FACULTY OF MEDICINE AND HEALTH SCIENCES

# THERAPY FOR CHRONIC GROIN PAIN AFTER INGUINAL SURGERY

## A retrospective cohort

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# Preface

In the third bachelor of medicine, I chose to do an experimental dissertation, in order to gain some experience in experimental research, administrative work and communication with patients and health workers. I was thrilled when I learned that the subject of my dissertation originated from the department of General and Hepatobiliary Surgery at the University Hospital in Ghent, since I have an enormous interest in surgery. I was happy to get the possibility to add extra data to the subject of chronic pain after inguinal hernia, in order to increase the technology and, hopefully, improve the quality of life of patients suffering from chronic pain in the past and in the future.

In the first place, I'd like to express my sincere gratitude to Professor Frederik Berrevoet for letting me work with him on this subject and being an honest and helpful mentor every step of the way, even though he's a man with a busy schedule. With his advice and experience, he stimulated me from beginning to end, answering all my questions with patience. I'm also grateful for the freedom he gave me in setting up this research.

Two other very important people are Betsy Van Loo and Kathleen Segers. They are the study nurses at the department of General Hepatobiliary Surgery at UZ Ghent. Without them, I would have been lost in paperwork and logistics at the setup of this dissertation and throughout the entire time I worked at the department. I would like to thank them from the bottom of my heart and emphasize how important their work is for young students, who set their first steps in experimental research. They did not only help me with my dissertation, but also taught me a lot about working more structured and efficient.

I would like to thank Dr. Luís Abreu de Carvalho as well, for his help and advice at my first interview with patients.

Furthermore I'd like to thank the faculty of medicine and health science and everyone who was involved directly or indirectly at the University of Ghent.

At last, I'd like to thank Judith Beel, Tom Van Reybrouck and Mieke Fiems for support and proofreading my dissertation.

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# 1. Abstract Nederlands

De keuze van behandeling voor chronische liespijn is nog steeds controversieel. In deze studie werd een evaluatie gemaakt van de resultaten van verschillende behandelingen voor chronische pijn na liesbreukchirurgie om extra gegevens te verzamelen over dit onderwerp. Om dit te kunnen uitvoeren werden 18 patiënten op een retrospectieve manier geselecteerd, gebaseerd op het melden van chronische pijnklachten na primair liesbreukherstel. Ze werden geïnterviewd, vulden een vragenlijst in en ondergingen een kort klinisch onderzoek. De informatie gehaald uit deze zaken in combinatie met hun medisch dossier werd de bron van de data voor deze studie.

De steekproef van de studie was heel divers qua pijnsymptomen en behandeling. Dit demonstreert de complexiteit van dit onderwerp en de bijhorende therapie. De interventie die in deze studie het meest invloed had op de pijn was het verwijderen van synthetisch materiaal, zoals mesh en ring. Het gedeeltelijk of volledig verwijderen van de mesh of de ring gaf een succespercentage tussen 52.9% en 71.4%. Het verwijderen van de mesh gaf een algemene daling in VAS-score van 4 en wanneer er tijdens de operatie een meshoma gevonden werd, daalde de VAS-score zelf met 4.4. Het slaagpercentage van de niet-chirurgische behandelingen was 20%. De lage levenskwaliteit werd gelinkt aan hoge VAS-scores en meerdere ingrepen.

Er moet meer onderzoek gebeuren naar het ontwikkelen van nieuwe mesh om zo de incidentie van chronische pijn veroorzaakt door mesh te doen dalen. Verder moet er ook een duidelijke definitie van chronische pijn en bijkomend één internationaal beoordelingsinstrument gedefinieerd worden om het vergelijken van verschillende studies te vergemakkelijken. Chronische pijn moet altijd op een multidisciplinaire manier aangepakt worden om zo de juiste behandeling voor iedere patiënt, individueel, te vinden. De keuze van behandeling moet gebaseerd worden op eerdere behandelingen, ervaring van de verantwoordelijke artsen en zowel persoonlijke als klinische data van iedere patiënt.

## 2. Abstract English

The choice of treatment for chronic inguinal pain is still controversial. In this study, an evaluation of outcomes of different therapies for chronic pain after inguinal hernia surgery was made in order to collect extra data on this subject. To do so, 18 patients were retrospectively selected based on complaints of chronic pain after primary hernia repair. They were invited for an interview, a questionnaire and a short clinical exam. This information, in combination with the data from their medical file, was the source of data for this study. The efficiency of therapy was measured, using the VAS score for pain and the EuraHS QoL questionnaire for quality of life.

The study sample showed very diverse pain symptoms and treatments which demonstrates the complexity of the subject and its therapy. The intervention with the strongest influence on the pain was the removal of synthetic material such as the mesh and ring. Partly or completely removing the mesh and/or the ring gave a success rate between 52.9% and 71.4%. Removal of mesh gave a general decrease in VAS score of 4 and when a meshoma was found, the VAS score dropped even more with 4.4. The success rate of non-surgical treatment was only 20%. The low quality of life was linked to high VAS scores and multiple surgeries.

More research on mesh development should be done in order to reduce the incidence of chronic pain caused by mesh. Furthermore, a clear definition of chronic pain with one international assessment tool should be defined, in order to facilitate comparison of the results of different studies. Chronic pain should always be approached in a multidisciplinary way in order to find the correct treatment for each patient. The choice should be based on previous treatment, experience of the responsible surgeons and personal, as well as clinical, data.

## 3. Introduction

An inguinal hernia is one of the most common pathologies and inguinal surgery is one of the most frequently performed procedures as a result. A lot of studies already compared some techniques for inguinal pain or analysed the incidence of chronic pain, however few research has been done on the different therapies for chronic pain after inguinal surgery. The aim of this study is to retrospectively evaluate important differences in outcome after the most used therapeutic options, such as surgery or nerve blocks by infiltrations.

The lifetime risk for inguinal hernia is 27-34% for men and 3-6% for women. Although it is frequently executed, there is still a significant percentage of post-operative complications, partly due to the complex anatomy of the region. The most important complication is chronic post-operative inguinal pain (CPIP) due to the risk of touching nerves in the region during procedure (1-3). In 10-12% (rates from 0-47 were found in several studies) of patients, groin pain lasts longer than 3 months and can be classified as chronic pain (1). One of the definitions of CPIP is as a new or different quality of pain arising as a direct consequence of a nerve lesion or disease affecting the somatosensory system after inguinal hernia repair (2). There is still no consensus on the definition of chronic pain, which makes it harder to perform research on it. A lot of studies use different kinds of definitions, which makes it hard to compare these studies. Important influences according to the inguinal hernia guidelines are: anatomic structures involved, type of repair, psychological, genetic, social and behavioural influences (1). Outcomes for chronic pain are a lower quality of life (QoL), depression, cognitive impairment, somatic comorbidities and sleep deprivation. The most important outcome is an impaired quality of life (4).

Another important complication next to chronic pain is recurrence. The lifetime recurrence rate of inguinal hernia was 10-15% of which 57% occurred in the first decade (5). The recurrence rates dropped since the usage of mesh and now CPIP has become the most important and most researched outcome.

The majority of patients have some sort of pain relief by different kinds of therapy, but it is still not clear what the protocol on the treatment of chronic pain should be. The aim is to analyse the different treatments of patients complaining about chronic pain and their results in order to higher the level of evidence in treatment protocol.

It is important to not underestimate the effects of chronic pain on the lives of patients. Different studies show that chronic pain results in an impaired quality of life. Magnussen et al. saw the

greatest differences with standard population in the fields of “role-physical” and “bodily pain” (6).

## Nerves in the region

Knowledge of the anatomical region is very important to prevent postherniorraphy inguinodyna and other complications. Especially knowledge of the nerves is paramount. The ilioinguinal, iliohypgastric and genitofemoral nerve are located in the groin. The iliohypogastric nerve originates from T12-L1 and is located between the two aponeuroses of the internal and the external oblique muscles. The ilioinguinal nerve originates from also T12-L1 and is located between the internal ring and the spina iliaca anterior superior. The genitofemoral nerve originates from L1-L2 and contains two branches: the genital branch and the femoral branch. It is the inguinal segment of the genital branch that is of importance for inguinal hernias. It lies close to the vena spermatica externa between the inguinal ligament and the ductus deferens. It can also be found in the internal ring (4, 7). Touching these nerves during surgery can cause chronic pain postoperative. A study by Voorbrood showed that the majority of neuropathic pain after inguinal hernias was located in the ilioinguinal nerve (6, 8).

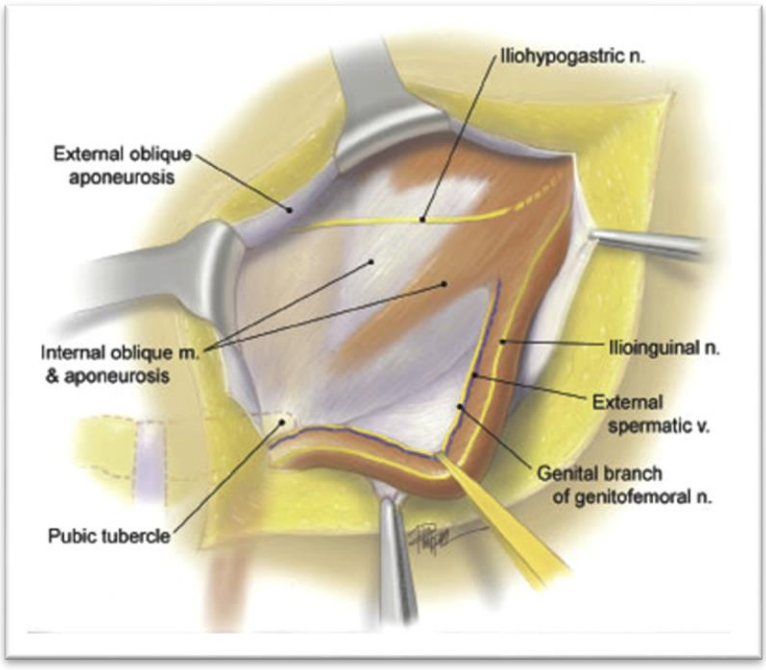



*Figure 1: Anatomy inguinal region (anterior approach). (Courtesy of Parviz K. Amid, MD, Los Angeles, CA.)*

# Treatment of Hernia

## Surgical techniques

Surgeons use different techniques for inguinal repair. The most used techniques are Lichtenstein, transinguinal preperitoneal hernia correction (TIPP), transabdominal preperitoneal patch plasty (TAPP) and totally extraperitoneal patch plasty (TEP) as recommended by the new International Guidelines of the Hernia Surge group. It is already clear that a mesh-based repair is superior to other surgical techniques (1, 3).

### *Open Lichtenstein Repair (OLR)*

The Lichtenstein procedure is an open extra-peritoneal surgery performed under local, locoregional or general anaesthesia. First a 5-6cm incision is made from the tuberculum pubicum towards the lateral side. The superficial epigastric vessels that reach the dermis are ligated and the aponeurosis of the external fascia is incised. This is a critical nerve-related phase. The surgeon must be very careful to not touch the nerves in the region, especially the N. Ilioinguinalis. Next steps are reduction of the hernia sac and closure.

### *Transinguinal preperitoneal repair (TIPP)*

TIPP is an open preperitoneal surgery with anterior approach: the peritoneal space will not be opened during the procedure. The incision is made at the border of the external aponeurosis with the oblique muscle. After identification of anatomic structures, the hernia sac will be reduced through the internal ring to reduce the preperitoneal space. The mesh is introduced through the internal orifice. The correct location and placement of mesh is checked. Afterwards repair of the external oblique aponeurosis is performed (9, 10).

### *Total extraperitoneal laparoscopic repair (TEP)*

These are the steps for TEP procedure under general anaesthesia: After an infraumbilical incision and an opening in the rectus fascia, the rectus abdominis is retracted and an extra peritoneal space is created with a insufflated balloon. Dissection of the retropubic space on the symptomatic side starts after a thorough identification of the anatomic structures in the region. The next step is identification and reduction of the hernia sac. After placement of the mesh, a contralateral exploration is necessary to exclude another hernia. When found, it will be repaired with similar techniques (11, 12).

*Transabdominal preperitoneal repair (TAPP)*

TAPP approach is performed under general anaesthesia and the abdomen is insufflated with CO2. The surgeon uses three trocars. After incision of the peritoneum, the hernia sac is localized. To expose the Cooper ligament, a dissection of adipose tissue in the parapubic region is performed. The next step is reduction of the hernia sac and placement of the mesh, which is stapled to the cooper ligament. The mesh has a cut for the spermatic cord. At the end, the peritoneum and skin incisions are closed using staples ore stiches (13).

## Comparing the techniques

The results of the different studies that were analysed in advance of this study had very different outcomes. Some stated that there was no significant difference in incidence of CPIP between the different surgeries (11, 14) and other studies saw a big difference between the types of surgery (15). This means that more additional factors influence the outcome, but is also means that more research is needed on this subject. Possible additional factors are patient demographics, surgical skills and experience, methods to analyse pain, follow up etc.

## Complications

The different techniques have different complications. It is important to inform patients about these complications. For the Lichtenstein repair, Singh et al. demonstrated a significant higher incidence of cord oedema in comparison to laparoscopic surgery, but a lower incidence of seroma. Male patients should be informed about the possible testicular complications. Testicular volume and testosterone levels decreased significant after open surgery and the hormones FSH and LH increased. Only LH also increases significantly in laparoscopic surgery (12). Other disadvantages are the higher incidence of impairment of inguinal sensibility, in comparison to laparoscopic repair, and bigger incision scars (16).

TEP and TAPP are frequently used laparoscopic techniques. They both have their advantages and disadvantages, thus neither of them are preferred above the other. Seroma, scrotal oedema, cord swelling, testicular and/or urinary bladder pathology, inguinal nerve lesions, chronic pain and recurrence are named in the International guidelines to have similar rates in TEP and TAPP. The different access of the procedure results in different complications: TEP has an increased risk of vascular injuries, while TAPP has an increased risk of visceral injuries (1). Other differences are a longer operative time for TAPP and the fact that an incision and suture has to be made in the peritoneum, which makes the procedure more invasive and gives more pain early postoperative (11, 17).

Comparing TIPP with Lichtenstein, various results were found. A study by Bockerink et al. found that TIPP was as durable over time as Lichtenstein with a lower incidence of chronic pain at one year, but it was not significant. Koning et al. found a significant difference in favour of TIPP, but only over 20 days. It shows a lower incidence of hyper- or hypoesthesia. No difference was found in studies comparing TIPP to TEP (9, 18-21).

As a conclusion in comparing these techniques, it is safe to say that all options have a certain place in inguinal repair. There is not one technique that is superior above all. For surgeons it is important to gain experience in one technique, because experience shows better results (22).

### Follow-up

Follow-up is an important aspect of treatment. It is important for inguinal hernia repair, especially to detect chronic pain or to examine for recurrence. Most studies use a follow-up of 5 to 10 years for chronic pain. It is important to realize that a follow-up of 5 or 10 years will not show an actual recurrence rate. For chronic pain the follow-up for incidence shouldn't be so long, because of the early onset of chronic pain in the first months or years. Although it would be interesting to see the evolution of the pain over a long period of time (5).

## Symptoms and description of chronic inguinal pain

Postherniorraphy inguinodyna is classified by the International Association for Study of Pain (IASP) into nociceptive and neuropathic pain. To differentiate between nociceptive and neuropathic pain, a physical examination is done, as proposed by an expert panel. Neuropathic pain is caused by direct nerve damage, while nociceptive pain is caused by activation of nociceptors by molecules, thus secondary to tissue damage. Most studies state that around 50% of the chronic pain is neuropathic (23, 24). It is important to make a difference between the neuropathic and nociceptive because the treatment differs between the two techniques. This is possible by using pain questionnaires such as the DN4 (Doleur Neuropatique 4) or McGill Pain Questionnaire (4, 8).

Nguyen et al. gave an overview of the symptoms and descriptors of CPIP. Neuropathic pain was described as hypo- or hyperesthesia, allodynia, hyperalgesia, stabbing, burning, pulling, throbbing, shooting, prickling, sharp and localized. It is triggered by the Tinel sign and can radiate to scrotum, labium and the upper thigh. It's getting worse with movement and/or sexual Intercourse. Lying down and flexion of hip and thigh can relieve the pain. Non-neuropathic pain is a more constant pain that is rather a complete area instead of a localized spot. There are no trigger points or radiation and its characteristics are gnawing, tender, pounding and/or pulling. The pain can also originate from

the pubic tubercle and is then described as somatic pain. If the pain is focused on labia or scrotum and related to sexual dysfunction without a specific trigger point, it can be classified as visceral pain (2).

## Risk factors CPIP

The most published factors next to the operation technique that also influence the incidence of chronic pain are usage of mesh, age, surgery for recurrence, gender, BMI, suturing techniques, unilateral vs. bilateral hernia, preoperative pain and early postoperative pain. This chapter will show a summary of described risk factors in several studies.

The international guidelines strongly recommend the *usage of mesh* for inguinal hernia surgery (1). In a review paper, published in the American Journal of Surgery, Sajid concludes that lightweight mesh has an advantage over heavyweight mesh on the incidence of chronic pain, but more research is necessary (25). The fixation of mesh doesn't seem to be an important variable for chronic pain (26-29).

Different studies conclude that *preoperative and early postoperative groin pain* are both strong risk factors independent of the type of surgery (11, 12, 15, 26-28). *Recurrence* of hernia is another important predictor of CPIP (29). One study by Niebuhr et al. showed a higher risk of chronic pain in patients, who had a *smaller hernia defect* and, in contrast with what is said above, fixation of mesh did have an influence on chronic pain during exercise (in a disadvantage for tack vs. glue). A smaller mesh would also have a negative effect on pain during exertion (28).

*Surgical experience* is a very important factor in the occurrence of complications or recurrence of a hernia, especially in laparoscopic techniques (16), and should be taken in account whilst analysing the results of this study.

Most important patient-related factors are *age, gender and BMI*. Older people are more likely to be asymptomatic than younger people. Younger people have more complaints about discomfort, pain and sensation of mesh, as M. Ali has reported (29). Especially patients < 40 years were associated with high rates of pain (28). One study stated that younger patients had a higher risk of chronic pain, but the elder patients had more severe pain (12). Not only age, but also gender has an impact on the incidence of chronic pain. Even though men are more likely to develop a hernia, women are more likely to have CPIP (15, 27, 30). The BMI of a patient seems to have an effect on post-operative complications, especially in Lichtenstein procedures, which suggest to use laparoscopic

approach in these cases (11). A high BMI also shows higher risk of chronic pain in TAPP as well (28). Highest pain rates were found in patients with highest BMI (BMI ≥30), but a significant difference was found starting at a BMI of 25 (28).

## Multidisciplinary approach of CPIP

An expect group of 26 surgeons has developed a guideline based on international consensus on diagnosis, management and treatment of chronic pain. After an expectative phase of 3 months and with no recurrence visible, imaging (ultrasonography or MRI) is necessary to reveal the cause of the lasting pain. If nothing has been found on imaging, a pain management team is composed around the patient, if possible, with experience in chronic pain after inguinal surgery (4). It is paramount to form a multidisciplinary pain team around the patient to achieve the best possible result, because of the different treatment options that are possible to reduce the pain (8).

The treatment of chronic post-operative inguinal pain contains a surgical and nonsurgical approach. A multidisciplinary approach is necessary for the best possible outcome. The nonsurgical approach is based on behavioural (e.g. physiotherapy), topical (e.g. lidocaine), pharmacological and interventional therapy. The available interventional therapies are nerve blocks, neuroablative techniques and neuromodulation. Nonsurgical approach should be used in all patients before moving towards surgery (2, 4).

The possible surgical treatments are selective neurectomy and triple neurectomy, besides the removal of mesh, suture material, tacks or staples (2, 31). The triple neurectomy is the favoured surgical treatment over selective neurectomy out of anatomical and technical considerations. Both open and endoscopic approaches are possible. Open anterior surgery is indicated when a recurrence is present. If pain is present as well, a triple neurectomy is indicated. For chronic pain without recurrence or with a meshoma open as well as endoscopic surgery is a possibility. Reoperation is best performed by an experience herniologist (2, 4).

Some surgeons recommend prophylactic surgery of the contralateral groin in case of inguinal hernia, but the results of Köckerling et al. conclude that reoperation should not be recommended because of the higher risk of reoperation and bladder problems (32).

Sun et al. reoperated 8% of their patients suffering from CPIP. A study analysing the prevalence of chronic pain during 5 years of postoperative follow up demonstrated a gradual decrease in prevalence during the first 5 years, with a clear decrease at 3.5 years postoperative. They

concluded that surgery for chronic inguinal pain should be delayed for four years after primary surgery, unless there is severe pain or a recurrence (30). Sun et al. saw an improvement of pain in long-term follow-up after reoperation, but not immediately after surgery (33). A case study by Köckerling et al. suggested early intervention for patients with severe postoperative pain that lasts longer than 7 days and when they suspect that the pain is of surgical origin in order to prevent chronic pain in the future. This was confirmed by Lange et al. (4, 34). The origin of such severe pain is often a nerve or vascular injury (1).

Fig. 2 shows an algorithm on management on CPIP by Lange et al. This algorithm gives a clear overview on current recommendations towards pain management. It is important to realize that more research is necessary to convert this into a firm evidence-based algorithm, as said by the researchers themselves (4).

## Non-surgical treatment of chronic pain

### *Pharmacological*

During the first 3-6 months postoperative 'watchful waiting' is indicated, as well as 'basic' analgesics. The recommended pharmacological treatments for non-neuropathic pain are NSAID's and steroids. For the treatment of chronic neuropathic pain, a long list of medication is given by Nguyen et al. : gabapentin, SSRI's, tricyclic antidepressants, opioids, tramadol etc.
These basic analgesics can go from simple paracetamol towards more powerful analgesics like tramadol. There are currently no studies specific on the effect of analgesics on chronic inguinal pain, but 'regular' pain medications, used in other chronic pain situations, are used in chronic inguinal pain as well (4).

Another aspect of pharmacological use is the prophylactic administration of medication preoperative in order to prevent postoperative pain. A randomized placebo-controlled, double-blinded trial by Sen found lower pain scores at 6 months follow-up after administering a 1.2mg dose of gabapentin preoperative. They saw lower VAS-scores, tramadol consumption and patient controlled analgesia in the first 24 hours and also a higher satisfaction score. At 1, 3 and 6 months, the follow-up pain scores were lower in the gabapentin group. Impairment of daily activities were lower in the first month as well, but no significant difference was found at 3 and 6 months. This study shows that preoperative-administered gabapentin reduces acute postoperative pain and may help to reduce chronic pain (35).

*Interventional therapy*

Nerve blocks and neuromodulation are the two forms of interventional non-surgical therapy that are often used in treatment of chronic pain.

Local anaesthetic nerve blocks are used on the four IHN, IIN, GFN and paravertebral by guidance such as anatomic landmarks, ultrasound or nerve-stimulator guidance. This guidance is implemented because of higher success rates when the nerve is first visualized, located through ultrasound or by nerve stimulation (36-38). Medication used as blockers in different studies are bupivacaine and triamcinolone, lidocaine and saline, depomedrol and chirocaïne, methylprednisolone with local anaesthetic (LA), cortivasol with LA (8, 38-41). A combination of steroids with local anaesthetics seems to have the highest success rates, especially on duration of the effect. The outcomes in one of the studies reviewed by Werner showed that 33 out of 38 patients had major improvements (21 no longer fulfilled the criteria of DN4 and 12 no longer had severe or moderate pain) (39). A randomized, placebo-controlled, crossover designed study with 12 patients and 12 people in the control group showed no evidence for short-term or long-term analgesic efficacy (40). A study by Magnussen saw that people treated with nerve blocks prior to reoperation had more pain postoperative than those who didn't receive nerve blocks. This was the only study read where nerve blocks were harmful (6). These local infiltrations should be performed by the pain team. Based upon the effect of previous blocks, other blocks were repeated after several months (4, 41). Thomassen et al. showed complete pain relieve in 55.3% after several injections (41). A review by Khan found an analgesic benefit with steroids of 55-75% out of four studies. There were no adverse effects registered (38).

In conclusion, nerve blocks showed clear improvements over different studies in a large percentage of patients and should be considered as a non-surgical therapy prior to surgery. In most studies there was no complete pain relief, but a significant reduction of pain. Doctors should inform patients about these results in order to create realistic expectations on the results of the nerve blocks.

Another interventional therapy is sensory stimulation or neuromodulation. The technique is based on paraesthesia in the pain region by nerve stimulation (2). Two frequently used techniques are pulsed radiofrequency (PRF) and conventional continuous radiofrequency (CRF). PRF uses electromagnetic energy in or near nerves in a rapid change between high and low voltages (0-40V) in order to block nerve conduction. CRF uses the technique of irreversible thermos-coagulation (45-80° C) to block nerves. CRF was more efficacious in different chronic pain states, but there is not enough evidence to conclude the same thing for chronic pain following inguinal surgery. Both

CRF and PRF seem to help lowering the vas-scores of patients. The most important disadvantage is an average of 12 months pain relief, which proves that it does not offer a permanent solution (39). Neuromodulation is an upcoming technique in pain management. More RCT's should be performed to increase the level of evidence.

Another neuromodulation technique is the use of peripheral nerve stimulation (PNS). PNS is discussed in this chapter, because it is a neurostimulation technique, but it is actually a surgical procedure performed by neurosurgeons. Under general anaesthesia a lead is planted close to the affected nerve and connected to an internal pulse generator. The stimulator is activated one week after surgery. PNS has been proven to work on other body parts, but few research has been done on the effect of PNS on inguinal chronic pain. Other neurostimulation techniques are dorsal root stimulation (DRG) and spinal cord stimulation (SCS) (8).

Both nerve blocks and neuromodulation show significant results in different studies. A study by Voorbrood gave priority to nerve infiltrations (blocks), because of the easier and less invasive aspects of the technique. Patients that didn't respond after three injections with anaesthetics received neuromodulation by PNS (8).

### Surgical treatment of chronic pain

The surgical management of chronic pain after inguinal hernia operation consists of different techniques, because of the heterogeneous origin of inguinal pain after operations. The cause of pain can originate from the material used for the primary surgery, the touching of nerves or scar tissue in the anatomical region. Sometimes no cause whatsoever is found.

The most important technique is a neurectomy. It includes resection of the genitofemoral, iliohypogastrical, ilioinguinal or lateral femoral cutaneous nerves or a combination of several nerves. The resection is performed by open or endoscopic surgery and by selective or triple neurectomy. A review by Werner concluded out of more than 20 studies about surgical management of chronic pain that neurectomy may provide long-lasting analgesic effects in the population (6, 39).

The complete or partial removal of mesh can also relieve pain symptoms. As well as the removal of the suture at the pubic tubercle. Neurolysis, another technique, is clearing the nerve from surrounding tissue or material by dissection. A combination of all techniques discussed above is also possible of course. Magnussen found that all of these techniques benefit in the majority of

patients, but none of them showed clear advantage over the others (6). There was no description of the decision-making process for the different techniques. So the question remains on when to do what for different patients.

Magnussen et al. performed reoperation on 111 patients with pain complaints. 62% had a decrease of pain, but 19% felt no difference and in 19% the pain worsened. The majority of patients' benefits from reoperation, but almost one in five patients are in a more painful state afterwards. The procedure in this study was a nerve block followed by single neurectomy, in the majority of cases (6). Campanelli et al. performed anterior-posterior exploration of the inguinal region on 46 patients, of which 44 triple neurectomies and 2 resections of the iliohypogastric nerve, and it resulted in pain relief for 40 patients (87%). VAS scores dropped from 7.89 average to 1.89 (42). Ramshaw et al. saw moderate (41%) and significant (48%) improvement in the majority of patients after laparoscopic repair (43). Another study by Bischoff showed a general pain reduction from 6.0 to 3.0 with the numeric rating scale (NRS), but a negative effect of reoperation in 1 out of 8 patients after mesh removal combined with selective neurectomy (44). These studies show similar results on relieve of pain, but also show an increase of pain in 10-20% of the population. The results are still promising with a clear general reduction in pain, although it will be important to find the cause of the increase in pain in the smaller group. It is important to inform patients about possible complications after surgery. They should know the chances of success and failure. A Belgian study by Valvekens and colleagues showed a reduction of pain in 1 in 3 patients. No subdivisions between neurectomy, mesh-removal, exploration or infiltration of pain were made (45).

Indications for reoperation are acute excruciating pain, recurrence, meshoma with refractory pain after conservative treatment, abscess, and pain lasting longer than 3-6 months with therapy resistance. A reoperation should be recommended by the pain team after non-surgical treatment and performed by an expert heriologist (4).

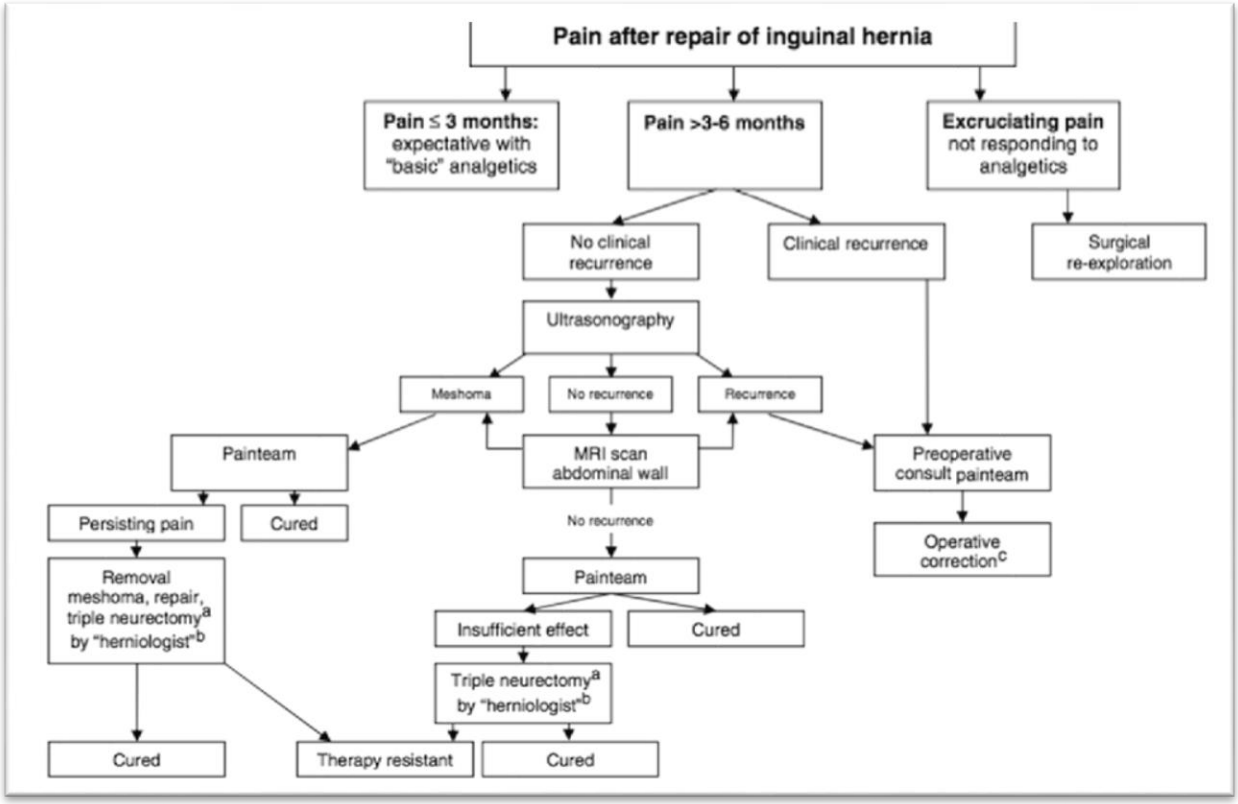



*Figure 2. International consensus algorithm for CPIP management. (Lange JF)*

## Aim

Inguinal hernia is a very frequent pathology and, as a result, inguinal surgery is one of the most frequently performed operations. If you combine this with an average incidence of post-operative chronic pain around 10%, one can conclude that chronic pain is a prevalent problem in the society. Inguinal pain has an influence on the quality of life of patients because of the pain, but also because of the physical limitations that result from the pain.

Patients often think that the pain is a normal consequence and that there's nothing to do about it. Therefore, it is paramount to perform active follow-up of patients who have complained about pain in the past, as will happen in this study. Once these patients are identified, doctors can educate them on their problem and explain the different treatment options. To be able to do this in a clear way, a distinction between different therapies must be made. What therapy is the best option in which case? Chronic pain is a multimodal problem. There is not one simple solution, but the more research is done, the clearer it will become to initiate a certain therapy.

The purpose of this study is to retrospectively evaluate the best treatment outcome for chronic pain after inguinal surgery in a small cohort. Treatment outcomes will be evaluated by VAS score and quality of life. Pre- and postoperative evaluation of pain was analysed in relation to surgical and non-surgical treatment after inguinal pain, following inguinal hernia repair.

# 4. Materials and methods

## Background research

The articles used as extra information or to compare results with, where obtained via PubMed and Embase. First, articles for the general introduction on inguinal therapy and chronic pain were selected. 8 articles from Pubmed were selected out of 46 articles based on MeSH terms “Chronic pain” “Groin” “Hernia, abdominal”. One article was found by “postherniorraphy pain syndrome”. The other 10 articles from Pubmed were found in bibliographies of the other articles using the snowball method. 8 articles were selected on Embase with ‘inguinal pain’ ‘groin pain’ ‘abdominal wall hernia’ for the years 2018-2019 out of a selection of 67 articles and 5 of these articles were used.

The goal of the second search was to select articles on treatment of chronic pain after inguinal surgery. Via MeSH terms ‘Reoperation’, ‘Chronic Pain’ and ‘Hernia, Inguinal’ on PubMed, one extra article was selected out of 10. Based on MeSH terms ‘Chronic pain’, ‘Hernia, Inguinal’, ‘Drug therapy’ and subheadings ‘therapy’ and ‘surgery’ 6 articles were selected based on title out of 173 articles. 2 more articles on RCT studies were added based on a review by Werner. Combining ‘Chronic pain’ and ‘Hernia, inguinal’ with ‘topical drug administration’ or ‘cognitive behavioural therapy’ gave no results. The third search consisted of finding articles with similar studies to be able to compare the results of the descriptive statistics: Mesh terms were ‘Chronic Pain’, ‘Hernia, inguinal’, ‘Surgical Procedures, Operative’, ‘Abdominal Wall’ and ‘Quality of life’. Other terms were just entered in general search. Another 24 articles were found on PubMed. During the writing of this dissertation, PubMed was frequently consulted for new articles on specific topics, reaching a total of 89 references. The Sobotta Atlas was used as anatomic background.

## Study design

The study wants to evaluate outcome after surgical and non-surgical treatment. The best way to do so, would be through a prospective cohort, but because of limited time and a limited amount of chronic pain patients due to inguinal hernia repair at UZ Ghent in one year, a retrospective cohort was chosen.

## Stetting

After approval of the UZ Ghent ethical board for this prospective cohort, a profound research of a database of the department of general and hepatobiliary surgery for inguinal hernia between the years 2008-2018 was conducted. Out of a total of 1557 patients, 72 were retrospectively selected

based on an appointment for chronic pain in the past (using the definition 'pain lasting longer than 3 months postoperative' for chronic pain) longer than 3 months after surgery and they received an invitation for an interview and clinical examination to scale their chronic pain and quality of life and ask about their experiences before, during and after surgery and, if applicable, their received treatment for chronic pain. The invitation consisted of an informative letter, the document of informed consent, an accompanying letter and a stamped return envelope.

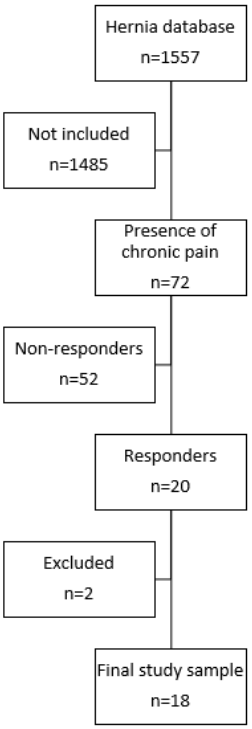
During the interview, patients were asked to fill in the EuraHS QoL score for inguinal hernias created by the European Registry of Abdominal wall Hernias. This questionnaire is a method to measure the quality of life before and after primary surgery with the use of mesh. In this study, it was used to measure the quality of life before and after treatment for chronic inguinal pain. It is a different approach of use of this questionnaire, but judgement was made that the questions were appropriate for this situation. Thereafter they were asked about their experiences before, during and after the initial surgery and therapies received for the chronic pain. At last, a short clinical examination was performed by the responsible physician.

When they were asked about the sensation of pain, a number of descriptive adjectives were presented and patients had to answer with yes or no. They could also add a description that wasn't presented if they didn't feel like there was a matched term for their sensation. Next to description of pain, we asked if there were other sensations in the painful area, such as tingling, numbness, itchiness. They were also asked if they felt any referral pain over the past time. Furthermore an evaluation was made of the course of the pain, by asking following questions: did the pain change over time? Is it constant, intermittent, fluctuating or at specific situations? To assess the quality of life, we asked them about the influence of the pain on sleep, general mood and relations and they filled in the EuraHS QoL for inguinal hernias. At last, they were asked how their last received therapy had an influence on the pain, using a pre-treatment and post-treatment VAS as well as the ordinal parameters 'none – little – average – great – completely solved'.

The short clinical examination consisted of locating the pain and any referral pain if present, checking the scars, giving pressure on the inguinal zone and letting patients blow on their hand to create pressure to check for recurrence.

## Participants

Out of a population of 1557 patients in the UZ Ghent inguinal hernia database, we selected 72 patients based on a consultation for chronic pain more than 3 months after the inguinal surgery. All patients were >18 and were operated for inguinal hernia between 2008 and 2018. All of them were followed at UZ Ghent for chronic pain. There were a lot of patients who've had treatment in the first 3 months postoperative and were then completely relieved of any pain, they weren't included since chronic pain starts at 3 months. In this study we only look at patients for whom the pain wasn't resolved after 3 months. Twenty of them signed informed consent and agreed to visit the hospital for an interview and a clinical examination (response rate 27%). One patient was excluded, because he didn't receive treatment, but only follow-up after the surgery with complaints of chronic pain. The pain disappeared after 4 months without any treatment. One other patient was excluded because he had an incomplete file and had problems remembering the events. The final total of patients that was included was 18 (response rate 25%).




*Graph 1: inclusion of the study population*

## Variables

The outcomes of this study are surgical technique, mesh removal, mesh replacement, neurectomy, other surgical interventions and non-surgical treatment using VAS score and QoL as the outcome measures.

## Statistical analysis

Because of limited data, this study will only describe the results and the data between the two treatment groups (surgical and non-surgical treatment) will not be compared. If any results stand out, they will be pointed out during description. Outcomes are chronic pain, and quality of life. Statistical analysis of the data was completed using IBM SPSS statistics for Windows version 25.

## Data sources

All of the data used in this study are obtained in the inguinal hernia database of UZ Ghent hospital and from direct information from the interviewed patients or their files, after they signed informed consent.

# 5. Results

## Participants

The patients were divided into two groups: surgical treatment (n=13) and nonsurgical treatment, consisting of nerve blocks, cryoablation, neurostimulation and pain medication (n=5). The majority of patients in the surgical groups received nonsurgical treatment before undergoing surgery, following the international guidelines (source) as the proper way to treat, with exception of pain clearly caused by the mesh or other synthetic material placed by surgery.

## Descriptive data

### Demographics

The average age of the population is 62.3 years (IQR: 55.25-73.50). There are fifteen males and three females. The surgery group consists of two females and the non-surgery group consists of one female. Inguinal hernias appear more in male patients, so it makes sense that there are more male patients with chronic pain. Jobs were divided into three categories: sedentary jobs (e.g. office jobs), normal labour (e.g. teacher) and hard labour (e.g. construction work). Four patients, all in the non-surgery group, had sedentary jobs, 11 patients over both groups had normal jobs and three patients in the surgery group work or have worked in hard labour. 6 patients were already retired, 2 were unemployed of which 3 had a disability statute. This parameter was used because people doing hard labour would have more limitations in their job when they suffer from chronic inguinal pain. 77.7% are using some form of chronic pain medication. All five patients in the non-surgical therapy group are still using pain medication. 7 out of 18 are frequent nicotine users (e.g. cigarettes) or have used it in the past for a certain amount of time (≥10 pack years). Patients were asked if they were unusually stressed before primary surgery or following treatments. They all answered negative. A summary of these descriptive data is given in table 1.

| ***Demographics*** | Surgery (n=13) | Non-surgery (n=5) | Mean (n=18) |
|---|---|---|---|
| ***Age*** | 58.1 | 73.2 | 62.3 |
| ***Gender (male)*** | 84.6% (n=2) | 80% (n=1) | 83.3% (n=3) |
| ***Job (hard labour)*** | 23.1% (n=3) | 0% (n=0) | 16% (n=3) |
| ***Chr. pain medication*** | 69.2% (n=9) | 100% (n=5) | 77.7% (n=14) |
| ***Smoker*** | 46.2% (n=6) | 20% (n=1) | 38.8% (n=7) |
| ***BMI*** | | | |
| *Normal [18,5-25[* | 46.2% (n=6) | 20% (n=1) | 38.9% (n=7) |
| *Overweight [25-30[* | 30.1% (n=4) | 60% (n=3) | 38.9% (n=7) |
| *Obese [30-40[* | 23.1% (n=3) | 20% (n=1) | 22.2% (n=3) |
| *Mean weight* | 25.4 | 26.8 | 25.8 |

*Table 1: Descriptive demographics for the three study groups: Age (years), gender, Job (incidence of hard labour), use of chronic pain medication, smoking and BMI.*

The average BMI is 25.8 (IQR: 22.8-28.6). No one in the study was underweight. Seven patients in this study are overweight and four are obese. The other seven patients have a normal weight.

## Clinical data

The most important clinical data collected were: primary surgical technique, sensation of pain, additional symptoms, course of the pain and presence of radiating pain. The types of surgery used to reduce the inguinal hernia are shown in table 2 with associated numbers. All primary operations happened between 2002 and 2017. 5 primary surgeries happened at other hospitals (1 TEP, 2 TIPP and 2 TAPP). The TIPP technique is the most frequently used technique in this study and at UZ Ghent. Two operations didn't have any information in patient's medical files and the patients didn't remember what kind of surgery they received. The operations were left out for further analysis.

| | Surgery (n=13) | Non-surgery (n=5) | Total (n=18) |
|---|---|---|---|
| ***Lichtenstein*** | 0% (n=0) | 20% (n=1) | 5.6% (n=1) |
| ***TIPP*** | 53.8% (n=7) | 80% (n=4) | 61.1% (n=11) |
| ***TAPP*** | 15.3% (n=2) | 0% (n=0) | 11.1% (n=2) |
| ***TEP*** | 15.3% (n=2) | 0% (n=0) | 11.1% (n=2) |
| ***No data*** | 15.3% (n=2) | 0% (n=0) | 11.1% (n=2) |

*Table 2: Type of primary surgical technique.*

To objectify the sensation of pain, we told the study group different adjectives to describe the pain on which they had to say 'yes' or 'no'. If a patient wanted to add a sensation, they were free to do so. In table 3, an overview of the incidence of different sensations is given for each category of treatment. In the following section of the table, an overview of the four most important additional symptoms is given to check for neuropathic pain for each group.

Two patients who didn't suffer from pain anymore and couldn't remember the sensation. They were left out of this analysis. There is one variable that stands out for sensation of pain: stabbing pain is felt in 66.6% of the study population that still felt pain. Two patients couldn't answer this question since they didn't have any pain anymore and couldn't remember the exact sensation. Other variables that were interesting: burning, pinching and electric shocks were only felt in the surgery group.

| ***Pain sensation*** | Surgery (n=13) | Non-surgery (n=5) | Total (n=18) |
|---|---|---|---|
| ***Burning*** | 30.8% (n=4) | 0% (n=0) | 22.2% (n=4) |
| ***Cold pain*** | 0% (n=0) | 20% (n=1) | 5.6% (n=1) |
| ***Electric shocks*** | 7.7% (n=1) | 0% (n=0) | 5.6% (n=1) |
| ***Stabbing*** | 53.8% (n=7) | 60% (n=3) | 55.6% (n=10) |
| ***Glowing*** | 7.7% (n=1) | 20% (n=1) | 11.1% (n=2) |
| ***Pinching*** | 23.1% (n=3) | 0% (n=0) | 16.7% (n=3) |
| ***Pressing*** | 7.7% (n=1) | 40% (n=2) | 16.7% (n=3) |
| ***No description given*** | 7.7% (n=1) | 20% (n=1) | 11.1% (n=2) |
| ***Additional symptoms*** | | | |
| *Tingling* | 53.8% (n=7) | 0% (n=0) | 38.8% (n=7) |
| *Pins and needles* | 38.5% (n=5) | 20% (n=1) | 33.3% (n=6) |
| *Numbness* | 38.5% (n=5) | 40% (n=2) | 38.8% (n=7) |
| *Itching* | 23.1% (n=3) | 20% (n=1) | 22.2% (n=4) |
| *None* | 23.1% (n=3) | 60% (n=3) | 33.3% (n=6) |
| ***Course of pain*** | | | |
| *Constant* | 53.8% (n=7) | 0% (n=0) | 38.8% (n=7) |
| *Intermitted* | 46.2% (n=6) | 60% (n=3) | 50% (n=9) |
| *No description* | 0% (n=0) | 40% (n=2) | 11.1% (n=2) |
| ***Radiating pain*** | | | |
| *present* | 46,2% (n=6) | 20% (n=1) | 38,8% (n=7) |

*Table 3: Incidence of symptoms: pain sensations, additional symptoms for neuropathic pain, course of pain and referral pain in the two groups.*

When looked at additional symptoms: 66.6% (n=12) of the study population suffers from at least 1 additional symptom. Tingling and numbness had the highest incidence, but numbness appeared in all three groups, where tingling only happened in the surgery group. These additional symptoms are linked to neuropathic damage as an origin for the chronic pain (by the DN4 questionnaire).

Patients were asked about when they felt pain, by giving them the descriptions 'constant' or 'intermitted' or some other description if they felt these terms were not appropriate. Two patients who didn't suffer from pain anymore, weren't capable of giving a description. In the non-surgical group, the pain was always intermitted. The surgery group was divided between constant and

intermitted. 7 out of 18 patients suffer from radiating pain. The radiating pain is most felt in the upper thigh (femoral branch of the genitofemoral nerve) and the scrotum (genital branch of the genitofemoral nerve). There was a higher incidence of radiating pain in the surgery group (46.2%) compared to the non-surgery group (20%).

Next to a complete description of pain, questions about improvement or deterioration, by using non-medical tools, that changed the feeling and intensity of pain, were asked. Half of the patients didn't feel any difference whatsoever, 8 patients felt that changing position helped most. Tension (e.g. belt) made the pain worse in two patients as well as heavy lifting.

Because there is a vast variety in the different treatments, an overview will be given of the number of painkiller, nerve block or surgery used as treatment in each group. Most patients received multiple treatments for chronic pain. Table 4 shows the numbers for each therapy. Surgery and infiltrations were the most used therapies. 13 patients received 22 operations (an average of 1.7 surgeries for each patient). 9 patients received 17 sessions of infiltrations (an average of 1.9 infiltrations for each patient). Oral medication was used by almost all patients, but only 6 of these oral treatments were prescribed in the pain clinic. Most oral medication was prescribed by the G.P. Most frequently used medication was tramadol, Lyrica and paracetamol. Two patients used dermal patches. These 18 patients received a total of 59 therapies. This is an average of 3.27 therapies per patient. The surgery group had significantly more treatments (3.77) than the non-surgery group (2).

| | Surgery (n=13) | Non-surgery (n=5) | Total (n=18) |
|---|---|---|---|
| ***Surgery*** | 22 | 0 | 22 |
| ***Infiltrations*** | 13 | 4 | 17 |
| ***Cryoablation*** | 3 | 0 | 3 |
| ***Neurostimulation*** | 1 | 0 | 1 |
| ***Oral medication*** | 9 | 5 | 14 |
| ***Dermal medication*** | 1 | 1 | 2 |
| ***Total*** | 49 | 10 | 59 |

*Table 4: summary of used therapies in 18 patients.*

During the clinical examination patients were checked for location of pain, scar tissue, recurrence of hernia and oedema. 6 patients showed no clinical abnormalities apart from the scar from the primary surgery. The location of pain was around de scar tissue or in the groin area for all other patients, except one, who also suffered from infra-umbilical abdominal pain due to a cycling

accident. There was no abnormal scar tissue in any of the patients and no recurrence or oedema were noticed.

## Outcome data

### Effect of different types of surgical treatment

To analyse the effect of treatment, a new subdivision will be created. Instead of looking at the 18 patients, we'll be looking at the 26 surgical treatments that have been given to these 18 patients. Four surgeries have been left out, because they were not in patients files and the patients themselves couldn't provide enough information. The 22 other surgeries will be divided into four groups: 'Lichtenstein' (L), 'TIPP', 'open exploration' (OE) and 'laparoscopic exploration' (LE). Since it is not possible for patients to recall their correct VAS scores before and after every treatment, they will be scored as 'no decrease', 'little decrease', 'average decrease' and 'complete decrease' of pain.

First, an overview of the number of different operations will be given, using date, location and length of hospital stay, previous treatments and duration since primary inguinal repair. In the next chapter the specifics of surgery will be shown (table 7): removal of mesh and/or ring, neurectomy and type of repair. The following chapter discusses findings during surgery: complications, meshoma, recurrence and possible cause of pain. In the last chapter the decrease of pain for each surgery and each assumed cause will be given.

#### *Context of surgery*

Out of these data, it seems like there is no preference for type of surgical treatment in this sample at UZ Ghent. Years of treatment are all between 2010 and 2019. One surgery is left out of the 'years after repair' variable because he didn't remember the year of the primary surgery that happened in the Netherlands. The patient files at UZ Ghent not always showed the length of hospital stay for each surgery. The number of cases used to calculate this variable are showed next to the mean length of stay for each surgery. An overview is given in table 5.

The average time between the initial hernia repair and surgery for treatment of chronic pain is 3.76 years. The surgery was the first step of treatment for only seven cases (31.8%). The other 68.2% received previous treatment by surgery (45.5%) and/or non-invasive treatment (50%). All cases except one are performed at UZ Ghent. The average hospital stay is 2.46 days (missing n=13).

| | L | TIPP | OE | LE | Total |
|---|---|---|---|---|---|
| ***N*** | 2 | 6 | 9 | 5 | 22 |
| ***Year surgery*** | 2010-2012 | 2010-2018 | 2013-2019 | 2015-2018 | 2010-2019 |
| ***After repair(y)*** | 2.50 | 5 | 2.50 | 4.78 | 3.76 |
| ***Pr. surgery*** | 0% | 50% | 55.6% | 40% | 45.5% |
| ***Pr. treatment*** | 100% | 16.66% | 55.55% | 60% | 50% |
| ***Hospital (UZ)*** | 100% | 100% | 88.88% | 100% | 95% |
| ***Hospital stay*** | / (n=0) | 2 (n=2) | 3 (n=6) | 1 (n=1) | 2.46 (n=9) |

*Table 5: A summary of descriptive information for each group is given. The year of surgery as well as the years between this surgery and the primary surgery are given. Previous surgery and treatment refer to previous treatments for pain. The hospital of treatment as well as the length of hospital stay are displayed for extra context.*

### *Specifics of surgery*

The surgical procedures are standardized to a certain point, but during surgery, the surgeon will decide what should happen based on clinical data, preoperative imaging and the surgeon's own judgement of the situation to decide what should happen. Table 6 shows the therapeutic options used in this study per category surgery type.

Mesh and ring removal were divided in categories 'no', 'partly' and 'complete'. If the mesh was completely removed, the choice whether or not the mesh should be replaced was made by the surgeon.

In 77.3% of the surgeries the mesh was partly or completely removed, with the majority (55%) completely removed. In 77.3% of the cases the rings were partly (13.6%) or completely (63.6%) removed. When the mesh is completely removed, it makes sense that the ring, if present, is removed as well. In three cases in the 'open exploration group' only the ring has been removed. A new mesh was placed in 9 out of 12 (75%) cases where the mesh was removed completely. There is only one surgery where a neurectomy was performed. This patient already had a neurectomy of the ilioinguinal and the iliohypogastric nerve in previous surgery without a significant decrease. This previous surgery is not included because there was no information about this surgery from the files and from the patient as well.

There were 9 cases where the mesh was replaced. Types of mesh used for replacement were mostly Rebound Hernia Repair Mesh, one case of Prolene Hernia System Mesh (PHS Mesh) and one case of Ultrapro® Partially Absorbable Lightweight Mesh. Both cases from the Lichtenstein group had a mesh replacement. All five cases from the 'TIPP' group that had complete removal of previous mesh, received a new mesh. No mesh replacement was performed in the 'OE' group. In

the last group of 'LE' both cases that had complete mesh removal, received a new mesh. Additionally one case of the 'LE' group did not receive a new mesh, but a new PET ring.

During surgery, several probable causes for pain can be discovered such as abscesses, meshoma or recurrence of hernia. Table 6 shows their incidence for each group. Two surgeries were complicated by an abscess and two TIPP surgeries were complicated by a small hernia. There is one variable that stands out: 40.9% of cases showed meshoma. There were most meshoma in proportion to the number of cases for TIPP. One patient with a meshoma may have had a muscular tear due to a previous surgery. The surgeons were not sure whether this was the cause of the pain or if it was the mesh that caused the pain.

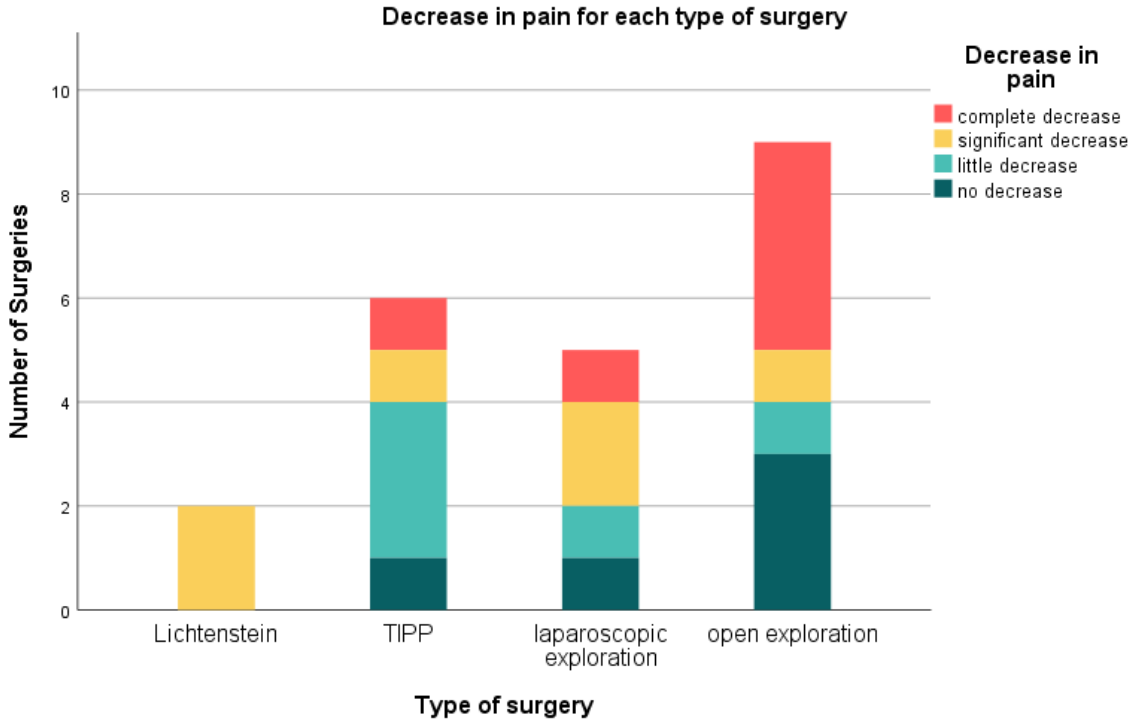
| ***Mesh rem.*** | L (n=2) | TIPP (n=6) | OE (n=9) | LE (n=5) | Total (n=22) |
|---|---|---|---|---|---|
| *No* | 0% (n=0) | 0% (n=0) | 55.6% (n=5) | 0% (n=0) | 22.7% (n=5) |
| *Partly* | 0% (n=0) | 16.7% (n=1) | 11.1% (n=1) | 60% (n=3) | 22.7% (n=5) |
| *Completely* | 100% (n=2) | 83.3% (n=5) | 33.3% (n=3) | 40% (n=2) | 54.5% (n=12) |
| ***Ring removal*** | | | | | |
| *No info* | 0% (n=0) | 0% (n=0) | 22.2% (n=2) | 60% (n=3) | 22.7% (n=5) |
| *partly* | 0% (n=0) | 16.7% (n=1) | 11.1% (n=1) | 20% (n=1) | 13.6% (n=3) |
| *Completely* | 100% (n=2) | 83.3% (n=5) | 66.6% (n=6) | 20% (n=1) | 63.6% (n=14) |
| ***Mesh replacement*** | | | | | |
| *applied* | 100% (n=2) | 83.3% (n=5) | 0% (n=0) | 40% (n=2) | 40.9% (n=9) |
| ***Neurectomy*** | | | | | |
| *applied* | 0% (n=0) | 16.7% (n=1) | 0% (n=0) | 0% (n=0) | 4.5% (n=1) |
| ***Findings*** | | | | | |
| *Abscess* | 50% (n=1) | 0% (n=0) | 0% (n=0) | 20% (n=1) | 9.1% (n=2) |
| *Meshoma* | 50% (n=1) | 66.7% (n=4) | 22.2% (n=2) | 40% (n=2) | 40.9% (n=9) |
| *recurrence* | 0% (n=0) | 33.3% (n=2) | 0% (n=0) | 0% (n=0) | 9.1% (n=2) |

*Table 6: therapeutic options during surgery, their incidence and findings for each type of surgery.*

### *Decrease of pain*

The most important outcome is, of course, the decrease of pain after surgery. Since multiple variables can be the cause of pain relief, they were all checked to see if decrease of pain stood out in a specific category. First of all, decrease of pain was sorted by type of surgery (graph 2). The Lichtenstein technique showed good results. The TIPP is the only group with a majority feeling no or little decrease (66.7%). The open exploration technique has the highest percentage of complete release of pain and no decrease at all. At last, the laparoscopic exploration has a divided population as well.

Improvement after surgery is seen in 77.3%, with a complete release of pain in more than 1 out of 4 patients. 54.6% shows a significant or complete decrease of pain, so one could say that in 1 out of 2 patients the surgery was successful.



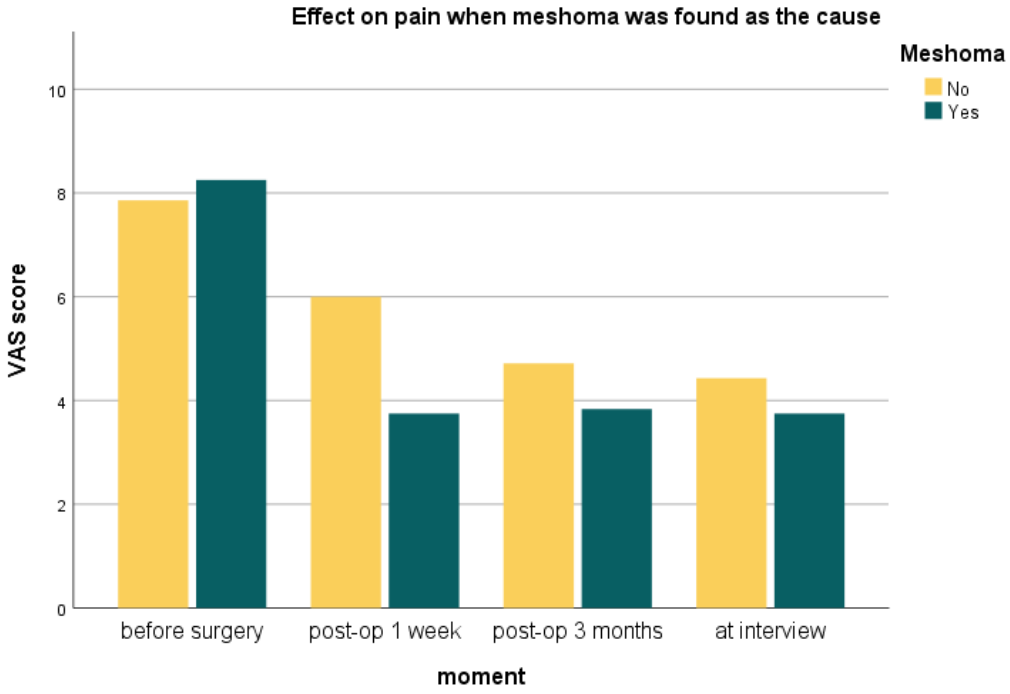

*Graph 2: Decrease of pain defined as 'none', 'little', 'significant' or 'complete' for each type of surgery.*

Not only the surgical technique to reach the inguinal zone can have an effect on the outcome of chronic pain, but also the removal of mesh and/or ring during surgery (table 7). During 21 of the 22 surgeries something was taken out. The decision to remove a part or the complete mesh or ring is made by the surgeon after the inspection of the inguinal area. Only 3 patients showed no decrease in pain after removing the synthetic material from previous surgery. Removing these materials has an effect. 60% after partly removal of mesh, 50% after complete removal of mesh, 66.7% after partly removal of ring and 75% after complete removal of ring show a significant to complete decrease of pain. Removing synthetic material does not always have an effect, but it does in the majority of cases, showing that it is a useful approach for treating postoperative chronic inguinal pain. There is not one action that stands out, so it is the surgeon's experience and analysis of the situation that should be the deciding factor.

| ***Decrease*** | Partly M | Complete M | Partly R | Complete R |
|---|---|---|---|---|
| ***None*** | 20% (n=1) | 16.7% (n=2) | 33.3% (n=1) | 25% (n=1) |
| ***Little*** | 20% (n=1) | 33.3% (n=4) | 0% (n=0) | 0% (n=0) |
| ***Significant*** | 40% (n=2) | 25% (n=3) | 33.3% (n=1) | 25% (n=1) |
| ***complete*** | 20% (n=1) | 25% (n=3) | 33.3% (n=1) | 50% (n=2) |
| ***N*** | 5 | 12 | 3 | 4 |

*Table 7: Decrease of chronic pain for each type of removal. M stands for Mesh and R stands for Ring. N is the number of a certain group of removal.*

Since the most important reason to remove synthetic material in this sample study is the presence of a meshoma, we will compare the decrease of pain between the patients, in which a meshoma was found, and the other cases. In graph 3, we note an immediate decrease in pain in the meshoma group of 4.5 at one week postoperative, while the non-meshoma group shows a decrease of only 1.86 at one week. The pain stays stable in the meshoma group, while the non-meshoma group has a gradual decrease over a longer period of time. Despite the gradual decrease, the meshoma group still had a significant larger decrease at the time of the interview.




*Graph 3: The influence of meshoma identified as cause of pain on the intensity of pain. .*

The probable cause of pain, found by the surgeon, is showed in table 8. Two surgeries showed an abscedated mesh due to a nearby abscess, in both cases the mesh was removed with a significant and complete decrease of pain as a result. In nine cases the mesh was crumpled instead of spread out as it should be. In seven of these cases the mesh was completely removed. In the two other

cases the mesh was partly removed, causing little and significant release. Removing this meshoma showed significant or complete decrease of pain in a large amount of patients. A probable explanation could be that the damage by the meshoma was already done to the surrounding tissue. Four cases showed a broken ring or mesh during surgery. Partly or complete removal of the broken parts appears to be a good therapy since 3 out of 4 patients did not suffer from pain anymore and the other patients showed a significant decrease of pain.

Other causes during surgery were displacement of mesh and clips, ring touching nerves and hard lymph nodes. The displaced mesh was replaced by a new one and the loose clips were removed, but this showed no decrease in postoperative pain. The ring touching the nerves was removed and showed a complete decrease of pain. The hard lymph nodes were removed and tested for malignity. The APD showed normal lymph nodes, but their removal showed no difference in pain after surgery.

In four cases, the surgeon could not find a probable cause for the chronic pain. In these four cases a part or all of the synthetic material was taken out by the surgeon. Only one patient felt a significant decrease of pain. The cause of pain in the other three cases remains unknown.

| ***Decrease*** | Mesh with pus | Crumpled mesh | Broken mesh/ring | Other | unknown |
|---|---|---|---|---|---|
| ***None*** | 0% (n=0) | 11.1% (n=1) | 0% (n=0) | 66.7% (n=2 | 50% (n=2) |
| ***Little*** | 0% (n=0) | 44.4% (n=4) | 0% (n=0) | 0% (n=0) | 25% (n=1) |
| ***Significant*** | 50% (n=1) | 33.3% (n=3) | 25% (n=1) | 0% (n=0) | 25% (n=1) |
| ***complete*** | 50% (n=1) | 11.1% (n=1) | 75% (n=3) | 33.3% (n=1) | 0% (n=0) |
| ***N*** | 2 | 9 | 4 | 3 | 4 |

*Table 8: decrease of pain grouped by probable cause of pain discovered during surgery.*

### Effect of non-surgical therapy

Next to surgical treatment, patients have been treated with non-invasive techniques in the pain clinic. 13 out of 18 patients have been treated with non-invasive therapy and they received a total of 24 treatment sessions. In table 9, a summary of the kind of treatment is given, with their effect on the chronic pain.

Infiltrations were the most used non-invasive therapy. They were performed 12 times. Two patients were completely released of their pain after the treatment and four treatments did not cause any difference in pain. Six times the infiltrations showed some effect, but it did not really make a difference for the patient's quality of life. Half of the group 'little decrease' had a very good

temporary decrease of pain, which they described as significant, but it only lasted for a couple of weeks, sometimes months, before completely relapsing to their pre-infiltration VAS score. Because of this, the therapy was scored as 'little decrease'. This therapy can be tried in patients when there is an assumption of neuropathic pain, because in some patients, it can be a permanent solution.

Oral treatment in the pain clinic was applied in 6 different patients. There was no significant difference in 66.6% of the patients. But in one patient, the oral medication provided a complete decrease of pain. The pain disappeared approximately one year after surgery, while using paracetamol. It is not clear whether the paracetamol caused the decrease or whether the pain just disappeared over time. Twelve out of 16 patients had used some form of chronic medication for pain, given by their general practitioner, but it did not give them enough pain release to stop them from looking for alternate solutions.

One patient was helped with dermal 'Versatis' patches. It did not decrease the VAS score, but it did decrease the frequency of moment of pain. The other patient felt no difference. Two patients received a total of three cryoablation sessions with no influence on the pain and in one patient even worsening the situation by creating numbness and an increase in VAS score. The other patient that received the cryoablation also received neurostimulation without any effect.

If we look at the total effect of non-surgical treatments, without pain medication prescribed by G.P., we notice that the percentage of significant and complete decrease is only 20%.

| *Decrease* | None | Little | Significant | Complete | Total (N) |
|---|---|---|---|---|---|
| ***Infiltrations*** | 33.3% (n=4) | 50% (n=6) | 0% (n=0) | 16.7% (n=2) | 12 |
| ***Oral*** | 33.3% (n=2) | 33.3% (n=2) | 16.7% (n=1) | 16.7% (n=1) | 6 |
| ***Dermal*** | 50% (n=1) | 0% (n=0) | 50% (n=1) | 0% (n=0) | 2 |
| ***Cryoablation*** | 100% (n=3) | 0% (n=0) | 0% (n=0) | 0% (n=0) | 3 |
| ***Neurostimulation*** | 100% (n=1) | 0% (n=0) | 0% (n=0) | 0% (n=0) | 1 |
| ***Draining abscess*** | 100% (n=1) | 0% (n=0) | 0% (n=0) | 0% (n=0) | 1 |

*Table 9: decrease of pain sorted by sort of non-surgical treatment.*

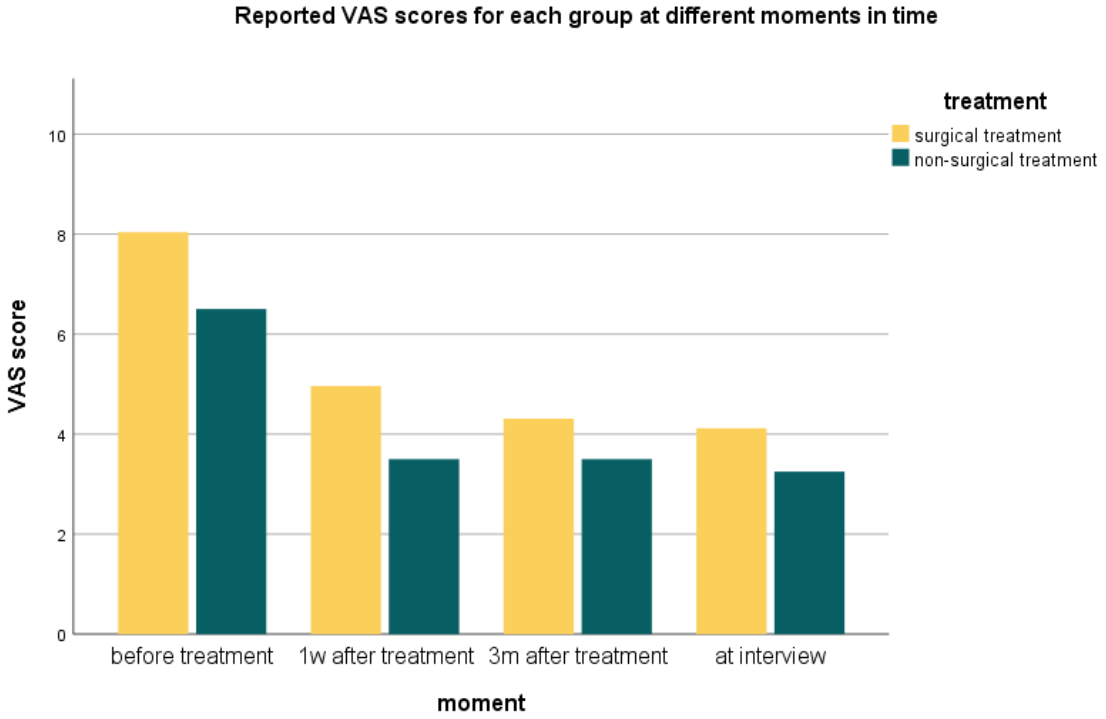
### Comparison of surgical and non-surgical success rates

The success rate of surgery in general was 54.5%. A meshoma was the most common cause of pain in the surgery group and removing the mesh and/or ring partly or completely showed the highest decrease in pain. If, after an operation where mesh was used, a patient complains of chronic pain, the mesh should be considered as a possible cause of the pain and the removal of the mesh should be seen as a potentially effective treatment for chronic pain.

Comparing the success rates to the non-surgery group, a lower general success rate was found (20%) with a success rate of 16.7% for infiltrations, 33.4% for oral treatment by pain clinic and 50% success for dermal patches (only two patients).

### Chronic pain

The target of this study is to evaluate which therapy was most effective to reduce or resolve chronic pain. Analysing the intensity of pain is key to collect objective data. To do so, we asked patients about their chronic pain before treatment, at one week after treatment, at three months after treatment and during the interview. The VAS score was used. Calculating the difference in VAS score between the two parameters 'before treatment' and 'at interview' for each group, we will be able to see which treatment is the most effective over a longer period of time (graph 3).




*Graph 4: VAS score at different moments in time for every group.*

The graph shows a clear difference in pain between the moment before treatment and the three different moments after treatment as well for the surgical as for the non-surgical group. The surgery group shows a decrease of pain in the three months post-operative, while the non-surgery group shows the same VAS scores at one week and at three months. Between VAS three months postoperative and VAS at the time of the interview, there was almost no further decrease. In general, both techniques show a clear decrease in VAS score, so we could conclude that the responsible doctors chose the appropriate technique for the individual cases. The surgery group

showed a slightly higher decrease of pain than the non-surgery group. The average decrease in this group was 3.92 compared with 3.25 in the non-surgery group between preoperative vas and VAS at the time of the interview.

Twelve out of thirteen patients from the surgery group showed a decrease in pain between preoperative pain and pain at 3 months as well as at the time of the interview. Notable was that 3 out of 13 patients showed an increase of pain between pain at three months and at the time of the interview, after an initial decrease. In all three cases the mesh was completely removed and in two cases replaced with new mesh. In the cases where there was no placement of a new mesh, the surgeon wrote in the patients file that there is suspicion that the pain is not of inguinal origin and is maybe caused by a muscle tear. In one of the two other patients, an abscess was found near the mesh. One patient showed no decrease since three months and three patients had a complete relieve of pain at the time of the interview. One of them showed no pain directly after surgery, another one showed no pain three months postoperative and the third had a slow decrease of pain to end at zero (VAS at three months was still 4). These three had a meshoma or a broken mesh and it was partly or completely removed. The complete survey of which interventions happened during surgery is found in table 6.

Two out of five patients from the non-surgery group received infiltrations, the others used oral or dermal pain medication. Three of them couldn't give VAS scores for post-treatment pain at one week and three months, because they didn't remember exactly when they started and they kept on using these medications. Important to point out is that 9 out of 13 patients from the surgery group received infiltrations at some point in their course of therapy with little to no improvement. This means that only 2 out of 11 (18.2%) showed significant improvements using infiltrations. These two showed complete relieve of pain. The three other patients are satisfied with their pain medication. It decreases the pain enough to not disturb their daily life. One patient went from 9 to 3 over the past six years. The other two went from VAS 2 at three months post-operative to VAS 0 on pain medication. Every one of this group had a decrease in VAS score. There is no clear evidence to attribute the decline in VAS score to the oral or dermal pain medication, because there is a possibility that the pain just disappeared over time. Another fact is that 8 patients from the surgery group used pain medication but they've switched to other therapies because oral pain medication wasn't sufficient.

Next to general VAS scores at the time of the interview, a more detailed survey on their VAS score in specific situations was taken using the EuraHS QoL questionnaire to have a more complete view

on the chronic pain of each patient. Three different situations are checked: rest, activity and pain during past week. Pain during rest was defined as pain when laying down. Pain during activities contained normal activities like walking, as well as sports and driving (table 10).

The surgery group had more pain during activities than during rest, with an average of 3.78 in the week before the interview. Only one patient suffered more during rest. Two patients didn't have any pain during rest, activities and in the past week.

In the non-surgery group 3 out of 5 patients didn't suffer from pain anymore. One patient felt significantly more pain during activities and was the only patient in this group on whom the pain had a significant impact on the quality of life. There was one other patient who felt more pain during rest.

| ***VAS score*** | Surgery (n=13) | Non-surgery (n=5) | Mean (n=18) |
|---|---|---|---|
| ***Pain during rest*** | 3.00 | 1 | 2.83 |
| ***Pain during activity*** | 4.56 | 1.80 | 3.83 |
| ***Pain during past week*** | 3.78 | 1.20 | 2.83 |
| ***Limitations*** | | | |
| *Daily activities* | 2.67 | 1.20 | 2.50 |
| *Outdoors* | 3.78 | 1 | 3.22 |
| *Sports* | 6 | 0 | 4.08 |
| *Hard labour* | 5.17 | 2.33 | 1.06 |
| ***Cosmetic hinder*** | | | |
| *Shape abdomen* | 1.69 | 0 | 1.22 |
| *Scar tissue* | 1.31 | 0 | 0.94 |
| ***Pain affecting*** | | | |
| *Sleep* | 69.2% (n=9) | 0% (n=0) | 50% (n=9) |
| *Mental state* | 53.8% (n=7) | 20% (n=1) | 44.4% (n=8) |
| *Relations* | 46.2% (n=6) | 0% (n=0) | 33.3% (n=6) |
| *No effect* | 7.7% (n=1) | 80% (n=4) | 27.8% (n=5) |

*Table 10: VAS score at different moments in time, quality of life by Intensity of limitations during varying activities and cosmetic hinder scored 0 = no pain and 10= extreme, non-liveable pain. Number of patients with an effect on quality of sleep, mental state and relations.*

## Quality of life

When looking at results of treatment for chronic pain, it is important to not only look at the influence on the pain itself, but also at the influence on the quality of life (table 5): limitations, pain affecting and cosmetic hinder. Patients were asked about physical influence of pain in their daily life by answering the section 'limitations on activities caused by pain or discomfort in the groin area' from the EuraHS QoL questionnaire (Appendix document 1). Daily activities were defined by indoor activities e.g. work in the household and outdoor activities were defined by walking, cycling and

driving. Other than physical influence, the effect of pain on mental health was assessed by asking questions about the quality of sleep, their mental health state and their social interactions with others. 5 patients didn't perform any sports and 3 didn't perform any hard labour. They are left out of the analysis of these variables.

The surgery group showed highest scores in the 'Hard labour' section and during more intense activities like walking, cycling, driving and sports. Two patients didn't have any limitations in all sections. Three patients didn't perform any sports and one patient never did any hard labour. One patient only felt pain during hard labour and one other patient only had some limitations during daily activities and hard labour but not in the 'outdoors' and 'sports' sections. Three out of five patients in the non-surgery group didn't have any limitations. The two other patients didn't perform any sports and were most limited during hard labour (VAS 6 and VAS 1).

Effect on sleep, mental state and relations were checked as well to measure the quality of life. It is clear that the non-surgery group, which has a lower VAS score, has a lower influence of the pain on their quality of life. Only one patient felt an effect on his mental state, while the other four did not feel that the pain interrupted their lives. This is in contrast to the surgery group where only one patient did not feel an influence on these variables. Chronic pain has an influence on sleep in 50% of patients. 44.4% of patients feel an influence on their mental state described as 'feeling down' and in some cases even borderline depression. 33.3% felt an influence on their relations with their environment. The influence on their quality of life results in use of sleep medication and anti-depressants.

The EuraHS QoL (Appendix document 1) has a section for cosmetic hinder. This variable is more linked to number of surgeries than it is to these different treatments.

After analysing these results it is clear that the more pain one person has, the lower their quality of life is and the more treatment they receive to resolve their pain. Surgery, pain medication, infiltrations etc. are all optional treatment paths. It is important to not only have resolving of pain as a major outcome, but to think of the quality of life as well. To do so, it is important to look at each person individually and discuss the right path for each of them in consultation with the patient. The expertise of the surgeon is of paramount importance.

## 6. Discussion

Despite the high incidence of chronic pain after inguinal hernia surgery, evidence for one therapeutic option with a clear advantage that is generalizable for all patients hasn't been found yet. This research tried to add extra data to the topic, so treatment would be more straightforward for patients and their physicians. A database, containing 1557 patients who underwent inguinal surgery, was checked for consultations more than 3 months postoperative with complaints of chronic pain. These patients were invited to the hospital for an interview, a questionnaire and a short clinical exam to evaluate the pain at different moments in time and their quality of life. After collecting the necessary data a comparison was made between surgical therapy, which was in the majority, and a smaller group of non-surgical treatment as well as a comparison between the different types of surgical therapy.

The participation of patients and use of their data was collected by the 'opting-in' principle. Their information was used in this study only when they actively wanted to participate and signed the informed consent. To evaluate the VAS score and the quality of life, the EuraHS QoL questionnaire was used. Since the EuraHS QoL questionnaire is not elaborate, additional questions were asked during the interview based on DN4 for neuropathic pain. A disadvantage of a more open interview is that it becomes more difficult to compare the data. We still chose to do so, to be able to get the complete picture of a patient's situation. An elaborate questionnaire specific for chronic pain after inguinal surgery should be created in which all different treatment options are questioned in detail and it should be standardized. At the moment, a lot of different questionnaires are used: DN4, EuraHS QOL, EQ-5D, HERQL, CCS, SF-36 (short form health study) and McGill (1, 6, 8, 13, 29, 38, 39, 41, 45-54). SF-36 and EQ-5D are both more general health surveys, while HERQL, CCS and EuraHS QOL are hernia-specific assessment tools. DN4 and McGill are both assessment tools for chronic pain, not specific for inguinal hernia. The use of EuraHS, with elements of DN4, gives a combination of assessment of pain (with subdivision of neuropathic and non-neuropathic pain) and quality of life, specific for inguinal pain after hernia repair. Still, there is a need for one general assessment tool for the evaluation of pain and quality of life after inguinal pain, in order to make straightforward comparisons between similar studies.

A lot of studies about the cause and incidence of chronic pain after different surgical techniques about chronic pain have already been published, but studies about the treatment to resolve this pain are limited. This retrospective analysis looked at a population with different, and sometimes, several treatments. The complexity of the treatment paths of all these patients, together with the

small study population, lowers the impact of the results. One study by Magnussen was retrospective as well, but they only looked at surgical treatments. Four prospective studies found, looked at chronic pain treated by surgery and one only analysed the neurostimulation or nerve blocks as a therapy. Prospective cohorts have a higher level of incidence, so these study settings are preferable (6, 8, 42-44, 55, 56). A prospective study wasn't possible for this research due to a shortage of time. Other articles about the therapy of chronic pain are often reviews and/or international consensuses by expert groups (4, 39, 57). It is clear that more research with a higher level of evidence should be performed in this subject to strengthen the consensuses by expert groups. An advantage of the study sample is that 21 out of 22 surgeries were performed in UZ Gent between 2010 and 2019. The procedures were unicentric and performed by the same surgeons.

The question whether the demographic data of patients influence the outcome after different treatments is difficult to answer. The small number of patients in this study is not a random sample of the population, therefore the demographic data from this study is compared with the data from larger similar studies, so that outstanding variables become clear. The most important demographic variables were age, BMI and the presence of neuropathic pain. The mean age of the study sample is 62.3 years. The high age is influenced by the fact that patients had to visit the hospital during the day to participate in this study and isn't a measure of the variable as a prognostic factor for chronic pain. A study by Langeveld proved that in the young group (18-40 years) 43% presented pain, in contrast to the middle age group (40-60 years) with 29% and the elderly (>60 years) with 19%. This indicates that our in our study sample age cannot be seen as an important factor in terms of chronic pain. The non-surgery group was on average 15.1 years older. The fact that older age is related to a lower intensity of pain, could be a reason why the age in the non-surgery group is higher, since surgery is often preferred in patients with higher VAS scores (58). High BMI, and more specific obesity, is a risk factor for CPIP. This variable could influence the outcomes of certain therapies, but there were no significant differences between groups. 61.1% was overweight or obese (22.2%). It is not a coincidence that the majority of the population is overweight, since the higher the BMI, the more risk of chronic postoperative inguinal pain (1, 14, 28). Looking at the distribution of neuropathic and non-neuropathic pain in this study, we found that 66.7% of patients showed signs of neuropathic pain before treatment. Still, neurectomy was only performed once in this study sample. The cause for the low incidence of neurectomy was that during surgery, a meshoma was found in 7 cases. Pain caused by mesh is defined as non-neuropathic pain, so postoperatively only 3 patients, instead of 10 were diagnosed with neuropathic pain. In 2 cases the origin of pain was not certain and there was chosen not to perform a neurectomy. In literature, we found that

neuropathic pain is the cause of pain in about 50% of the cases according Amid et al. and Loos et al.

The chronic pain is caused by the initial inguinal surgery, but different techniques are used to treat inguinal hernia. As described in the introduction, laparoscopic options are preferred above the Lichtenstein repair, but TIPP repair gives similar results to laparoscopic techniques on the outcome of chronic pain. Looking at the distribution of primary surgeries in this study, 4 different techniques were used. TIPP was the most used technique, it included 61.1% of the primary surgeries. 22.2% was laparoscopic and Lichtenstein, seen as a technique more vulnerable to chronic pain, was only used twice and not after the year 2012. TIPP was the most performed surgery in both groups, but this does not mean that TIPP has the lowest success ratio for chronic pain. The distribution of primary surgery in this sample is not a correct representation of the incidence of chronic pain for each type of primary surgery from the initial database of 1556 patients. It would be interesting to have the total number of each surgical technique in the initial hernia database and their success ratio. Only then a conclusion about the most and least successful techniques on chronic pain can be made. Looking at the literature: most articles prefer laparoscopic hernia repair to open techniques, but in the international guidelines for inguinal hernia the authors concluded that TIPP presents comparable outcomes with a lower cost and possibly less complications. Lichtenstein is proven to be inferior to other techniques (1, 9, 55, 59-63).

The complexity of chronic pain and its treatment is highlighted by the number of actions performed in this study sample. There were 57 therapies performed in 18 patients, of which 22 surgeries and 21 non-surgical interventions (16 therapies with oral and dermal pain medication left out). The non-surgery group only received 4 infiltrations and all of them oral pain medication. The majority of treatments was in the bigger surgery group. The complexity of these patients' history makes it difficult to draw hard conclusions for the different treatments. Only surgery and infiltrations have a relatively large sample group. No articles were found where all types of pain and all types of therapy were included, so a comparison with a similar article is hard to make. An article about surgery as a therapy confirmed the complexity of treatment (56). The complexity of treatments in this study is not surprising. Guidelines demand a more clear hierarchy and a more simple treatment path (1, 4). The subdivisions in this study with effect of surgery and effect of non-surgical treatment can be compared to similar articles (in following chapters), but articles were prospective cohorts where only one type of treatment is performed. This gives a more clear view on the outcomes of a specific kind of treatment. The complexity and variety of patients and treatment in this study group may be

the weakest point of this study. Choosing one type of treatment for one type of pain would give more straightforward results. This is a point of improvement for future studies within the field of chronic inguinal pain.

50% of the surgery group underwent a previous non-invasive type of treatment. This is the correct treatment path according to the guidelines. On the other hand, 50% did not follow the guidelines. A possible cause is the judgement made by the surgeon that there is, for example, a problem with the mesh. In these cases (31.8%) surgery was the first step of treatment. Looking at the effect on pain of these cases and the cause of the pain found during surgery: 66.7% of first surgeries showed a significant or complete decrease of pain, while following surgeries only showed a success rate of 40%. The lower success on secondary surgeries is confirmed by the guidelines. Valvekens et al. also found that the outcome of surgeries as a therapy for chronic pain is hard to predict (1, 45). Campanelli et al. found a mean decrease in pain of 6 at the VAS score with an effect in 87% of the study sample after surgical treatment (42). Amid et al. found a significant decrease in pain in all patients who underwent previous non-invasive therapies after a triple neurectomy for their diagnosed neuropathic pain. His research shows that when guidelines are followed and strict inclusion criteria are met, the outcome of surgery is a lot better than results in this study or in other studies (64). His findings match with the findings in this study. Outcome is hard to predict, but the more the guidelines are followed, the higher the success of therapies. This is reinforced by the success rates of surgery with previous non-surgical treatment compared to surgery as the first step in treatment. Surgery performed without earlier treatment showed a success rate of 36.4%, while surgery with earlier treatment showed a success rate of 72.7%. These numbers are in line with the international guidelines on hernia surgery (1).

The majority of surgeries consisted of removal of mesh and/or ring. A meshoma was identified as the cause in 40.9% of surgeries, thus displacement of the mesh seems to be an important cause of pain. Possible causes could be: type of mesh, surgical skills or the way the mesh is attached to the tissue. 40.9% is a high incidence of meshoma. Other studies describing findings during surgery found different percentages. Sharma et al. describes the removal of mesh in 105 surgeries. 38.5% of the found causes were meshomas. In three other studies, a meshomas was found as the possible cause of pain. The incidences were 17.4%, 20% and 25.1%. The incidence of meshoma is comparable to Sharma et al, but higher than the incidence in the studies by Chen, Moore and Zwaans et al. (54, 65-68). It is not clear why problems whit mesh were so frequent in this study sample. Other studies that investigated the relationship between mesh removal and pain confirmed

that removal of mesh is an appropriate technique to reduce pain in certain patients. Andresen et al. stated that surgery for chronic pain should include mesh removal. This is confirmed by another study of Zwaans that found a beneficial effect in 2 out of 3 mesh removals (67, 69-71).

In this study, removal of mesh was a useful intervention in treatment. But not only mesh removal is a possible option, ring removal as well. In 7 cases of surgery only the ring was partly or completely removed, the success rate was 71.4%. For mesh removal, the success rate was 52.9%. Only 6 out of 12 (50%) that were completely removed showed significant or complete decrease in pain. In 3 out of 5 cases where the mesh was partly removed, a significant decrease was found. These numbers show that when a surgeon thinks of the ring as the problem and acts on it, the success rates are higher than when the origin of pain is the mesh in this sample study. Öberg et al. reported a case study on the removal of the mesh ring with complete relieve of pain. Lourenço et al. found 4 patients in a study sample of 693 patients with residual pain at 6 months and removal of the ring in 3 patients made the pain disappear. The other patients showed spontaneous recovery. A study by Andresen et al. showed discomfort because of the ring in 1 out of 80 patients. After removal of the ring, the pain disappeared as well (72-74).

The type of mesh may be a cause of meshoma or chronic pain. Types of mesh, used in primary surgery, in this sample were Prolene Hernia System Mesh Heavyweight Mesh (PHS Mesh), Mesh plug, Rebound Hernia Repair Mesh, Ventralex™, Polysoft Mesh, 3D MAX™ Mesh and Ultrapro® Partially Absorbable Lightweight Mesh. The Rebound Mesh is the most used mesh in the department of abdominal wall surgery as well as in this study sample. It was also the most effective mesh, since only 2 out of 9 (22%) meshes were removed. The one Ultrapro® Partially Absorbable Lightweight Mesh used, was successful as well. Types of mesh that had to be removed in all cases were PHS Mesh, Mesh plug, Ventralex™ and 3D MAX™ Mesh. When meshes were removed, they were replaced with new mesh in 7 cases: once with a plug and an Ultrapro® Partially Absorbable Lightweight Mesh and five times with a Rebound Hernia Repair Mesh. Torres-Villalobos et al. evaluated 6 placements of Rebound Mesh in pigs and found that the Ninitiol ring of the mesh prevented shrinkage and folding of the mesh, giving less meshoma and recurrence (75). In a randomized controlled trial by Magnusson, the 3-year outcomes, comparing PHS, Ultrapro and Lichtenstein, showed no significant difference between the techniques based on the SF-36 questionnaire and they were all recommended for use in hernia surgery. Another study by Magnusson showed lower recurrence rates comparing PHS to Lichtenstein (76, 77). A prospective study by Ladurner et al. showed no significant difference between lightweight and heavyweight

mesh as well. This is confirmed in a review by Trandafir (78, 79). There are not a lot of articles published on the use of Ventralex mesh, both Martin et al. Tollens et al. and Vychnesvskaia et al. conclude that Ventralex is a safe option in preventing recurrence and comorbidities, but as F. Berrevoet notes, there is need for further evaluation of this mesh in order to make any hard conclusions (65, 80-83). Both this study and the literature are in favour of rebound mesh. Another important factor is experience with a certain type of mesh. A study by Takahashi found that residents, being unexperienced, were a risk for recurrence (84). We can conclude on the use of mesh that experienced surgeons using rebound mesh could show the best results in terms of recurrence of creating meshoma.

When the ring or mesh was broken, removal was 100% successful in decreasing pain, as well as in case of an abscedated mesh. When the cause was unknown, results are bad: 75% showed no or little decrease in pain even after taking out the synthetic material. In conclusion about mesh removal: it was the most outstanding variable in the results when comparing the different surgeries and should be seen as an effective technique in the treatment of chronic inguinal pain as confirmed by Amid, Loos and Bisschof as well as the Hernia Surge Group and many others (1, 23, 24, 44).

Next to removal of synthetic material, neurectomy has proven to be an effective technique, for reducing chronic pain, by different studies. Surgery, specific for neuropathy, consists of removal and/or replacement of mesh in combination with a neurectomy. Aasvang et al. found a higher success rates for a combination of mesh removal with triple neurectomy than for mesh removal alone. Loos et al. found that triple neurectomy gave good to excellent results in more than half of their study sample and moderate results in another 24%. Amid et al. found a significant or complete after triple neurectomy in 96% and in 87.5% of patients in two different studies. Only patients with neuropathy were selected. Chen et al. found a significant decrease in pain in all 20 patients after performing a triple neurectomy. (1, 4, 23, 24, 44, 54, 64, 65, 85).

Surgery does has its effect on the chronic pain, but what kind of interventions have the most effect, is not yet obvious. The success rate, defining success as significant or complete decrease of pain, is just above the 50% for surgery in general. This arguments that surgery is definitely a legitimate treatment for chronic pain, but it doesn't mean that other techniques no longer have to be considered. Other studies came to the same conclusions: surgery decreases the intensity of chronic pain in patients, but not in all of them and it is hard to predict in what situations and with which techniques the surgery will be successful. An experienced surgeon in the field of inguinal

hernias should make the decision whether or not to operate for every case individually after trying non-operative therapies (1, 42, 45, 56).

Only 16.2% of the infiltrations that were given, had a lasting effect with complete release. Three patients stated that the pain was completely gone for some time, but after a couple of weeks or months, it came back. Infiltrations, just like surgery, can be useful in certain cases, but it has a lower success rate in the long term in this study sample. It was still a permanent solution for two patients so it should always be considered as a treatment option. This temporary effect of infiltrations is known and confirmed by several studies. In one study by Palumbo et al., 18 out of 25 patients (72%) showed a good result with infiltrations and 4 out of 25 had satisfying results, while 2 out of 3 patients with no satisfaction received surgery without any amelioration of pain. Another study, by Voorbrood et al., found a success rate of 62%. These results are completely opposite to what is found in this evaluation, but the difference is that both studies gave neuropathic pain as an inclusion criteria. Infiltrations only work on neuropathic pain (8, 41, 45, 50, 55, 65, 86). The oral pain medication given by the pain clinic showed a success rate of 23.3%, but it is not clear whether the paracetamol caused the decrease or whether the pain just disappeared over time. Especially when taking in to account that 12 out of 16 other patients had used some sort of pain medication without significant results. This takes the success rate of oral and dermal pain medication to 11.1%. Two patients were satisfied with dermal ‘Versatis’ patches. Pain decreasing over time is seen in the results of this study and confirmed by Burgmans et al. for chronic pain after TEP surgery. They found an incidence of pain at three months of 18.9% which decreased to 11% at one year. Palumbo et al. gave oral pain medication to a study sample before starting infiltrations. 8 out of 32 patients were completely relieved of any pain, showing a success rate of 25%. This is an argument to always start with oral therapy before proceeding with more invasive therapy such as infiltrations or surgery (86, 87).

Regarding reported VAS scores, a clear decrease of pain was seen between, before and after therapy and a smaller decrease of pain in the following months and years. The small decrease of intensity pain after three months has been noted in different studies by Burgmans et al. after TEP repair and Magnusson et al. It can be an argument to introduce watchful waiting in patients with low VAS scores and no influence on quality of life (6, 87). Both the surgery and the infiltrations (in the non-surgery group) showed a clear decrease of VAS scores. Patients in the surgery group started off with higher VAS scores and had a slightly higher VAS score at the time of the interview. Since groups are so small, no significant difference can be concluded about decrease of VAS score

between those groups. Interesting to point out is that it seems that people with a higher pain intensity are more likely to undergo surgery than patients with a lower pain intensity, but they both had a similar decrease. The fact that both groups have a clear and similar decrease in pain, can be caused by a good assessment of the responsible surgeon, between different types of treatment, or by a comparable effect of the different techniques on chronic pain. It is also striking that reported VAS score at time of the interview (asked during open interview) and VAS score during past week (chapter in EuraHS), asked at the end of the interview, differ more than 2 points within the non-surgery group and 0.3 points within the surgery group. The question whether patients really did have more pain on the day of the interview or whether they had some sort of white coat syndrome, is hard to answer. This points out one of the big problems with assessing pain: it is completely up to the patient to score their pain and thus completely subjective.

The quality of life was affected more in the surgery group for all elements of the subdivisions 'limitations' and 'pain affecting'. These big differences in quality of life can be caused by a number of variables, such as: number of procedures, difference in pain intensity or personal events and character. The effect of number of procedures on the quality of life is hard to assess. An argument for the relation between these variables, is the dissatisfaction of the surgery group about the esthetical appearance of the abdomen: while they felt cosmetic hinder, nobody in the non-surgery group felt any cosmetic hinder at all. The origin of this hinder may be caused by the number of operations they underwent and the associated insecurity of the strength of the abdominal wall. No studies were found on the relation between number of surgeries and satisfaction of abdominal wall appearance. Another influence on quality of life is the intensity of pain: higher intensity of pain causes a lower quality of life. This is a clear conclusion looking at both groups in this article. Nikkolo et al. found that a VAS score under 2 points had no influence on the quality of life. This confirms the results found in this experiment with an average VAS score in the past week of 1.2 in the non-surgery group and almost no effect on the quality of life. Other authors confirm the link between chronic inguinal pain and quality of life as well (53, 55, 88, 89). Differences in coping with chronic pain between patients probably has an influence on the quality of life and subjective feeling of pain. One other study was found where similar considerations were noted (53).

The limitations of the study included the selection of patients, as it is based on an invitation and requires the 'goodwill' of patients. If the pain is resolved, they are inclined to not respond on an invitation that no longer concerns them, especially if they have to visit the hospital to participate in the study. Some other non-responders might not find the time to join the study or have other

personal reasons such as disbelief in the effect of the study on the outcome of their problem. These and other causes create a selection bias, which can have a major influence on the results. Especially if only 18 out of 72 potential participants respond on the invitation. This study suffered from the same weaknesses as other retrospective studies. The response rate is 25% which is too low to be a population based study sample by the opting-in principle. A sample size of 18 patients isn't enough to perform relevant statistical tests, so the results of the study contain only descriptive statistics. It is key to create a bigger sample size, to increase the validity of the results. To do so, bigger databases and more complete data should be collected in future research in combination with a more effective study setting to attract more volunteers (e.g. data from all inguinal surgeries in Belgium instead of only data from UZ Ghent).

Recall bias is one of the most important limitations in retrospective studies. The inclusion criteria were patients with prior surgery between the years 2008 and 2018. The files at the UZ Ghent between the years 2008-2010 were not as elaborate and complete as in the more recent years. Some patients had a hard time remembering events from several years ago (e.g. one patient was excluded because of an incomplete file and problems recalling his events). Other patients seemed to remember everything, but there is always a risk of recall bias. A detailed medical file on their pain score and quality of life was preferred for data to the patient recalling the events at the time of the interview, but not all files were that complete. In those situations data was based on information given by the patient during the interview. This emphasizes the importance of a complete consultation and adding all the data collected to the patient's file. We asked patients about their VAS scores before and after primary surgery and subsequent therapy in a retrospective way. This can give a recall bias and a confirmation bias. This probable underreporting of successful therapy can steer results of this study in a negative way.

Another bias could be created by the several definitions for chronic pain. There is a lot of discussion about the definition, because some say 3 months is too short. There are arguments to support this: even in this study, one patient dropped out because the pain disappeared without any treatment only after a period longer than 3 months. Time has its share in the disappearance of pain, which makes it hard to set clear borders for having or not having chronic pain.

Other things that should be added to future similar studies is explicitly asking about mesh sensation. It did not happen in this study and none of the patients mentioned it themselves. Another part that could be improved is a more strict including criteria (e.g. only one type of treatment) with larger

sample group to be able to make hard conclusions. The cost-effectiveness of the study results was not checked.

In conclusion, the outcome of surgery as a treatment for chronic pain is hard to predict. It is most successful in selected cases and after non-invasive treatment. The interventions during the surgery, chosen by the surgeon after analysing the situation, had the most effect on surgery, and not the approach of the surgery itself. Removal of mesh and/or ring showed the strongest decrease in pain, especially when a meshoma was found. The success rate of non-surgical therapy was only 20% long-term, but it proved its worth in some cases. There was a clear link between the quality of life and the intensity of pain: the higher the VAS score, the lower the quality of life.

When treating chronic pain after inguinal surgery, there must be cooperation between the pain clinic and the department of abdominal wall surgery to assess the type of pain in order to give each individual the best possible treatment. There is not one way to treat chronic inguinal pain. Following the international guidelines from the Hernia Surge Group, gave the best results in this paper. Therefore this paper advocates to use these guidelines in each case of chronic pain after inguinal hernia repair (1). Mesh removal is an important aspect of treatment and should always be taken into account, when the treatment plan is drawn up, as a viable option.

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FACULTY OF MEDICINE AND HEALTH SCIENCES

# 8. Appendix: EuraHS QoL Questionnaire

## *EuraHS QoL voor liesbreuken*

| | |
|---|---|
| **naam van de studie** | **Masterproef Esther Beel** |
| **studienummer** | **B670201838115** |

## Schaal voor het meten van de levenskwaliteit

De EuraHS-QoL schaal is een methode voor het meten van de levenskwaliteit bij mensen voor (preoperatief) en na (postoperatief) de operatie van een liesbreuk met gebruik van een netje voor het herstel van een defect.

Deze vragenlijst is opgesteld door chirurgen van de werkgroep "European Registry for Abdominal Wall Hernias (EuraHS)".

**Gelieve de vragen over de volgende onderwerpen te beantwoorden:**

1. **Pijnervaring op de plaats van de liesbreuk.**
2. **Beperkingen van activiteiten door de liesbreuk.**
3. **Cosmetische hinder.**

**Daarvoor kunt u het cijfer aanduiden dat overeenkomt met uw huidige toestand.**

**Een 0 staat voor de best mogelijke ervaring** (geen pijn, geen beperking en cosmetisch mooi) **en een 10 staat voor de slechtst denkbare ervaring** (zwaarste pijn, volledige beperking en cosmetisch extreem lelijk)**. Indien u één van deze activiteiten niet uitvoert kunt u in de laatste kolom de X omcirkelen.**

**Persoonsgegevens:**

| | |
|---|---|
| **naam** | |
| **geboortedatum** | |
| **datum invullen vraaglijst** | |
| **datum van de operatie** | |

# *EuraHS QoL*
# *voor liesbreuken*

**NAAM:** **DATUM:**

## Schaal voor het meten van de levenskwaliteit

**Gelieve de vragen over de volgende 3 onderwerpen te beantwoorden.**

**Daarvoor kunt u het cijfer aanduiden dat overeenkomt met uw huidige toestand. Een 0 staat voor de best mogelijke ervaring** (geen pijn, geen beperking en cosmetisch mooi) **en een 10 staat voor de slechtst denkbare ervaring** (zwaarste pijn, volledige beperking en cosmetisch extreem lelijk)**. Indien u één van deze activiteiten niet uitvoert kunt u in de laatste kolom de X omcirkelen.**

| **1. Pijn op plaats van de liesbreuk** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0 = geen pijn** | | | | | | | | | | **10 = ergst mogelijke pijn** | |
| **Pijn in rust** (neerliggen) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| **Pijn bij activiteiten** (wandelen, fietsen, sport algemeen) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| **Pijngevoel van de laatste week** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| | | | | | | | | | | | | |
| **2. Beperkingen van activiteiten door pijn of onbehaaglijkheid op plaats van de liesbreuk** | | | | | | | | | | | | |
| | **0 = geen beperking** | | | | | | | | | | **10 = volledige beperking** | |
| **Beperking bij dagelijkse activiteiten** (binnenshuis) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | X |
| **Beperkingen buitenshuis** (wandelen, fietsen, autorijden) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | X |
| **Beperkingen tijdens sport** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | X |
| **Beperkingen tijdens hard werken** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | X |
| | | | | | | | | **X = Indien U deze activiteit niet uitvoert** | | | | |
| | | | | | | | | | | | | |
| **3. Cosmetische hinder** | | | | | | | | | | | | |
| | **0 = heel mooi** | | | | | | | | | | **10 = extreem lelijk** | |
| **Vorm van de buik/lies** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| **Plaats van de liesbreuk en het litteken** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |