentre randomized controlled study³⁶ found a 10% incidence of chronic pain after laparoscopy and 14% after open surgery in 1983 patients ($P > 0.05$), without significant differences in VAS scores between the two groups at 6, 12, and 24 months.

In summary, many of the studies concerning laparoscopic treatment of inguinal hernia are of poor quality regarding pain assessment, but the data from the trials with better design may suggest that the development of chronic pain is less or similar after laparoscopic hernia repair. However, future studies with a detailed description of the pain type and intensity, its social consequences and its time course are needed to allow final conclusions. If a lower risk of chronic pain can be established by laparoscopic repair, this may be the most important indication for this technique.

Mesh vs non-mesh repair

Two studies compared a non-mesh with a mesh technique, and did not find any difference in chronic pain incidence.^{37,57} A lightweight mesh caused a reduced feeling of a foreign body compared with conventional mesh, but no significant differences in pain ($P = 0.06$).⁴⁵ However, the pain incidence and severity are only given for those with moderate pain (VAS 5 of 10) at rest. Pain during activity was only assessed for a subgroup of 70 of 108 patients with high, but not defined levels of activity. A significantly higher incidence of pain was found after Lichtenstein's procedure (38%) compared with a Shouldice repair (7%) in a study of 146 patients ($P < 0.05$), but follow up was only 60%.³⁰ The review by Poobalan and colleagues⁴⁴ found three articles in which there was less pain after mesh-repair compared with non-mesh.^{1,15,46} The EU Hernia Trialists review also concluded that mesh repair caused less pain than non-mesh repair.¹⁴

There are no valid data on the use of an unsutured layout mesh vs a sutured mesh, or between a plug vs a flat mesh repair.

In conclusion, the overall data suggest that there is less chronic pain after a mesh repair compared with non-mesh, which may be explained by an easier suture technique with the repair and thus a smaller risk of nerve damage.

Neurological testing and nerve lesions

Even though 25^{4,5,7,13,17,19,27,30,31,34-40,42,45,47,49,54-57,59} of the reviewed studies stated that they conducted a physical examination sometime during follow up, only five studies^{19,27,31,42,56} contained data that indicated some type of hands on examination of the sensory function in the surgical area. One study of 101 patients found that 50% (numbers not shown) with pain or discomfort had paraesthesia compared with 23% in patients without pain ($P < 0.05$), but did not report how the sensory testing was performed, and only examined patients' complaints of pain.⁵⁶ Another study showed that a prickly sensation was present in 17% and numbness in 9% of patients after open surgery, but did not examine whether the neurological abnormalities were associated with chronic pain, or explain how they conducted the sensory testing.¹⁹ One article did not show exact data, but noted that out of 93 patients with chronic pain 23 (25%) had discomfort and a disturbed sense of touch. However, there were no data from the pain free group.²⁷ These articles support earlier observations of chronic pain and sensory dysfunction,¹¹ wherein 31% of 276 patients had numbness after 12 months, which significantly correlated ($P = 0.042$) with the pain. Ninety per cent of patients with sensory dysfunction had hypoaesthesia and 10% had anaesthesia, whereas dysaesthesia and allodynia were uncommon. However, the article does not clarify how the sensory testing was done and what the exact findings were in pain-free patients.¹¹ In a large, long-term follow-up questionnaire-based study of open and laparoscopic herniorrhaphies,¹⁵ 10% of 490 patients had experienced sensory changes lasting for more than 1 yr, of which 8% had hypoaesthesia and 2% had pain that was provoked by touch or movement of the affected area. However, there were no details on the method of sensory testing, and only patients with symptoms were invited to a physical examination. Only one study undertook thorough neurophysiological sensory testing 6–12 months after inguinal herniorrhaphy.³¹ Patients suffering from post-herniorrhaphy pain and pain-free patients ($n = 72$) were examined for differences in hypoaesthesia, mechanical pain threshold (von Frey filaments), deep-pain threshold (pressure algometry), brush allodynia, thermal thresholds, and the cremaster reflex. Twenty-eight per cent of patients had experienced pain; neuropathic pain descriptors (shooting, pricking) were most frequent. VAS score at rest was 22 (range 12–30). Mechanical hypoaesthesia or tactile allodynia was seen in 51% of all patients. However, there was no overall difference in the incidence and type of sensory

dysfunction between the pain and non-pain group, except that the pain response to repeated von Frey filament stimulation was significantly higher (VAS 10 vs 2 out of 100) in the pain group ($P<0.002$) and following brush evoked stimulation ($P<0.02$). Thus, there were no between group differences with regard to mechanical pressure thresholds, warm or cold detection thresholds, algometry, or cremaster reflex function. Subsequently, the conclusion was made that sensory abnormalities had a low specificity for chronic pain.³¹

Our search found two studies that investigated the role of nerve transection or division.^{42,54} A telephone interview study of patients having elective resection of the iliohypogastric and ilioinguinal nerves during a tension-free mesh herniorrhaphy ($n = 191$) reported no complaints of postoperative pain. No patients reported pain after 1, 6, or 12 months, but 7% of patients complained of numbness or sensory loss after 1 yr. However, there are no data on the numbers of nerves identified, and no control group was included.⁵⁴ These findings are in contrast to a recently published, randomized controlled study⁴² where 405 of 813 patients had transection of the ilioinguinal nerve during mesh repair. The results showed no significant difference in pain frequency or intensity between the group with nerve transection and those with nerve preservation at any time during follow up (1, 6, 12, and 33 months, $P>0.2$ at any follow up). Two vs three per cent ($P=0.39$) reported numbness, 4 vs 11% ($P<0.02$) loss of sensation, and 8 vs 9% ($P=0.89$) loss of pain sensation, respectively. Again, there was no information on the method of sensory testing and how to correlate these findings to the development of chronic pain.⁴² It should be emphasized that this study only focuses on the ilioinguinal nerve and does not consider iliohypogastric nerve injury as a possible cause of chronic pain. Another study²⁷ found that in 1051 patients treated by open or laparoscopic herniotomy, with a median follow up of 44 months, a follow-up rate of 95% and a yearly physical examination in all patients a lesion of the ilioinguinal nerve was one of three prognostic variables for the development of chronic pain (OR 1.95, $P<0.05$).

In a previous study, nerve identification and/or surgical transection of the ilioinguinal, iliohypogastric, or genitofemoral nerves did not correlate with the development of chronic pain, but there were no specific data on the identification or transection rate of the nerves.¹¹ In addition, the intraoperative data were collected retrospectively and the study had a follow up of only 38%.

It seems that sensory disturbances are common after inguinal herniorrhaphy and that these patients may be at a higher risk of also having chronic pain. Thus, nerve injury after inguinal herniorrhaphy may be a prerequisite for development of chronic pain, although other (unknown) factors must be involved. There is a major lack of well-defined studies on identification and potential lesions of all the nerves in the surgical area in relation to development

of chronic pain. Nevertheless, an intraoperative damage or resection of the related nerves should be avoided.

Early postoperative pain

Several studies had a design that would have allowed a calculation of early postoperative pain as a predictor for chronic pain, but only three studies presented such data. In a prospective study²⁵ of 313 patients undergoing a laparoscopic repair, a telephone survey with a standardized questionnaire was conducted in 83% of participants after 12–36 months (average 24 months). Patients that had pain on coughing on the 6th postoperative day had a significantly ($P<0.05$) higher risk of developing chronic pain, but the method of early postoperative pain assessment was not described. Similarly, in another study of 123 patients, four patients that developed a chronic neuralgia type pain had higher VAS scores on day 14 ($P=0.03$).¹⁹ This is in agreement with a large prospective study⁹ of 466 unselected patients 1 yr after surgery, with a follow-up rate of 90%, where the risk of chronic pain was significantly higher in patients with a high early postoperative pain score compared with those with a lower postoperative pain score (9 vs 3%, $P<0.05$) after 1 week. The same correlation was found in patients with severe pain after 4 weeks (24 vs 3%, $P<0.001$). There is no data in the literature to assess the role of specific analgesic therapies in reducing the development of a chronic pain state after inguinal herniorrhaphy.

The relatively few data available suggest that the severity of early postoperative pain correlates with the risk of developing a chronic pain state. These results call for studies of the preventative effect of effective acute pain therapy.

Influence of chronic pain on daily activities and socioeconomic consequences

Not surprisingly, most studies of chronic pain as a primary outcome have investigated the impact of pain on the patient's everyday life and activities. Only a limited number of studies have investigated the consequences of chronic pain with regards to socioeconomic consequences, unemployment, and sexual dysfunction; however, in a study of 560 patients treated laparoscopically or with open-mesh repair, 7.1 vs 13.6% ($P<0.05$) had restricted function as a result of chronic pain when walking, and 15 vs 21.5% during vigorous activity (ns).²⁴

A nationwide study in Denmark³ found that 17% of 1166 patients complained of restrictions during work, sport, or other leisure activities as a result of chronic groin pain, especially when standing longer than 30 min (32%), or climbing stairs (28%). Another study also described that pain affected daily activity in 17% of 226 patients, and 2% experienced a marked extreme decline in their ability to take part in recreational and social activities.⁴³ In accordance with the nationwide study,³ standing provoked pain, as did coughing and sudden movements.⁴³ These findings are also supported by a study of 172 patients,³¹ in whom 6% had

pain that caused a significant reduction in work or leisure activities. Furthermore, in a study in 120 patients, chronic pain had significant detrimental effects ($P < 0.001$) on walking, sleep, relationships with other people, mood and general enjoyment of life.¹⁰ Finally, one study found that 2.2% of 229 patients were unable to return to work, which was the same percentage as those that had severe pain, but no combined data were shown.⁶ Three other studies noted that pain interfered with daily activity in 7–10% of patients, but did not present details.^{17 19 39}

The current data seem to indicate that not only is pain after surgery unpleasant, but also that the pain restricts daily activities resulting in a lower quality of life.

Genital complications

In some studies one of the pain variables was testicular pain, which was found in 1–6% of patients.^{4 13 27 35 43 59} In 120 patients with complaints of severe or very severe groin pain 3 months after surgery, 22 patients (18%) had testicular pain at 30 months follow up.¹⁰ These findings may be related to the reported incidence of post-herniorrhaphy testicular atrophy in 2.6–4.5%.¹³

Sexual dysfunction may also be an adverse outcome after inguinal herniorrhaphy, but is less well described. Thus, pain-related postoperative erectile dysfunction was disturbing to one patient out of 84 (1.2%) in one study,⁵⁵ and in two patients out of 72 (3%) in another.³¹ Three out of 135 patients (2.2%) complained of pain-related erectile dysfunction and two others (1.5%) complained of shooting pain during ejaculation.⁵⁶ Finally, pain was found to interfere with sexual activity in 4% of 226 patients.⁴³ However, in most of these studies, there is an insufficient description of preoperative sexual function.

Nevertheless, the conclusion from these studies is that genital complaints are clinically significant after inguinal herniorrhaphy especially as many patients are younger males. Testicular pain may be caused by nerve damage or testicular ischaemia. The underlying mechanisms and predisposing factors for sexual dysfunction are unknown, but deserves thorough investigation.

Discussion

It appears from this updated review that even a relatively small operation such as inguinal herniorrhaphy may be followed by a risk of a chronic pain state in about 12% of patients (Table 2), with clinically significant effects on daily activities. Thus, the risk of a chronic post-herniorrhaphy pain state may be the most important outcome variable to consider in hernia surgery, as current methods of treatment have not been effective. Previously, hernia surgeons have considered prevention of a recurrent hernia as the primary outcome, but in contrast to chronic pain a recurrence can be successfully treated by a new operation.

Table 2 Conclusions from the present updated literature review

The risk of chronic post-herniorrhaphy pain is about 12%.
The risk of chronic postoperative pain is probably less after laparoscopic repair.
Intensity of early postoperative pain predicts chronic pain.
Women may be at higher risk of developing chronic pain.
Younger patients have more pain complaints.
Pain-related sexual dysfunction may be an important complication of groin hernia repair.
Nerve damage may be the most important pathogenic factor for chronic pain, but cutaneous sensory abnormalities do not correlate well with chronic pain.

Table 3 Future research areas in chronic post-herniorrhaphy pain

The role of preoperative pain (outside the inguinal area), neurophysiological and psychological assessments in predicting chronic pain.
Effect of intraoperative handling of nerves and muscles.
Pain after laparoscopic repair.
Central and peripheral nervous components in chronic pain.
Socioeconomic consequences of chronic pain.
Chronic pain after herniorrhaphy in children.
Role of genetics in chronic pain.
The role of effective postoperative analgesia to reduce chronic pain.
The time course of pain after 1, 5, and 10 yr (same patients).
Chronic pain and sexual dysfunction.
Treatment of chronic postoperative pain.

Although chronic post-herniorrhaphy pain is an important outcome, the conclusions drawn in our review are unfortunately mostly based on low-quality studies, where pain has not been the primary outcome variable. However, the available data suggest that intraoperative nerve damage may be a prerequisite for developing a chronic pain state (Table 2), but also that a nerve lesion will not necessarily lead to chronic pain, as many more patients have sensory abnormalities than pain after inguinal herniorrhaphy. Other important predisposing factors for a chronic pain state may be preoperative pain (in other areas of the body), and the intensity of the acute postoperative pain.

Future research (Table 3) should primarily be directed to high-quality descriptive studies on post-herniorrhaphy pain.²² Such studies should include a detailed description of preoperative, intraoperative, and postoperative factors, including a detailed neurophysiological assessment. So far, a complete assessment of all the potential risk factors²² has not been done in any study on chronic postoperative pain.

Recent studies have shown that preoperative assessment of nociceptive responses to heat stimulation may identify patients at risk of developing high-intensity acute postoperative pain following knee surgery⁵⁸ and Caesarian section.¹⁶ When these findings are combined with other studies to show that acute post-herniorrhaphy pain intensity may correlate with the risk of developing a chronic pain state,⁹ it may be possible before the operation to identify patients at risk for a chronic postoperative pain state. That pre-injury factors may be important had already been suggested by the elegant studies by Devor and co-workers who

showed that chronic neuropathic pain in rats was genetically determined.¹² Currently, genetic predisposition to pain is a popular research topic,³² but there are no data on surgical patients. When more knowledge has been obtained on potential pain genes the existence of large nationwide databases,² and the demonstrated high success rate in follow up³ may be able to throw further light on the genetic predisposition to chronic postoperative pain. Blood can be sampled both before and after surgery in large groups of patients who have or have not developed chronic post-herniorrhaphy pain.

As intraoperative nerve injury may be the most important pathogenic mechanism, another relevant research area is the role of the minimal invasive (laparoscopic) hernia repair technique. Unfortunately, this technique may also have a risk of nerve injury, but hopefully future improvements in surgical technique and knowledge on stapling or non-stapling fixation of the meshes may lead to a smaller risk of chronic pain with these techniques. Existing data support the hope that this may be achieved, but most of the published studies on laparoscopic vs open repair have had a low quality of pain assessment and its social consequences, as pain has not been the primary outcome variable. In the future, a significant reduction in the risk of a chronic pain state may be the most important indication for a laparoscopic repair, as there is agreement that the risk of a recurrent hernia is similar between a Lichtenstein mesh technique and a laparoscopic repair.

Finally, as the intensity of acute post-herniorrhaphy pain may correlate with the risk of transition to a chronic pain state, there is an urgent need for studies with improved multi-modal analgesia techniques to reduce acute postoperative pain and, thereby, hopefully chronic pain. In this context, conventional pre-emptive analgesia techniques of short duration have proven to be ineffective,³³ calling for studies with more efficient multi-modal pre-emptive analgesia and a sufficient duration of therapy, probably lasting at least 1–2 weeks.

In summary, chronic post-herniorrhaphy pain emphasizes the clinical importance of chronic postoperative pain, and also demonstrates that we presently have an imperfect knowledge of the pathogenic mechanism(s) involved. In the future, the primary focus should be to: identify pre-operative risk factors for high intensity acute and chronic postoperative pain, which may include genetic factors; define an operation where intraoperative nerve injury is avoided (minimal invasive surgery); and finally by improving acute postoperative pain treatment. Future studies should improve their methods of assessing chronic pain and its consequences,²² to allow interpretation of the potential risk factors and interventions. Finally, we emphasize that prophylactic methods to reduce chronic post-herniorrhaphy pain should have the highest priority, as existing treatment of chronic post-herniorrhaphy (or other postoperative) pain has been unsuccessful.

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