Journal of American Science

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MARSLAND PRESS
Multidisciplinary Academic Journal Publisher

Sparing versus Division of Ilioinguinal Nerve in Open Mesh Repair of Inguinal Hernia

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Abstract: Background: The inguinal hernias are common with lifetime occurrence of 27% for men and 3% for women. Inguinal hernia repairs represent one of the most common general surgery operations worldwide. An estimated 20 million inguinal hernia repairs are performed each year worldwide. **Aim of the Work:** To assess the influence of preservation versus elective division of the ilioinguinal nerve on chronic pain after tension-free inguinal hernioplasty in patients with inguinal hernia and admitted to the department of surgery, Ras El Tin General Hospital. **Patients and Methods:** This study included 80 patients who presented by inguinal hernia to the outpatient clinic who were admitted to the department of surgery, Ras El Tin General Hospital. **Results:** Our results showed that in the last follow up visit after 12 months of the operation, 5 patients of Group I (12.5 %) only had very mild pain with all other patients denied presence of any pain. **Conclusion:** Chronic postoperative pain after tension-free inguinal hernioplasty is pain which persists beyond normal tissue healing assumed to be 3 months.
[Mohamed Ahmed Helmy Shehab, Karim Fahmy and Mohamed Hamdy Abd El Halim Mohamed. **Sparing versus Division of Ilioinguinal Nerve in Open Mesh Repair of Inguinal Hernia.** *J Am Sci* 2019;15(11):39-51]. ISSN 1545-1003 (print); ISSN 2375-7264 (online). http://www.jofamericanscience.org. 6. doi:10.7537/marsjas151119.06.

Keywords: Inguinal Hernia - Ilioinguinal Nerve

1. Introduction

Inguinal hernia repairs represent one of the most common general surgery operations worldwide. An estimated 20 million inguinal hernia repairs are performed each year worldwide. [1, 2]

While most hernia repairs are performed with excellent outcomes and minimal morbidity, a small percentage of patients experience postoperative discomfort and pain that limit their activity and productivity.

Advances in the understanding of groin anatomy, operative technique, and prosthetics have improved the efficacy of these repairs with overall low recurrence rates and favourable outcomes. Chronic post hernioplasty inguinal pain has arguably become the most important and most frequent complication of inguinal hernia repair, with significant impact on patients' quality of life. [1, 2, 3]

The estimated risk of chronic moderate-to-severe pain following inguinal hernia repair is 10%–12%, with pain affecting activities of daily life estimated to be 0.5%–6%. [1]

Chronic post hernioplasty inguinal pain (CPIP) is defined as pain persisting or arising at least 3–6 months following the hernia operation after resolution of the acute postoperative inflammatory processes and mesh integration. [1, 2]

Inguinodynia (CPIP) occurs due to Injury or damage to the inguinal nerves which may occur intraoperatively or postoperatively. Intraoperatively, surgical manipulation, over dissection, stretching, electrical or thermal damage, crushing, partial or complete transection, or fixation or entrapment in suture may damage the nerves. The susceptible nerves and mechanisms of injury will vary by repair type and location. Anterior tissue and mesh-based inguinal hernia repairs directly expose to the inguinal nerves as they traverse the same anatomic planes and operative field of the repair. Posterior minimally invasive approaches indirectly expose to the inguinal nerves which may be injured within the inguinal canal with the use of penetrating fixation with tacking devices and sutures or with over - dissection of the retroperitoneal nerve structures found within the "triangle of pain" in the lateral preperitoneal space. Postoperatively, the nerves may become injured due to perineural scarring, irritation from excess fibrosis, entrapment in meshoma, inflammation, infection, recurrence, or granuloma/neuroma formation. [1-4]

Development of chronic post inguinal hernia repair pain is independent of the method of hernia repair as all inguinal hernia repair techniques may potentially cause injury. Understanding the neuroanatomy of the inguinal canal and the potential mechanisms for injury leads to lower rates of nerve injury and chronic pain and helps to guide prevention and treatment of inguinodynia. [1, 2]

Division of the ilioinguinal nerve during hernioplasty has been found to reduce incidence of chronic groin pain. However, the traditional approach

favours preservation of the ilioinguinal nerve during hernia repair. [1]

Aim of the Work

The aim of this work was to assess the influence of preservation versus elective division of the ilioinguinal nerve on chronic pain after tension-free inguinal hernioplasty in patients with inguinal hernia and admitted to the department of surgery, Ras El Tin General Hospital.

This was done in an attempt to define the best method in tension-free inguinal hernioplasty whether to preserve or resect ilioinguinal nerve.

2. Patients and Methods

Patients

This study included 80 patients who presented by inguinal hernia to the outpatient clinic who were admitted to the department of surgery, Ras El Tin General Hospital.

Patients were divided into 2 groups:

1. ***Group I*** included 40 patients; they underwent a classic tension-free inguinal hernioplasty with preservation of ilioinguinal nerve.
2. ***Group II*** included 40 patients; they underwent a classic tension-free inguinal hernioplasty with resection of ilioinguinal nerve.

Exclusion criteria:

1. Diabetics (peripheral neuropathy)
2. Recurrent hernias
3. Complicated hernias (irreducible, strangulated)
4. Bilateral hernias
5. Large Inguino-scrotal hernias
6. Long-standing hernias
7. History of previous abdominal incision
8. Impaired cognitive function
9. Limited mobility
10. Female gender

Methods

All studied patients signed an informed consent before being submitted to:

I. Proper history taking

- Patients' predisposing factors including any causes of raised intra-abdominal pressure as chronic cough, repeated straining or chronic constipation.
- Analysis of the presenting complaint:

1. The swelling: its size, reducibility, associated pain.
2. Previous attacks of complications:
   - Intestinal obstruction: colic, vomiting, distension and constipation.
   - Strangulation: constitutional manifestation as fever, tachycardia in addition to colic, vomiting, constipation, distension, constant severe pain over the hernia and skin changes.

II. Clinical assessment:

- Examination was done in the standing position first then supine position.
- Assessment of the swelling: site, size, reducibility and presence of impulse on cough.
- Deep inguinal ring test to differentiate between direct and indirect inguinal hernias.
- Examination of other hernia orifices.

III. Routine laboratory investigation:

- Complete blood count.
- Fasting blood sugar.
- Bleeding profile: INR, prothrombin time and activity.
- Liver function tests: SGOT, SGPT.
- Kidney function tests: Serum urea, Serum creatinine.

IV. Imaging assessment:

- Ultrasonography was the main imaging technique which was necessary in some patients to exclude other differential diagnoses.
- There is a high degree of sensitivity and specificity for ultrasonography in detection of occult direct and indirect inguinal hernias.[5]

V. Operative details:

- 80 patients were included in this study. Patients were randomly divided into two groups, each group included 40 patients.
- The first group underwent a classic tension-free inguinal (**Lichtenstein**) hernioplasty[6] with preservation of ilioinguinal nerve.
- The second group underwent a classic tension-free inguinal (**Lichtenstein**) hernioplasty[6] with resection of ilioinguinal nerve. Segmental resection of the ilioinguinal nerve was done.

VI. Follow up visits:

- All patients involved in the study were followed up in the outpatient clinic of department of surgery, Ras El Tin General Hospital.
- Follow up visits at first, second, sixth and twelfth post-operative week were done regularly for all patients, then after a year.

VII. Assessment of pain:

- Pain score used in this study was a four-categorical scale using the classification of chronic pain by the International Association for the Study of Pain.[7]
- Mild pain was defined as occasional or discomfort that did not limit daily activity with a return to pre-hernia lifestyle without the need of analgesics.
- Moderate pain was defined as pain that interfered with return to normal everyday activities with analgesics rarely being needed.
- Severe pain was defined as pain that incapacitated the patient at frequent intervals or interfered with everyday activities with frequent need of pain-killers.

Statistical Analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations and ranges when parametric. Also qualitative variables were presented as number and percentages.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:

- P-value > 0.05: Non significant (NS)
- P-value < 0.05: Significant (S)
- P-value < 0.01: Highly significant (HS)

3. Results

This study was conducted on 80 patients with non-recurrent inguinal hernia with 80 total inguinal hernia repairs being performed. The duration of follow up was 1 year. All patients completed the follow up visits.

The results of post-operative pain in first, second, forth, sixth and twelfth week then a year later were assessed in the two groups. The results of other parameters were also assessed regarding the demographic data, features of the hernia, presence of preoperative pain or any forms of neuropathies, presence of hypoesthesia and / or hyperesthesia and postoperative complications. Correlations between these parameters and postoperative pain were also investigated.

1. Demographic data:

Both groups included 40 male patients (50 %). Age of patients of Group I ranged from 27 years to 52 years at the time of operation with mean age of 37.84 ± 6.92 years. While age of patients of Group II ranged from 23 years to 62 years at time of operation with mean age of 39.08 ± 10.30 years. No statistical significance was present between the two groups regarding the age of the patients. The results of demographic data are shown in Table 1.

Table (1): Comparison between the two studied groups according to demographic data

	Group I		**Group II**	
Gender	Male	Female	Male	Female
	40	0	40	0
Age				
Min. – Max.	27.0 – 52.0		23.0 – 62.0	
Mean ± SD	37.84 ± 6.92		39.08 ± 10.30	
Median	37.0		40.0	

2. Hernia Features:

Inguinal hernias were on the right side in 20 patients of Group I representing 50 % of cases of the group and 25 patients of Group II representing 62.5 % of cases of the group. Left side inguinal hernias were present in the rest of both groups.

Direct inguinal hernias were found in 10 patients of Group I (25 %) and 15 patients of Group II (37.5 %). Indirect hernias were found in 30 patients of Group I (75 %) and 25 patients of Group II (62.5 %).

No statistical significance was present between both groups regarding the features of hernias, Table 2.

Table (2): Comparison between the two studied groups according to hernia features: side, direct versus indirect, type and reducibility

	Group I (n = 25)		**Group II (n = 25)**	
	No	**%**	**No**	**%**
Side				
Right	20	50.0	25	62.5
Left	20	50.0	15	37.5
Direct VS Indirect				
Direct	10	25.0	15	37.5
Indirect	30	75.0	25	62.5
Type				
Inguinal	40	100	40	100
Reducibility				
Reducible	40	100	40	100

3. Operative Details:

A classical tension-free inguinal hernioplasty was performed under spinal anesthesia in 36 patients (90 %) and 32 patients (80 %) in Group I and II, respectively. In the remaining 4 patients of Group I and 8 patients of Group II, the hernioplasty was

performed under general anesthesia. In six cases was due to failure of spinal anesthesia and six cases requested to be operated under general anesthesia.

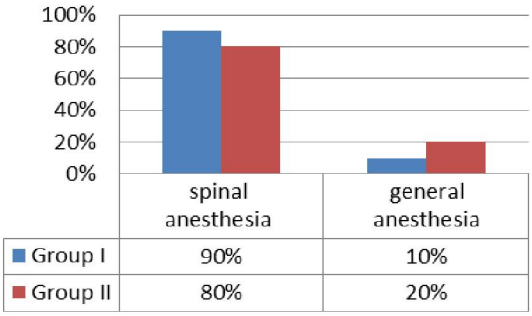

Fig. (1): Distribution of cases according to type of anesthesia used.

4. Postoperative pain:

Postoperative pain after tension-free hernioplasty is the main outcome of this study.

Early postoperative pain after *one week* ranged in Group I from mild pain in 20 patients (50%) to moderate pain in 16 patients (40 %) to severe in 4 patients (10%) while in Group II, mild pain occurred in 30 patients (75 %), moderate pain occurred in 8 patients (20%) and severe pain occurred in 2 patients (5 %). Early postoperative pain after one week was significantly lower in Group II than Group I according to the classification of chronic pain by the International Association for the Study of Pain IASP, Table 3.

Table (3): Postoperative pain after one week

Postoperative pain	Group I		Group II	
	No	%	No	%
No	0	0	0	0
Mild	20	50	30	75
Moderate	16	40	8	20
Severe	4	10	2	5

After *2 weeks* of the operation, postoperative pain was mild in 10 cases (25 %) of Group I and in 20 patients (50 %) of Group II. Moderate pain occurred in 16 patients (40%) of Group I and in 4 patients (10 %) of Group II. Severe pain occurred in 4 patients (10 %) of Group I and in one patient (2.5 %) of Group II.10 patients (25 %) of Group I and 15 patients (37.5%) of Group II denied presence of any pain. Difference of postoperative pain after 2 weeks is significantly lower in Group II than Group I according to the classification of chronic pain by the IASP, Table 4.

Table (4): Postoperative pain after 2 weeks

Postoperative pain	Group I		Group II	
	No	%	No	%
No	10	25	15	37.5
Mild	10	25	20	50
Moderate	16	40	4	10
Severe	4	10	1	2.5

After *4 weeks* of the operation, postoperative pain was mild in 14 cases (35%) of Group I and in 22 patients (55 %) of Group II. Moderate pain occurred in 15 patients (37.5%) of Group I and in 2 patients (5 %) of Group II. Severe pain occurred in only one patient (2.5%) of Group I. In Group II, no one still had severe pain after 4 weeks. Moreover, 10 patients (25 %) of Group I and 16 patients (40%) of Group II had no pain after 4 weeks of operation. Difference of postoperative pain after 4 weeks is significantly lower in Group II than Group I according to the classification of chronic pain by the IASP, Table 5.

Table (5): Postoperative pain after 4 weeks

Postoperative pain	Group I		Group II	
	No	%	No	%
No	10	25	16	40
Mild	14	35	22	55
Moderate	15	37.5	2	5
Severe	1	2.5	0	0

After *6 weeks* of the operation, postoperative pain was mild in 19 cases (47.5%) of Group I and in 19 patients (47.5 %) of Group II. Moderate pain occurred in 8 patients (20 %) of Group I and in one patient (2.5 %) of Group II. Severe pain occurred in only one patient (2.5 %) of Group I. 12 patients (30%) of Group I and 20 patients (50%) of Group II had no pain after 6 weeks of operation. Difference of postoperative pain after 6 weeks is significantly lower in Group II than Group I according to the classification of chronic pain by the IASP, Table 6.

Table (6): Postoperative pain after 6 weeks

Postoperative pain	**Group I**		**Group II**	
	No	**%**	**No**	**%**
No	12	30	20	50
Mild	19	47.5	19	47.5
Moderate	8	20	1	2.5
Severe	1	2.5	0	0.0

In the follow up visit after *3 months* of the operation, 21 patients (52.5%) of Group I and 26 patients (65 %) had no pain and did not receive any more analgesia. Postoperative pain was mild in10 cases (25%) of Group I and in 13 patients (32.5 %) of Group II. Moderate pain occurred in 8 patients (20%) of Group I and in one patient (2.5 %) of Group II. Severe pain still occurred in only one patient (2.5 %) of Group I. Difference of postoperative pain after 12 weeks is significantly lower in Group II than Group I according to the classification of chronic pain by the IASP, Table 7.

Table (7): Postoperative pain after 12 weeks

Postoperative pain	**Group I**		**Group II**	
	No	**%**	**No**	**%**
No	21	52.5	26	65
Mild	10	25	13	32.5
Moderate	8	20	1	2.5
Severe	1	2.5	0	0.0

In the last follow up visit after *12 months* of the operation, 5 patients of Group I (12.5 %) only had very mild pain with all other patients denied presence of any pain.

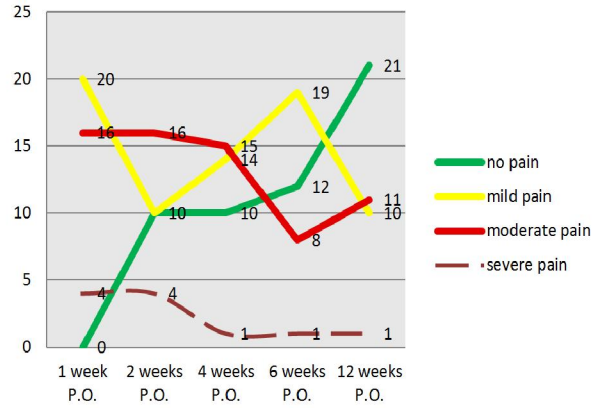

Fig. (2): Postoperative pain in patients of Group I through the whole study period.

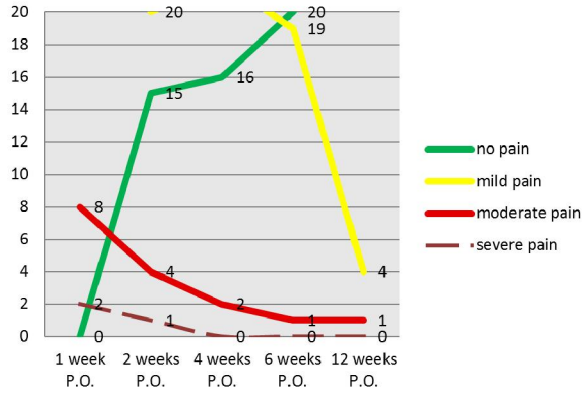

Fig. (3): Postoperative pain in patients of Group II through the whole study period.

5. Postoperative Hypoesthesia and Hyperesthesia:

Postoperative hypoesthesia and / or hyperesthesia are of the major outcomes of the study. Both of them were assessed after 1 year of the operation.

Postoperative hypoesthesia was found in only 10 patients of Group II (25 %). No patients of Group I complained of postoperative hypoesthesia. It means that postoperative hypoesthesia was significantly more in Group II in which ilioinguinal nerve was intentionally divided.

Postoperative Hyperesthesia was found in only 4 patients of Group I (10 %) but not found in patients of Group II. No statistical significant difference was found between the two groups regarding the postoperative hyperesthesia, Table 8.

6. Postoperative complications:

In both groups, postoperative complications were the same including scrotal edema, inguinal hematoma, hydrocele and surgical site infection. Scrotal edema occurred in 6 patients (15 %) of Group I and 4 patients (10 %) of Group II. Inguinal hematoma occurred in two patients (5%) of Group I and another patient of Group II. Hydrocele occurred in one patient (2.5%) in both groups. Surgical site infection occurred in 7 patients (17.5%) of Group I and 5 patients (12.5%) of Group II. No statistical significant difference was present between the two groups regarding the postoperative complications, Table 9.

Table (8): Comparison between the two studied groups according to Hypothesia and Hyperthesia Statistically significant

	Group I (n = 25)		Group II (n = 25)	
	No	%	No	%
Hypothesia				
Positive	0	0.0	10	25.0
Negative	40	100.0	30	75.0
Hyperthesia				
Positive	4	10.0	0	0.0
Negative	36	90.0	40	100.0

Table (9): Comparison between the two studied groups according to operative complications

Operative complication	Group I (n = 40)		Group II (n = 40)	
	No	%	No	%
No	24	60	29	72.5
Scrotal edema	6	15	4	10
Inguinal hematoma	2	5	1	2.5
Wound infection	7	17.5	5	12.5
Hydrocele	1	2.5	1	2.5

4. Discussion

Chronic pain following tension-free inguinal hernioplasty is becoming a significant clinical problem facing surgeons because of the dramatic decline in incidence of hernial recurrence which was, for decades, the main concern and the main outcome for hernial repair success. The attention of most surgeons nowadays is shifted towards the chronic post-hernioplasty pain as another parameter for hernial repair success. Moreover, with revolution of information technology, more patients are aware about different pain syndromes and more patients come to outpatient clinic complaining of chronic groin pain. Thus, a successful inguinal hernia repair means a lower risk of complications, a rapid recovery and a lower risk of chronic pain symptoms or recurrent hernias. Much differences still exists in the literature about its incidence, terminology, pathogenesis and treatment strategies. Different studies have been published dealing with this issue. Our study aims at identification the best management of ilioinguinal nerve in tension-free inguinal hernioplasty.

The ***International Association for the Study of Pain*** IASP has defined chronic pain as pain persisting beyond the normal tissue healing time, assumed to be 3 months.[7] ***European Society of Hernia*** used IASP definition in its guidelines published in 2009.[8]

Another *definition of* chronic post hernioplasty pain in the "***International guidelines for prevention and management of post-operative chronic pain following inguinal hernia surgery"*** [9] as pain arising as a direct result of a nerve lesion or a disease of the somatosensory system, in patients who did not have groin pain before their original hernia operation, or, if they did, the post-operative pain differs from the pre-operative pain. Moreover, they suggested that the IASP definition of chronic pain should be modified, for chronic groin pain only, from 3 months

postoperative to more than 6 months post hernioplasty.

Other studies stated that chronic neuralgia following hernioplasty is a debilitating pain including parasthesia, hypoesthesia and dysesthesia. Many patients also have long-term drug dependency, mood swings and are unable to return to their works.

In our study, we used the definition of chronic pain by the IASP.

Many authors used a four-point categorical scale (no, mild, moderate or severe pain) as a visual descriptive scale (VDS) for assessment of the chronic post hernioplasty pain. Mild pain was defined as occasional or discomfort that did not limit daily activity, with a return to pre-hernia lifestyle including sports and lifting objects without the need of analgesics. Moderate pain was defined as pain that interfered with return to normal everyday activities with analgesics rarely being needed. Severe pain was defined as pain that incapacitated the patient, at frequent intervals, or interfered with daily living as walking with frequent need of pain-killers.[10]

In most of the studies, there was no information on the method of sensory testing and how to correlate these findings to the development of chronic pain.[11] The study done by ***Mikkelsen et al.*** [12] is the only study with neurophysiological sensory testing 6–12 months after inguinal herniorrhaphy. Patients suffering from post herniorrhaphy pain and pain-free patients were examined for differences in hypoesthesia, mechanical pain threshold, deep-pain threshold, thermal thresholds and the cremasteric reflex.

Mui et al. [10] divided the groin region into 5 cutaneous areas, namely, outer upper, outer lower, inner upper, inner lower and scrotal region in relation to the groin incision for sensory assessment. An occupational therapist assessed sensation loss or changes in the 5 regions of each side. The non-operative side of each individual acted as the control. Sensation loss or changes were defined as any asymmetry between corresponding regions of the 2 sides demonstrated by the monofilament test.

We used the four-point categorical scale for chronic pain assessment. As well, presence of any sensory disturbance in the form of hypoesthesia, hyperesthesia or parasthesia was considered as a secondary outcome. We depended on subjective assessment rather than objective measures and it was one of limitation of our study.

In the first study dealing with chronic postoperative pain after hernioplasty done in 1996, ***Cunningham et al.*** [13] stated that 31% up to 63% of post-hernia repair patients reported either mild, moderate, or severe postoperative pain at 1-year follow-up. This percentage decreased to 10% up to 54% at a 2-year follow up.

In ***Alfieri et al.*** study, [9] the presence of overall groin pain either mild, moderate or severe at 6 months and 1 year of follow-up was 9.7% and 4.1%, respectively.

In a study by ***Callesen et al.*** [14] moderate or severe pain was present in 11% of patients during mobilization and in 5% at rest 4 weeks after operation. Nineteen percent of patients reported some degree of pain at 1-year follow-up; the pain was moderate or severe in 6% of cases.

In a recent review by ***Nienhuijs et al.*** [15] 29 studies were reviewed from 1996 to 2006 with a total of 8350 patients and a follow up duration ranging from 3 to 36 months. The authors concluded that after mesh repairs, the risk for developing suffer chronic pain was 11%.

Aasvang et al. [11] found that 12% of patients after hernioplasty were in risk for chronic pain.

In a study by ***Picchio et al.*** [16] chronic pain 1 year after operation was present in 25% of patients, and it was described as moderate or severe in 6% of these patients.

In a large-scale study by ***Bay-Nielsen et al.*** [17] chronic pain was present in 28.7% of patients one year after hernioplasty. It was severe and leading to some degree of functional impairment in 11% of patients.

Zanghi et al. [18] reported that incidence of chronic pain following inguinal hernioplasty is around 6-30%.

In a systematic review of chronic pain after inguinal hernioplasty done by ***Poobalan et al.*** [19] chronic postoperative pain occurred in 30% of patients.

Courtney et al. [20] reported in their large-scale study that chronic pain was present in 43% of patients, and it was reported as severe or very severe in 3% of cases.

According to the ***Guidelines of European Hernia Society*** [8] the overall incidence of moderate to severe chronic pain after hernia surgery is around 10–12%, [11] but it can be as high as 62.9%.

In our study, the overall incidence of chronic moderate to severe pain after 3 months was 26%.

We think that the variability of the incidence between different studies may depend on type of hospital in which the study was done either public hospitals, university institutions or specialized hernia centers. It may also depend on the different modality of defining and assessing the pain as well as different time of assessment and the design of study. Another factor is that patient without any postoperative complaint may be less likely to complete the follow up visits in some studies and so the incidence of chronic pain is exaggerated. The duration of follow up

visits plays an important role also as the longer the duration, the more probability of the incidence to be lower. Moreover, ***Aasvang et al.*** [11] and ***Poobalan et al.*** [19] claimed that studies with pain assessment as a primary outcome were more likely to have a higher incidence of chronic pain.

Our study was conducted in public hospital. We also used the standard definition of chronic pain by IASP. As well, all our patients completed the follow up visits. The duration of follow up in our study was 1 year.

Alfieri et al. [9] excluded from his study patients with mesh allergy, neurologic disorders, previous surgery in the inguinal region and patients on regular use of analgesia and pain killer agents.

Mui et al. [10] excluded patients with bilateral inguinal hernia, recurrent hernia, irreducible or strangulated hernia, large inguinal-scrotal hernia, history of previous abdominal incision, peripheral neuropathy, impaired cognitive function, limited mobility and female gender. On the other hand, ***Zanghi*** [18] excluded patients with bilateral hernias, recurrent hernias, strangulated hernias, diabetes mellitus, peripheral neuropathy and neuromuscular diseases.

In recurrent hernias, ilioinguinal nerve may be already injured or entrapped in previous operation as well as being more risky for unintentional injury due to the disturbed anatomy however in a study done by ***Aasvang et al.*** [11] hernia recurrence was not a risk factor for chronic pain. Patients with previous lower abdominal incisions may also have the ilioinguinal nerve being already injured or entrapped. We did not find any reasonable cause for exclusion of female patients. Most diabetic patients presented to us had a mild degree of peripheral neuropathy. Also, a correlation between diabetic neuropathy and chronic postoperative pain was an outcome of the study.

Many theories have been postulated in an attempt to understand pathophysiology of chronic post hernioplasty pain. Many factors have been studied as predictors for this pain and so for its prevention. These included repair of recurrent hernias, different repair techniques (laparoscopic either TAPP or TEP, open either Lichtenstein or Shouldice), use of synthetic mesh, type of used mesh, methods of mesh fixation, previous damage to inguinal nerves as well as experience of surgeons.

Mui et al. stated that inflammation and fibrosis induced by the mesh which is in close proximity to the ilioinguinal nerve in addition to unintentional injury or strangulation of the ilioinguinal nerve during suturing may contribute to the phenomenon.[10]

According to ***Gillion et al.*** [21] damage to 1 or more of the three inguinal nerves passing through the surgical field is one of the main causes of chronic post hernioplasty pain. This theory is supported by the association between chronic pain and sensory disturbances. A nerve may be damaged during operation as a result of perineural fibrosis, entrapment by staples, sutures, or prosthetic materials, and direct lesions due to stretching, contusion, electrical injury, and partial or complete division of the nerve.

Aasvang et al. [11] and ***Poobalan et al.*** [19] found a four-fold higher rate of moderate to severe chronic pain after reoperation of recurrent hernia.

Regarding use of synthetic meshes, most studies comparing mesh with non-mesh repair reported less chronic pain with mesh repair including the ***EU Hernia Trialists Collaboration review*** [22] and the two studies done by ***Aasvang et al.*** [11] and ***Poobalan et al.***[19] The ***Guidelines of European Society of Hernia*** [8] consider it as level 1B evidence.

Bringman et al. [22] studied lightweight mesh versus standard polypropylene mesh in 590 patients operated with the Lichtenstein technique. At 3-year follow-up, there were no differences in chronic neuropathic pain, hypoesthesia or hyperesthesia between the groups. Only, more men in the standard mesh group could feel the mesh in the groin which was statistically significant, 22.6% versus 14.7%. ***Paajanen*** [23] also emphasized that there was no difference of pain after use of a conventional polypropylene mesh, lightweight mesh or partially absorbable mesh in 2 years of follow-up provided that all patients were operated on by the same surgeon with the same technique. However, in another two earlier randomized studies of 117 and 321 patients, respectively, the use of lightweight mesh was associated with significantly less pain of any severity after one year follow up.

Fibrin glue and non-fixation techniques have been compared to mesh fixation with staples in laparoscopic hernia operations. Reduced early postoperative pain with the non-stapling techniques was found in two studies. In ***Lau's*** study, the risk of chronic pain at 1 year was lower with fibrin glue. [24]

In ***van Veen's*** trial, [25] hernioplasty was performed by first-year and second-year residents under the supervision of an experienced general surgeon; the rate of severe chronic pain was clearly increased.

In our study, we tried to standardize these factors; we excluded patients with recurrent hernias, all our patients underwent a classical tension-free Lichtenstein hernioplasty using standard prolene mesh fixed by sutures. So, the only variant of our study was the management of ilioinguinal nerve during hernioplasty.

Alfieri et al. [9] claimed that the terms ''division'', ''resection'', ''dissection'', ''transection'', ''section'' and ''neurectomy'' were

often used and reported wrongly, and so affecting the real results of different studies.

For standardization of terminology, ***Alfieri et al.*** [9] stated that cutting or dividing a nerve means interrupting the continuation of a nerve while resection of a nerve or neurectomy means excising a part of a nerve along the inguinal canal.

In our study, we used the term "division" of ilioinguinal nerve but according to these new guidelines, it should be named "neurectomy" of ilioinguinal nerve.

There is increasing evidence to suggest that prophylactic resection of ilioinguinal nerve during open hernia repair is not only associated with minimal morbidities but also can potentially decrease the incidence of chronic groin pain following operation.

In a single-center prospective study of 1, 332 cases, ***Izard et al.*** [26] concluded that identification and preservation of all three inguinal nerves during open inguinal hernia repairs with or without mesh reduced chronic severe groin pain after inguinal hernioplasty to 0.8%.

In another Italian prospective multicenter study of 973 patients, ***Alfieri et al.*** [9] supported this conclusion. Moreover, the authors stated that the risk of developing chronic pain increased with the number of nerves concomitantly undetected or divided ($P < 0.006$). The authors explained the increased risk of developing chronic pain with the number of nerves divided by the fact that resection of the unidentified nerve has generally been performed distal to its origin, letting the zone of the injured nerve intact to continue to generate a pain signal and exposing it to neuroma formation.

In the study by ***Ravichandran et al.*** [27] the first one to assess the effect of division of the ilioinguinal nerve in a randomized manner, no evidence was found to support the benefit of ilioinguinal nerve division in relation to postoperative pain. However, this study was limited by its small sample size as well as the short follow up of 6 months.

Picchio et al. [16] found, in a randomized controlled study, that pain one year after hernioplasty with polypropylene mesh was unaffected by elective division of the ilioinguinal nerve. Also, the division of the ilioinguinal nerve was significantly related to sensory disturbances in the area of distribution of the nerve.

Cunningham et al. [13] found no relation between the preservation or elective division of the ilioinguinal, iliohypogastric, or genitofemoral nerves and chronic pain in their large retrospective study. However, the study was limited by having a follow up of only 38% of patients and not providing specific data on the identification or division rate of the nerves.

In the contrary, ***Tsakayannis et al.*** [28] in their retrospective review of 191 patients who underwent elective excision of the ilioinguinal nerve during open hernia repair, showed that no patients reported pain after 1, 6, or 12 months follow-up. Only, 7% of patients complained of numbness or sensory loss at 12 months of follow-up.

In another retrospective study, ***Dittrick et al.*** [29] reported a significantly lower incidence of chronic groin pain in patients who had elective neurectomy during open inguinal hernia repair when compared with the control group (3% versus 25%). However, this study was limited by its inhomogeneous distribution of patients (66 patients versus 24 patients).[8]

In a prospective randomized controlled study by ***Mui et al.*** [10] a total of 100 patients were divided into 2 groups. First group included 50 patients in whom ilioinguinal neurectomy was done while in the second group, the ilioinguinal nerve was preserved. The incidence of chronic groin pain within the normal daily activities was the same between the 2 groups. But also, significantly fewer patients in the neurectomy group developed chronic groin pain upon exertion: cycling for 10 minutes and walking up 3 flights of stairs (8% versus 28.6%). So, the authors concluded that prophylactic ilioinguinal neurectomy during Lichtenstein hernioplasty decreases the incidence of exertional postoperative chronic groin pain and that ilioinguinal neurectomy should be considered as a routine surgical step during open mesh hernia repair. However, this study also was criticized as being of short duration (6 months follow up) and being of small sample size (100 patients in both groups).[8]

Wantz [30] stated that chronic pain was absent in 546 patients who underwent hernia repair with elective division of the ilioinguinal nerve, whereas it was present in patients with preserved nerve. In another randomized clinical trial, ***Malekpour et al.*** [31] recommended elective division of ilioinguinal nerve to reduce development of chronic pain.

Some authors restored the resection of ilioinguinal nerve only when an injury has occurred. ***Amid et al.*** [32] did not recommend a simple division of the inguinal nerves. Instead, neurectomy, with complete resection of the entire length as far proximally and distally as possible and ligation of the transected ends, was recommended.

Some papers reserved ilioinguinal neurectomy with or without resection of iliohypogastric and genitofemoral nerves only for surgical treatment of chronic neuropathic pain after one year postoperatively.[8] ***Madura*** [6] stated that elective resection frequently results in annoying numbness but if resection is done as a management for neuropathic

pain, so numbness will not be a frequent complaint since all patients will be happy to trade numbness for pain relief. ***Madura et al*** [33] reported a success rate of 80% in a study including 100 patients with inguinal nerve entrapment. ***Amid*** [32] preferred to do a one-stage triple inguinal neurectomy under local anesthesia as a treatment for post hernioplasty chronic neuropathic pain with a success rate reaching 96%.

Others recommended to completely resect the ilioinguinal nerve only in case of being in the way of the surgical field or being suspected to be injured during the operation.[8]

In the ***International guidelines for prevention and management of post-operative chronic pain following inguinal hernia surgery,*** [8] the working group criticized papers comparing chronic pain after division or neurectomy versus preservation of only a single nerve (the ilioinguinal nerve or less common the iliohypogastric nerve) without giving any data concerning the other two nerves as that all three inguinal nerves contribute to the sensory innervation of the groin. So, their findings, with even an apparently a big evidence grade of recommendation, may be distorted because the other two inguinal nerves could be unintentionally divided or injured through the operation and, for that, chronic pain could result.

The ***international guidelines*** failed to postulate any recommendations for manipulation of the preserved nerve: whether to remove covering fascia or not.[8] Keeping in mind 1) theory of perineural fibrosis, resulted from excessive dissection, skeletonization or manipulation of the nerve, as a possible cause of chronic pain and 2) the recommendation of ***Amid*** [32] to avoid removal of cremastric layer to prevent injury of ilioinguinal nerve, so it means that we can criticize the conclusions of ***Izard*** [26] and ***Alfieri***, who insisted to always identify and preserve the inguinal nerves, as trying to over-dissect the tissues to identify and preserve the inguinal nerves may cause fibrosis around them and may cause, unintentionally, the chronic pain.

The ***international guidelines*** did not postulate any recommendations for management of cut ends of the nerve: whether to ligate, cauterize or leave it.[8] However, ***Amid*** stated that the transected ends should be ligated to close the neurilemmal sheath to prevent formation of neuromas. He also stated that proximal end should be implanted within the fibers of the internal oblique muscle in order not to be adherent to inguinal ligament or external oblique muscle and so subjected to traction during any movement of hip joints as walking.[32]

In our study, we assessed elective neurectomy versus preservation of ilioinguinal nerves in terms of chronic postoperative pain in our hospital. We did segmental resection of the ilioinguinal nerve. In our other group, we did identification and preservation of ilioinguinal nerve without doing over-dissection or removing the fascia surrounding it.

Our study was conducted for one year follow up. ***Aasvang et al.*** found no correlation between incidence of pain and follow up period.[11] However, Some papers suggested improvement of pain over time. In 2 studies, done by ***Wright et al.*** and ***Tschudi et al.*** incidence of chronic pain decreased with long follow up. ***Nienhuijs et al.*** [15] stated that chronic pain tended to be less after a longer follow-up as chronic pain attenuates spontaneously over time.

Poobalan et al. supported this observation and found a significant predictive value between preoperative pain and chronic pain ($P<0.005$).[19]

Moreover, ***Aasvang et al.*** found, in their review, that any condition of preoperative chronic pain as headache, back pain and pain from scars elsewhere in the body was significantly correlated with the development of chronic pain. The authors concluded that preoperative pain may increase the risk of development of chronic pain.[11]

On the contrary, ***Liem et al.,*** in their large randomized study, 994 patients were studied and no significant relation between the development of chronic and preoperative pain was found in them ($P=0.2$).[30]

In our study, 88.8% of patients with chronic postoperative pain complained of preoperative pain either mild or moderate. We found a statistical significance in relation between preoperative pain and the risk of developing chronic pain postoperatively ($P=0.005$).

Bittner et al. reported an overall risk of complications after inguinal hernia operations from 15 to 28%. The authors found that hematomas and seromas were the most frequent early complications.[19] ***Schmedt et al.*** found a similar incidence of complications.[19, 20] While ***Nordin et al.*** found a higher incidence of complications ranging from 17 to 50%.[22]

Simons et al. stated that the risk of hematomas varies between 5.6 and 16% while the risk of wound infection should be below 5%.[8]

In our study, the overall incidence of postoperative complications in the two groups was 30%. Wound infection was the most frequent, found in 17.5% in group I and 12.5% in group II. The overall incidence of scrotal edema was 25%; it was the second most common complication. Inguinal hematoma and hydrocele were present in 12.5% in both groups.

By definition, chronic post-hernioplasty pain is different from early postoperative pain which occur

soon after surgery, controlled with simple analgesia and resolved within 2-4 weeks. ***Nienhuijs et al.*** [15] stated, in their systematic review, that 2 trials found a correlation between pain in the early postoperative period and developing of chronic pain. Also, in a prospective study by ***Callesen*** [14], 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 versus 3%, P<0.05) after 1 week. They concluded that intensity of pain in early postoperative period was a predictive factor for chronic pain. This was in agreement with findings of ***Lau et al.***[24] Thus, ***Bay-Nielsen et al.*** hypothesized that compression to or injury of the nerve may be a pathogenic risk factor for both acute and chronic pain.[17]

In our study, the overall incidence of severe pain at 1 week follow-up was 15% while at 2-week follow-up; the incidence was decreased to 12.5% of patients. After 3 months, the overall incidence of severe pain was 2.5%.

The incidence of severe pain in group I and group II was 36% and 16%, respectively after 1 week. In ***Picchio*** trial, moderate to severe pain after 1 week was 19% and 20%, respectively.[16]

The incidence of moderate pain 4 weeks postoperatively was 68% and 20%, respectively while severe pain was present in 16% of group I and absent in group II. In ***Picchio*** trial, moderate to severe pain was present in 23% and 18%, respectively.[16] In ***Mui et al.*** trial, during daily activities, moderate pain was present in 34% of patients with preserved ilioinguinal nerve and 21.3% of patients with resected nerve while severe pain was present in only 2.1% of patients with resected nerve.[10]

In group I, the pain after 3 months was mild in 16%, moderate in 44% and severe in 4%. While in group II, the overall incidence of pain was 20% after 3 months: mild in 16% and moderate in 4%. In ***Picchio*** trial, the pain after 6 months was mild in 25%, moderate in 9% and severe in 3% in group I. While in group II, the pain was mild in 26%, moderate in 6% and severe in 2%.[16] In ***Mui et al.*** trial, in the group with preserved nerve, chronic pain was present in 28.6%; with severe pain in 2.9%. While in the group with resected nerve, the chronic pain was 8%; all of them described it as a mild pain.[10]

Regarding the sensory disturbance, ***Picchio et al.*** reported increased incidence of sensory loss to pain and touch around the groin region in the group with resected nerve.[16]

Ravichandran et al. stated that hypoesthesia in the territory supplied by the ilioinguinal nerve occurred in 45% of patients with divided nerve and in 5-25% of cases with preserved nerve after 6 months.[27] Moreover, ***Dittrick's*** study, parasthesia was higher in the neurectomy group but not statistically significant (18% versus 4%, P = 0.1).[29]

However, ***Mui et al.*** reported no associated neurosensory disturbance or groin numbness with elective resection of the ilioinguinal nerve at the 6-month follow-up.[10] ***Mui et al.*** criticized ***Picchio's*** trial as there were no details about how to test skin sensation. As well, the author explained that cross innervation from other ipsilateral or even contralateral sensory cutaneous nerves may compensate the sensory loss caused by neurectomy.[16]

In our study, we found that postoperative hypoesthesia was significantly more after resection of the ilioinguinal nerve (25% versus 0%) and was significantly associated with absent chronic postoperative pain in our study.

Despite controversies in management of ilioinguinal nerve during hernioplasty, our results revealed that elective resection was better in terms of chronic postoperative pain. In addition, the postoperative hypoesthesia was not such a frequent complaint that affects daily activities of patients if compared to chronic postoperative pain. Our results supported that the elective resection of ilioinguinal nerve is superior to its preservation.

Conclusion

- Chronic postoperative pain after tension-free inguinal hernioplasty is pain which persists beyond normal tissue healing assumed to be 3 months.
- Chronic postoperative pain after tension-free inguinal hernioplasty is a significant clinical problem with high incidence reaching 26% of patients.
- Patients with preoperative pain are more prone to develop chronic postoperative pain after tension-free inguinal hernioplasty.
- Chronic postoperative pain after tension-free inguinal hernioplasty tends to be decreased over the time.
- Elective resection of the ilioinguinal nerve reduces the risk for chronic post hernioplasty pain.
- Elective neurectomy of the ilioinguinal nerve is associated with increased risk of postoperative hypoesthesia in inguinal region. Incidence of postoperative hyperesthesia does not differ after preservation or elective resection of the ilioinguinal nerve.
- Postoperative hyperesthesia, if presents, is associated with increased incidence of moderate to severe pain.

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10/12/2019