Neuropathic inguinal pain: neurectomy associated with open prosthetic hernioplasty for the prevention of post-operative pain

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INTRODUCTION: *Inguinal hernia is one of the most common surgical diseases in the world. Today, this disease is treated by surgical technique only. Among the late complications after surgery, the most frequent is the appearance of chronic post-operative pain after surgical treatment. The incidence of this complication is about 28% of patients undergoing hernioplasty suffering a varying degree of chronic pain, severe enough to interfere with normal daily activities.*
OBJECTIVES: *In this study we evaluated the onset of the neuropathic pain as a complication of inguinal prosthetic hernioplasty surgery.*
METHODS: *This is a prospective observational study run between September 2019 and August 2020. All patients, during the first visit conducted in an outpatient clinic, were recruited in a specific database. Subsequently, surgery was planned in election on one day surgery, patients were administered a specific questionnaire aiming at the identification of any pain and its exact location. The Inguinal Pain Questionnarie (IPQ) was used. During the surgical procedure the selective neurectomy of the 3 nerves has been documented, the entire population of patients has undergone a standardized surgical treatment. At the end of surgery, a follow-up was carried out administering two questionnaires (IPQ Short Form Modified and the IPQ Short Form Paresthesia Modified) concerning the possible chronic post-operative pain and the eventual paresthesia. The questionnaires were administered at first, third and sixth month from the date of surgery.*
RESULTS: *A total of 266 patients were screened from September 2019 to October 2020. Fiftyseven male patients were included in the study with a confirmed diagnosis of primary inguinal hernia. Clinical data, baseline characteristics and outcomes are described. Preoperatively, at the time of IPQ administration, 1.8% of patients had a pain score of 6, 10% of 5, 21% of 4, 31% of 3, 28% with a score of 2 and 7% of patients with a score of 1. In all cases the ileoinguinals and ileohypogastric nerves found were subjected to neurectomy, in 19% of cases also the genitofemoral nerve was subjected to surgical resection. At the end of the follow-up, the first questionnaire (IPQ Short Form Modified) results did show that, among the total of patients who had an open prosthetic hernioplasty with extensive nerves resection in the inguinal canal, 84% of them indicated a pain score equal to 0 (no pain) after 6 months of treatment and only 1.7% indicated a score equal to 4. Analyzing the second questionnaire on paresthesia (IPQ Short Form Paresthesia Modified), 79% of patients indicated a score equal to 0 by describing no paresthesia and no changes in sensitivity; 15.7% score 1; 3.5% score 2; 1.7% score 3.*
CONCLUSIONS: *Based on our experience and according to the modern literature, we would advise prophylactic total neurectomy of the inguinal canal nerves during prosthetic inguinal hernioplasty.*

KEY WORDS: Abdominal Surgery, Chronic pain, Inguinal hernioplasty, Neurectomy, Paresthesia

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Introduction

Inguinal hernia is one of the most common surgical diseases in the world. Worldwide, more than 20 million patients have groin hernia repair surgery each year[1], and mainly are male due to anatomical diversities in the inguinal duct.
Today, this disease is treated by surgical technique only [2]. The surgery of prosthetic hernioplasty is an operation not free from early and late complications [3]. Among the early ones we remember: seromas, hematomas, ecchymosis, reduced sensitivity at the level of the inguinal region, urinary retention, and constipation. The late complications, could include the appearance of chronic postoperative pain, testicular atrophy, sexual dysfunction, and of course, the development of relapses [4].
In particular, the appearance of chronic post-operative pain represents a frequent postoperative complication after surgical treatment for inguinal hernia repair. In fact, it is estimated that the incidence of this complication is about 28% of patients undergoing hernioplasty suffering a varying degree of chronic pain, severe enough to interfere with normal daily activities in 11% of cases [5].
In this study, we will evaluate the onset of the neuropathic pain as a complication of inguinal prosthetic hernioplasty surgery. Chronic post-operative inguinal pain can be the consequence of a direct injury of the nerves in the inguinal region: ileoinguinal, ileohypogastric and the femoral branch of the genitofemoral nerve as they can be bound, clotted, placed in tension and partially sectioned ending up in a neuroma. Pain could be caused by damage caused by rub of the nerve with the mesh prosthesis. It is also possible that a nerve remains in the mesh of the prosthetic network or that this stimulates, as a foreign body, an intense inflammatory response with the formation of fibrous tissues that can trap or compress the nerve [6].

Objectives

The aim of this study is to demonstrate that the execution of a correct neurectomy of the inguinal canal nerves, following inguinal hernioplasty, can be extremely advantageous in the prevention of the main post-operative complications such as chronic inguinal pain, paresthesias, and daily activities limitations.

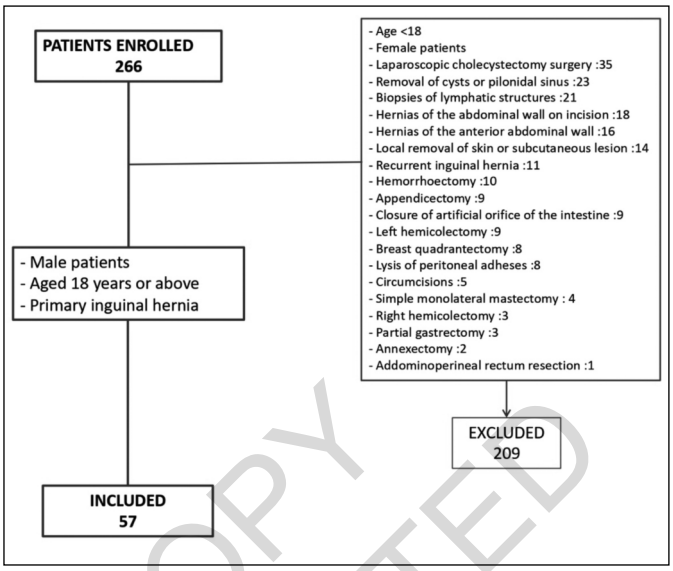
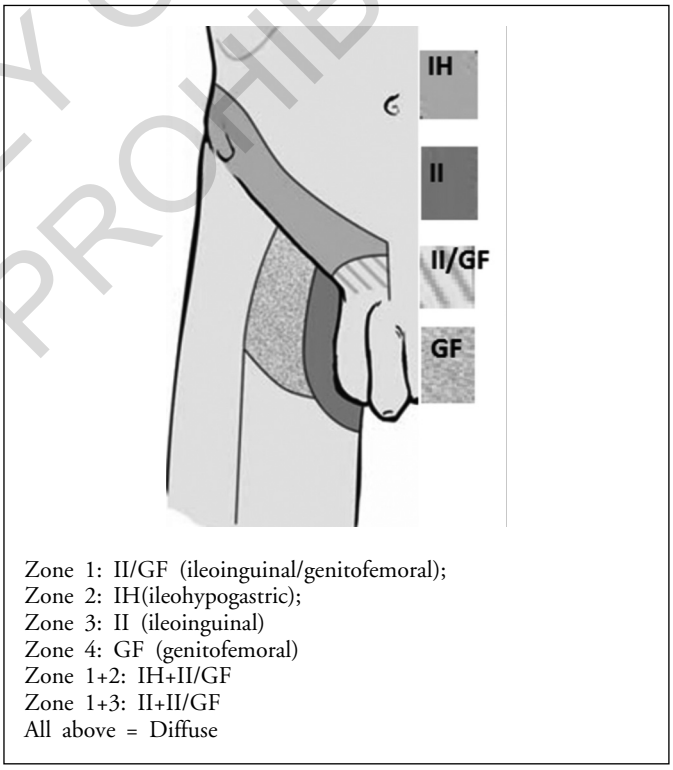


Fig. 1: Flow chart patients.



Zone 1: II/GF (ileoinguinal/genitofemoral);
Zone 2: IH(ileohypogastric);
Zone 3: II (ileoinguinal)
Zone 4: GF (genitofemoral)
Zone 1+2: IH+II/GF
Zone 1+3: II+II/GF
All above = Diffuse

Fig. 2: Localization of pre-operative pain by skin area.

Methods

This is a prospective observational study run at the "Policlinico-San Marco" Hospital, between September 2019 and August 2020. The inclusion and exclusion criteria were identified (Fig. 1). We included 57 patients with diagnosis of primary inguinal hernia, followed by prosthetic inguinal hernioplasty surgery and by a follow-up through clinical monitoring and a dedicated questionnaire administration. During the first visit conducted in outpatient clinic, patients were enrolled in a specific database including: name, age, BMI and the main comorbidities. Subsequently, surgery was planned in election on one day surgery [7-8,40]. Once identified and marked the side with hernia, patients were administered a specific questionnaire to score pain and its location.

The Inguinal Pain Questionnarie (IPQ) [9] was used and developed as a modification of the one proposed by Kehlet and colleagues [10]. IPQ uses a fixed 7-point scale for pain assessment, in which each point correlates with pain quality and behavior rather than frequency or verbal description [9,11]. In addition to the questionnaire, an assessment of the topographical pain location has been made [12]. The 7 skin regions examined refer to the innervation regions of the Ileoinguinal (II), Ileohypogastric (IH) and Genitofemoral (GF) nerves individually or in association with each other (Fig. 2). We classified the different hernial defect following the classification proposed in 2007 by European Hernia Society (EHS) [13]. During the surgical procedure, selective neurectomy of the 3 nerves has been documented; data related to the anaesthetic perioperative patient risk score (ASA score), the type of anaesthesia (local, spinal or general) and the time of surgery were recorded [14]. At the end of surgery, a follow-up was carried out administering two questionnaires concerning the possible chronic post-operative pain and the paresthesia appeared. The questionnaires was administered at 6 months from the date of surgery, through phone interview by a doctor. The two questionnaires used were the *IPQ Short Form Modified* [15] and the *IPQ Short Form Paresthesia Modifie*d (Tables I, II). The first aimed to score pain from 0 to 6 points. In addition, if any pain, the patient had to identify the impact on its ability to perform daily activities. Each of these activities has been scored as "+1" that is added to the previous score, obtaining a total score ranging from 0 to 12. The design of the IPQ Short Form was based on the extensive use of IPQ, considered a reliable questionnaire but too detailed [15] to be administered in clinical practice. Similarly, to the first, the second IPQ Short Form Paresthesia modified questionnaire aimed to estimate the presence of paresthesia in the groin region identifying 7 different points possibly affected by paresthesia. Each of these has been scored from 0 to 6 points. The entire patient's population had a standardized surgical treatment, performed by the same surgical team, using the same surgical technique [16,17]. This technique is a modified Trabucco, which involves a horizontal overpubic surgical incision, opening of the aponeurosis of the external oblique muscle and evaluation of the hernial defect. In this phase, usually the course of the ileohypogastric nerve and of the ileoinguinal nerve is evidenced and these nerves are carefully removed by performing a wide resection so that the proximal and distal stumps are not incarcerated in the meshes of the prosthesis [18,19]. Subsequently, the hernial sac is isolated from the elements of the spermatic cord and reduced to peritoneal cavities [20]. At this point, a prolene plug (Perfix™ Light Plug) is placed and fixed with absorbable stiches. Once identified the genitofemoral nerve, we proceeded with its resection. In the case of repairing of a direct inguinal hernia, before applying the mesh, we proceeded to the straightening of the posterior wall of the inguinal canal, through the transversal fascia continuous suture with prolene 3/0 [21]. In the case of the repairing of an indirect hernia, after the positioning of the plug, we continue with the application of the mesh in shaped prolene in relation to the measurement of each inguinal channel (Hermesh™ 6 X 11cm), which is attached to the pubic tubercle with a stich in absorbable material [22]. Finally, we go ahead with the aponeurosis of the external oblique muscle synthesis through two semi-continue sutures with prolene 2/0, in order to pack a new inguinal external ring that allows the spermatic funicle course in the subcutaneous space and we proceed to suture by layers the surgical site.

Table I - *IPQ short form modified.*

IPQ SHORT FORM MODIFIED	Score	
Estimate of the worst pain felt in the inguinal region, in the post-operative phase, during this past week. (Follow-up 6 months)		
No Pain		0 pt.
Pain present but can easily be ignored		1 pt.
Pain present, cannot be ignored, but does not interfere with daily activities		2 pt.
Pain present, cannot be ignored, interferes with concentration on chores and daily activities		3 pt.
Pain present, cannot be ignored, interferes with most activities		4 pt.
Pain present, cannot be ignored, necessitates bed rest		5 pt.
Pain present, cannot be ignored, prompt medical advice sought		6 pt.
If you have experienced inguinal pain, to what extent has it limited your ability to perform following activities? More then one option may be selected.	Score	
Getting up from a low chair		+1
Sitting down (more than 30 minutes)		+1
Standing up (more than 30 minutes)		+1
Going up or down stairs		+1
Driving a car		+1
Exercising or performing sport		+1
Total (0 to 12)		

Statistical Analysis

Statistical analyses were performed obtaining the percentages of the collected data for all patients included in the study. The following data were collected: median age, BMI, incidence of chronic underlying diseases (radiculopathy, diabetes, reumathic/autoimmune deseases, postural problems, previous abdominal surgery), and the ASA score. The number of different types of hernia and the side affected was also collected in the preoperative and postoperative period, respectively; the IPQ and IPQ paresthesia score has been calculated, considering pain and possible paresthesia in both periods. Finally, the percentage of the different anesthesia technics used (local, spinal, general) was calculated.

Results

A total of 266 patients were screened from September 2019 to October 2020 (Fig. 1). Clinical data, patients' baseline characteristics and outcomes were recorded. Fiftyseven male patients were included in the study, over the age of 18 years and with a proved diagnosis of primary inguinal hernia. The median patients' age is 57 years (36 - 81 yrs), with an average BMI of 25 (19 - 35). The comorbidities reported were: diabetes mellitus (7%), radiculopathy (28%), rheumatic and/or autoimmune diseases (3.5%), postural problems related to work and/or physical activity (35%). Some patients (19%) reported to have had previous abdominal wall surgery, specifically 16% report previous surgery of prosthetic hernioplasty in the opposite side region compared to the site related to this study. The remaining percentage of patients reported previous interventions of appendicectomy (8.9%), hemicolectomy (1.8%) and abdominoplasty (1.8%). Another group of patients (36.8%) reported a feeling of weight at the scrotal bag level, others (59.6%) had hernial defect at the level of the right inguinal canal, the remaining 40.4% has the pathology on the left side (Table III). It appears that the 68.4 % of patients had a defect size of 3 (>3 cm), the 29.8 % of 2 (1.5 - 3 cm) and the 1.8 % of 1 (1.5 cm) (classification EHS 2007) [13]. The 59.6% has a hernial defect of indirect type, the 21.1% has a direct inguinal hernia, 19.3% has a double component both direct and indirect (table 4). Preoperatively, at the time of IPQ administration [9], 1.8% of patients had a pain score of 6, 10% of 5, 21% of 4, 31% of 3, 28% had a score of 2 and 7% a score of 1(table 5). When we asked to locate the cutaneous area suffering (Fig. 2) the 75% of patients indicate ZONE 1, the 3.5% indicate ZONE 2, the 10.5% report pain in both ZONE 1 and ZONE 2, the 7% in both ZONE 1 and ZONE 3, finally, the 3.5% does not report any pain localization (Table VI). In our experience, we have found in 81% of cases the presence of the ileoinguinal nerve of average size of 2.38 mm, in 77% of cases the presence of the ileohypogastric nerve of average size of 2,18 mm, in 80% of cases the presence of the genitofemoral nerve of average size of 1.60 mm. In all cases the ileoinguinals and ileohypogastric nerves found were subjected to neurectomy, for the 19% of cases the genitofemoral nerve was subjected to surgical resection too. The 60% of procedures was performed under local anesthesia, 37% under spinal anesthesia, only in one case the general anesthesia regime was necessary. At the end of the follow-up, the first questionnaire (IPQ Short Form Modified) results did show that the total of

TABLE II - *IPQ short form parestesia modified.*

IPQ SHORT FORM PARESTHESIA MODIFIED	Score	
Estimate of paresthesia in the inguinal region, in the post-operative phase, during this past week. (Follow-up 6 months)		
No paresthesia		0 pt.
Paresthesia present but can easily be ignored		1 pt.
Paresthesia present, cannot be ignored, but does not interfere with daily activities		2 pt.
Paresthesia present, cannot be ignored, interferes with concentration on chores and daily		3 pt.
Paresthesia present, cannot be ignored, interferes with most activities		4 pt.
Paresthesia present, cannot be ignored, necessitates bed rest		5 pt.
Paresthesia present, cannot be ignored, prompt medical advice sought		6 pt.
If paresthesia is present in the inguinal region, indicate which of these types is present. More then one option may be selected.	Presence	
Tingling sensation at rest		
Sensation of itching		
Unpleasant sensation (of discomfort) to the touch, compared to the contralateral region		
Loss of tactile and/or thermal sensitivity to the contralateral region		
Increased tactile and/or thermal sensitivity to the control side region		
Other (specify the feeling)		
Total (0 to 6)		

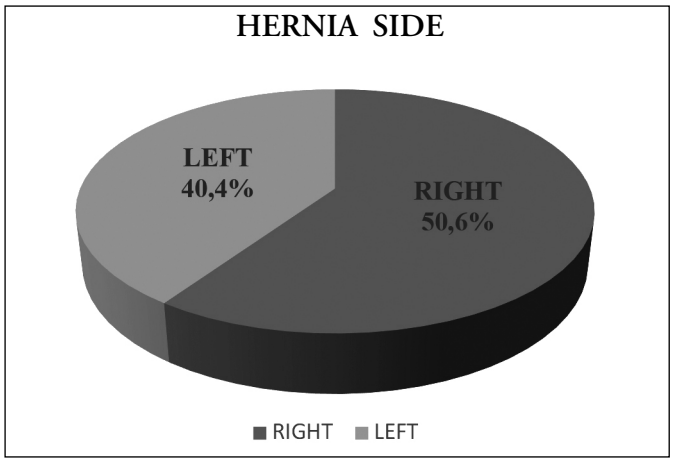


TABLE III - *Distribution according to laterality.*

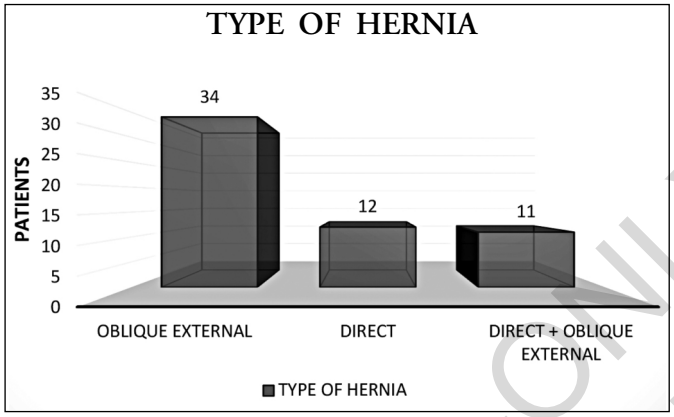


TABLE IV - *Distribution by type of hernias.*

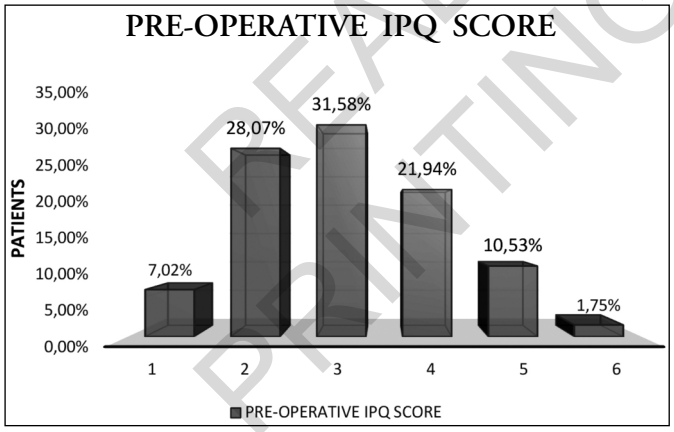


TABLE V - *Pre-operative IPQ score given by patients (%).*

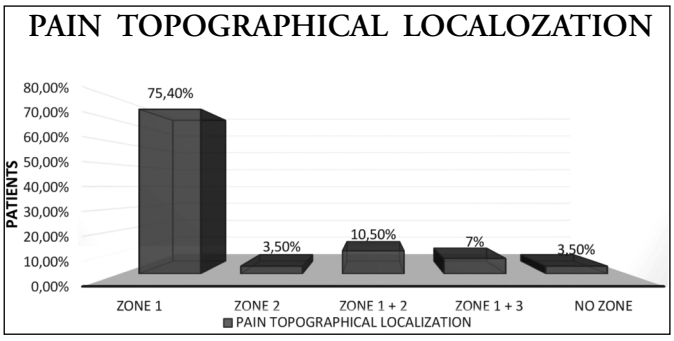


TABLE VI - *Pain topographical localization for pre-operative phase skin area.*

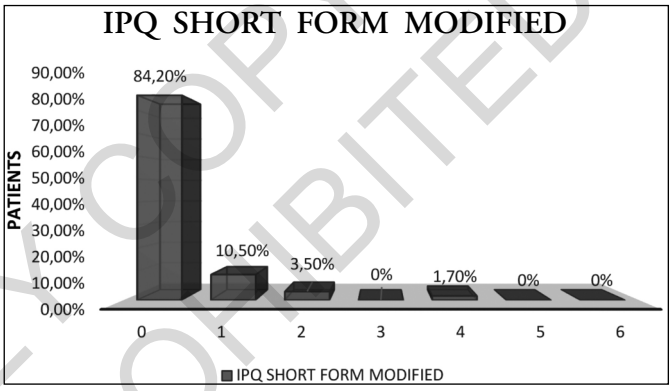


TABLE VII - *Results IPQ short form modified administered in follow up to 6 months after surgery.*

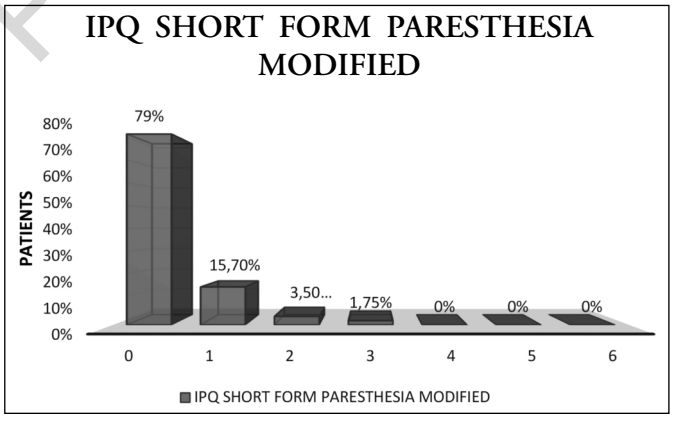


TABLE VIII - *Results IPQ short form modified paresthesia administered in follow up to 6 months after surgery.*

patients had an open prosthetic hernioplasty with extensive resection of the nerves in the inguinal canal, 84% of them indicated a pain score equal to 0 after 6 months; 10% a score equal to 1 and only in 2 of these it was necessary to type the appearance of pain; in one case, when standing for more than 30 min and in the other case a burning sensation; 3.5% indicated a score equal to 2; only 1.7% had a score of 4 (Table VII). Analyzing the second questionnaire related to paresthesia (IPQ Short Form Modified Paresthesia), the 79% indicated a score of 0; the 15.7% indicated a score of 1 describing in three of these cases a slight reduction in sensitivity compared to the contralateral region, in 2 other cases a slight feeling of paresthesia in the inguinal region is described, in one case a slight tingling sensation and in another case a slight hyperesthesia under stress, in

two cases nothing is described; 3.5% indicated a score equal to 2 describing in a single case a reduction in sensitivity in the region undergoing surgery compared to the contralateral; finally, 1.7% indicated a score of 3, identifying paresthesia as an alteration of sensitivity to the contralateral region (Table VIII).

Discussion

Modern scientific literature shows that the inguinal canal neuroanatomy is characterized by a great variability [20], in fact the identification of the nerves can be difficult because their course or structure can be barely evident [23,24].

During the postoperative period, it is important to differentiate chronic pain from acute pain. The last one appears early after surgery; it is easily managed with the use of any analgesics and generally resolves in the first 15-30 days without the need for further treatments. At the opposite, moderate or severe chronic pain is generally observed in the 3 months after surgery, this can last for 6 months or can even lead to a potentially debilitating condition for the patient over the following years, who will be unable to perform daily activities or return to work [25]. As a result, it poses a major clinical obstacle, as it is often immune to analgesic therapies and can be successfully treated with additional surgical procedures such as neurectomy, neurolysis, or neurinoma excision [26,27]. Nerve damage induces neuropathic pain [28], and chronic inguinal pain is classified into three categories: somatic, visceral, and neuropathic [29].

An increase in the frequency of chronic pain has been found in the '90s and some authors have attributed it to a greater use of mesh in the hernioplasty operation [30]. About the post-operative chronic pain treatment, there are different types of approaches in the literature, both medical and surgical, but unfortunately none of these so far guarantees a satisfactory percentage of success [33].

According to *P.J. O'Dwyer*and *M.G. Serpell*, medical therapies can be grouped into four classes: physical, pharmacological, nerve-block and psychological [34].

A multicentric Italian study, conducted by *Alfieri et al.* [25], focused its attention on the differences in the post-operative course-operating between patients undergoing nerves resection and patients in which the three nerves have been preserved, treated with open prosthetic hernioplasty surgery. The study showed that the lack of nerve identification during surgery it is significantly related to the risk of developing chronic inguinal pain. Similarly, the study correlates nerve resection with the onset of pain as a consequential event. This concludes by stating that the identification and preservation of nerves during surgery, significantly reduces the appearance of potentially disabling chronic pain. Contrary to the previous study, the study proposed by *Zannoni et al.* [35] conducts a comparative analysis of the results of two different types of neurectomy, both conducted during the hernioplasty surgery according to Trabucco, in order to prevent the onset of chronic post-operative pain. The study concludes that the wide resection of the nerves is a technique that guarantees a significantly lower incidence of post-operative chronic pain than the simple section. Moreover, the extensive resection has not led to sensitivity issues or these have been resolved during the first 30-120 days after surgery [36,39].

With this prospective study, we show that 94.7% of patients reported no post-operative pain and, the remaining percentage reported negligible pain 6 months after surgery. The 94.7% of all treated patients reported no changes in sensitivity or a negligible paresthesia in a small percentage. Therefore, despite the scientific literature very much encourages surgical treatment with nerve preservation ("Nerve Sparing"), a procedure widely established but with an incidence of chronic post-operative pain up to 37% [37,38], our results show that the execution of a correct neurectomy of the nerves of the inguinal canal can be extremely advantageous in the prevention of chronic pain and paresthesia. Indeed, we can say that, although this is a more invasive procedure, it certainly guarantees a better outcome, having found the appearance of neuropathic pain on 1.70% and the appearance of paresthesia on 1.75% of patients only, interfering with daily activities.

Conclusion

The incidence of patients who reported no pain and no paresthesia is 94.7%. Based on our experience and according to the modern literature, we would advise prophylactic neurectomy with total removal of the nerves of the inguinal canal during intervention of prosthetic inguinal hernioplasty.

Riassunto

INTRODUZIONE: L'ernia inguinale rappresenta una delle principali patologie ad interesse chirurgico. Allo stato dell'arte, risulta essere trattata esclusivamente mediante terapia chirurgica. La principale tra le complicanze tardive è il dolore postoperatorio, con un'incidenza di circa il 28% dei pazienti sottoposti ad ernioplastica inguinale, talvolta tale da interferire con le normali attività quotidiane. L' obiettivo di questo studio è la valutazione dell'insorgenza del dolore postoperatorio come complicanza dell'ernioplastica inguinale protesica.

METODI: Presso la nostra UOC è stato condotto uno studio osservazionale prospettico tra settembre 2019 ed Agosto 2020. I pazienti sono stati reclutati mediante visita ambulatoriale ed inseriti in un database.

Successivamente è stato programmato un intervento chirurgico in elezione in day surgery. La valutazione dell'eventuale dolore post operatorio è stata valutata medi-

ante uno specifico questionario: Inguinal Pain Questionnarie (IPQ). La neurectomia selettiva dei 3 nervi è stata documentata durante l'intervento chirurgico standardizzato. Il follow-up è stato effettuato mediante due questionari, somministrati al primo, terzo e sesto mese dalla data dell'intervento.

RISULTATI: Un totale di 266 pazienti sono stati reclutati. Lo studio comprende 57 pazienti di sesso maschile con diagnosi di ernia inguinale primaria. Sono stati descritti i dati clinici, le caratteristiche e gli outcomes. Prima dell'intervento, l'1,8% dei pazienti aveva un punteggio del dolore di 6, 10% di 5, 21% di 4, 31% di 3, 28% di 2 e 7% dei pazienti con un punteggio di 1. In tutti i casi in cui sono stati riscontrati, i nervi ileoinguinale ed ileoipogastrico sono stati sottoposti a neurectomia, nel 19% dei casi anche il nervo genito-femorale. Come risultato del primo questionario, l'84% dei pazienti ha indicato 0 come punteggio del dolore dopo 6 mesi e solo l'1,7% un punteggio del dolore pari a 4. Durante il secondo questionario, il 79% dei pazienti ha indicato un punteggio pari a 0 descrivendo nessuna parestesia e nessuna alterazione della sensibilità; 15,7% punteggio 1; 3,5% punteggio 2; 1.7% punteggio 3.

CONCLUSIONI: questo studio ha evidenziato, in linea con la letteratura attuale, il vantaggio di eseguire una neurectomia totale profilattica dei nervi del canale inguinale durante l'intervento di ernioplastica inguinale protesica.

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