Clinical Neurology and Neurosurgery 134 (2015) 7–11

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Comparison of effectiveness of different surgical treatments for meralgia paresthetica: Results of a prospective observational study and protocol for a randomized controlled trial

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ARTICLE INFO

Article history:
Received 6 January 2015
Received in revised form 10 March 2015
Accepted 5 April 2015
Available online 11 April 2015

Keywords:
Nerve compression
Entrapment
Neurolysis
Neurectomy
Nerve transection

ABSTRACT

Introduction: Various surgical procedures can be applied in the treatment of meralgia paresthetica. The two main ones are neurolysis and neurectomy of the lateral femoral cutaneous nerve. To date, no prospective or randomized controlled trial has compared the effectiveness of these procedures with standardized outcome measures. In this study we present our results for two prospectively followed cohorts and we present the protocol for a double blind randomized controlled trial (RCT).

Methods and analysis: All patients that had an indication for surgical treatment of idiopathic meralgia paresthetica between August 2012 and April 2014 were included in the study. The patient decided on the type of treatment (neurolysis or neurectomy) after informed consent had been given. Primary outcome was measured using the Likert scale obtained 6 weeks after the surgery. Successful pain reduction was defined as Likert 1 or 2. Secondary outcome measures were the Numeric Rating Scale (NRS) and Bothersomeness Index (BSI). In case of neurectomy the BSI for numbness was also obtained.

Results: A total of 22 consecutive patients were included: neurolysis was performed in 8 patients and neurectomy in 14 patients (one bilateral case). Successful pain reduction was observed more frequently after neurectomy (93.3%) than after neurolysis (37.5%, $P < 0.05$). Secondary outcome scores (NRS and BSI pain) were also better after neurectomy, although not significantly (respectively $P = 0.07$ and 0.05). Paired analysis of the scores before and after the surgery showed an improvement in both the NRS and BSI after the neurectomy procedure (both $P < 0.001$), while scores were not significantly different before and after the neurolysis procedure. Patient's scores for the BSI numbness after the neurectomy procedure were low (mean 1.4, SD ± 1.0, range 0–3).

Discussion: The results of our prospective study confirm results previous studies reported in the literature in that the percentage pain relief was better after neurectomy than after neurolysis. A RCT is needed to further investigate potential differences in effectiveness. The protocol for such a trial is presented in this article.

1. Background

Meralgia paresthetica is a mononeuropathy of the lateral femoral cutaneous nerve. Symptoms may consist of a burning or tingling sensation in the anterolateral part of the thigh. The severity can vary from slight discomfort to symptoms that severely disable patients in their daily activities. The exact pathophysiologic mechanism of meralgia paresthetica is still largely unknown, but probably consists of a combination of compression at the inguinal ligament (where the nerve makes an angle of nearly 90 degrees in standing position) and repetitive motion in the hip (for example during walking or cycling). This combination of compression and stretching can lead to various macroscopic and microscopic intraneural changes (Figs. 1 and 2) [1].

In most cases (90%) symptoms resolve spontaneously or with help of conservative treatment (e.g. pain medication, loss of weight, avoid wear of tight clothes and local injection with steroids) [2]. If symptoms persist, surgical treatment should be discussed with the patient. The surgical options are neurolysis (release of the nerve by incision of the inguinal ligament) and neurectomy (transection of the nerve) [3]. These different surgical procedures have various advantages and disadvantages. The obvious advantage of the neurolysis procedure is that sensation in the anterolateral part of the

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http://dx.doi.org/10.1016/j.clineuro.2015.04.007
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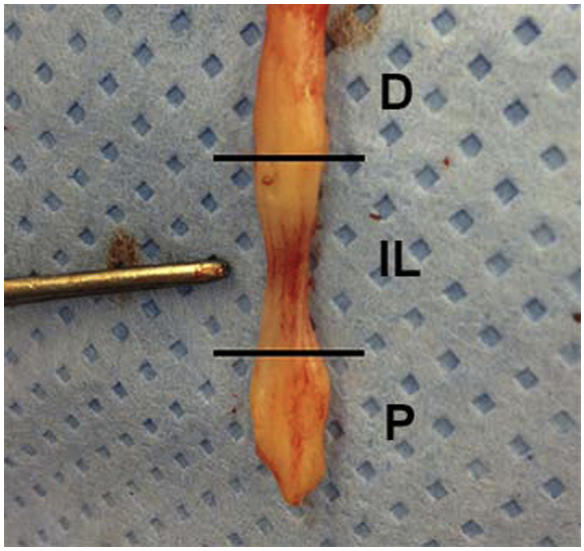

Fig. 1. Picture of a resected lateral femoral cutaneous nerve (LFCN) directly after the neurectomy procedure. Forceps points at previous site of compression at the inguinal ligament (IL). D = distal to ligament, P is proximal to the inguinal ligament.

thigh is preserved. The disadvantage is that the chance for pain relief is generally lower than after the neurectomy procedure [4].

The neurolysis and neurectomy procedures have been compared in a number of studies [4–7]. These studies however have several shortcomings: most studies have been performed in a retrospective manner, the studies are influenced by selection bias, and, often the reason for performing either a neurolysis or neurectomy procedure has not been mentioned. To provide better insight into the effectiveness of these different surgical procedures for meralgia paresthetica we have set up a double blind randomized controlled trial comparing these two procedures, called the STOMP trial (Surgical Treatment Options for Meralgia Paresthetica). In this article the protocol for this trial is presented. In addition, we report the results for a prospective study on 22 consecutive patients, in whom either a neurolysis or neurectomy procedure was performed. Outcome in this study was assessed using the same measures that will be used in the STOMP trial.

2. Methods and materials

2.1. Prospective observational study

All patient that were referred to our outpatient clinic with idiopathic meralgia paresthetica between August 2012 and April 2014 were included for prospective analysis. The diagnosis was made clinically and supported by temporary relief of symptoms after injection of local anaesthetic (19 patients) and/or inter-side difference in sensory nerve action potentials (SNAPs) or of somatosensory evoked potentials (SSEPs) (8 patients). The patients needed to have symptoms for at least 3 months with failed conservative treatment. The various advantages and disadvantages of both the neurolysis and neurectomy procedure were discussed with the patient. The patient chose the type of treatment pre-operatively after informed consent had been given: neither was the decision made by the surgeon, nor was the patient's decision changed intra-operatively by the surgeon.

Table 1
Likert scale.

1	Complete recovery
2	Almost complete recovery
3	Some recovery
4	Unchanged
5	Some worsening
6	Serious worsening
7	Worse than ever

Table 2
Bothersomeness Index for pain and numbness (filled in for each separately).

	Not bothersome		Somewhat bothersome			Extremely bothersome	
	0	1	2	3	4	5	6
BSI pain or numbness							

All patients were operated and followed in the outpatient clinic six weeks postoperatively by one of the authors. Primary outcome was determined using the 7-point Likert scale (Table 1). Likert 1 and 2, respectively complete and almost complete recovery, were defined as a successful result.

Secondary outcome measures (pain intensity measured using the Numeric Rating Scale and Bothersomeness Index for pain and numbness, see Table 2) were also obtained by the surgeon during this visit.

2.2. Surgical procedures

Both the neurolysis and neurectomy procedure patients were performed through a small transverse incision made just below the anterior superior iliac spine (ASIS), parallel to the inguinal ligament. The nerve was identified in fat tissue medial to the sartorius muscle and followed proximally towards the inguinal ligament. In case of neurolysis, the inguinal ligament was incised over the nerve and the nerve was lifted to incise the iliac fascia under the nerve, to completely free the passage through the inguinal ligament. In case of neurectomy, the nerve was retracted a few centimetres out of the pelvis and transected as proximal as possible. Subsequently,

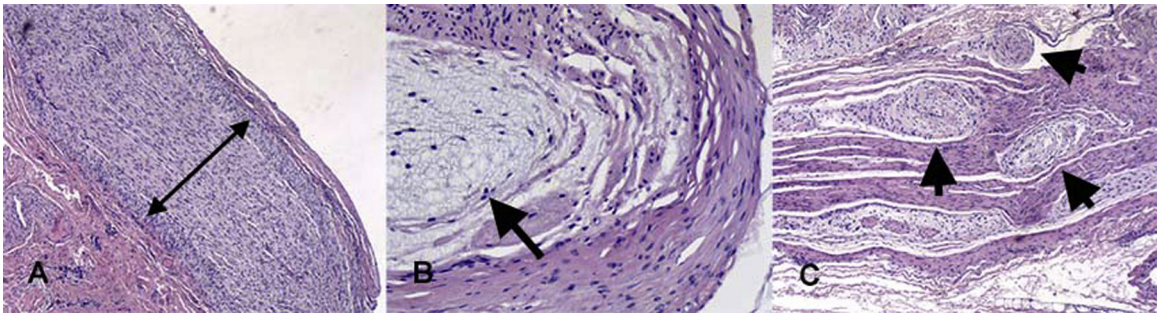

Fig. 2. Microscopic images of transverse (A and B) and longitudinal (C) sections taken through resected LFCN segments (H&E stain, magnification: A 4×, B and C 10×). (A) Thickened perineurium (between arrowheads), (B) mucoid deposition (pointed at by arrowhead), and (C) collagenous nodules between the nerve fascicles (pointed at by arrowheads).

a segment of the distal nerve was resected and subdivided into three parts that were sent for separate histopathologic analysis: (1) segment that was originally located proximal to inguinal ligament, (2) segment that was compressed at the inguinal ligament, and (3) segment distal to the inguinal ligament (Fig. 1).

2.3. Histological analysis

The site where the nerve exits the inguinal ligament was marked with ink to facilitate localization of different segments after pulling and transection of the nerve. After fixation in formalin the pieces were embedded in paraffin. Transverse and longitudinal sections were cut and stained with H&E. All slides were examined by the same neuropathologist for analysis of histological changes that are characteristic for chronic nerve compression: thickening of the perineurium, mucoid depositions, and collagenous nodules within the nerve fascicles (examples are presented in Fig. 2).

2.4. Statistical analysis

Difference in primary outcome (successful vs unsuccessful) and secondary outcome measures (NRS and BSI pain) between the neurolysis and neurectomy groups at 6 weeks was compared using the Mann–Whitney *U*-statistics (Software InStat by GraphPad). The same analysis was used for comparison of baseline characteristics between the two groups. In addition, paired analysis was performed for comparison of individual results before and after surgery with a Wilcoxon matched pairs test.

3. Results

3.1. Results of the prospective study

A total of 22 consecutive patients were operated because of persistent symptoms of meralgia paresthetica despite conservative therapy. Mean duration of symptoms was 3.9 years (±4.1 years, range 0.5–20 years). Fourteen patients chose the neurectomy procedure (one bilateral case) and 8 patients the neurolysis procedure. There were no significant differences in baseline characteristics between the two groups (Table 3). Although the mean duration of symptoms was slightly longer in the neurectomy group (4.6 years compared to 2.9 years in the neurolysis group), this did not reach statistical significance ($P = 0.0983$).

Successful pain reduction (scored as Likert 1 or 2) was observed in 3 out of 8 neurolysis cases (37.5%) and 14 out of 15 neurectomy cases (93.3%). This difference in primary outcome measures between the two surgical groups was statistically significant ($P = 0.0283$, see also Table 4). Scores for the secondary outcome measures (the NRS and the BSI for pain) were also better after the neurectomy procedure, although this difference was not statistically significant (respectively $P = 0.0683$ and 0.0542). Paired analysis of scores before and after the surgery however, did show an improvement in NRS and BSI pain after the neurectomy procedure (both $P = 0.0001$), while scores were not significantly different before and after the neurolysis procedure (respectively $P = 0.25$ and 0.125). Scores for BSI numbness after the neurectomy procedure were low (mean 1.4, SD ± 1.0, range 0–3). Re-operation was performed in 3 out of 5 failed cases of neurolysis at a mean interval of 5 months after the first surgery. Neurectomy resulted in complete pain relief in all three cases. The other 2 cases are still being followed in the outpatient clinic. There were no significant differences in baseline characteristics between the failed and successful cases of neurolysis, although the BMI tended to be slightly higher for the failed (28.8 ± 4.2) compared to the successful cases (24.1 ± 5.9) ($P = 0.25$).

Table 4
Results prospective cohort study.

Mean (±SD)	Neurolysis (8)	Neurectomy (14*)	*P*-value
Likert 1	2	10	*0.0283*
Likert 2	1	4	
Postop NRS	4.5 (±3.5)	1.5 (±2.6)	0.0683
Postop BSI pain	3.3 (±2.4)	0.9 (±1.8)	0.0542
Postop BSI numbness		1.4 (±1.0)	
Paired analysis (pre- versus postoperative)			
NRS neurolysis		0.2500	
NRS neurectomy		*0.0001*	
BSI pain neurolysis		0.1250	
BSI pain neurectomy		*0.0001*	

* 14 patients, one bilateral case, so a total of 15 neurectomy cases.

3.2. Histological analysis

Histological changes were observed in all neurectomy cases (including the 3 cases of reoperation after failed neurolysis), except for the one case in which neurectomy did not relief pain symptoms. In Fig. 2 examples of the three histopathologic changes that were observed are provided (thickening of the perineurium, mucoid depositions, and collagenous nodules between the nerve fascicles).

4. Discussion

4.1. Prospective study

The results of our prospective study confirm previous results reported in the literature in that pain reduction was more frequently observed after the neurectomy than after the neurolysis procedure. This is the first study however that has compared the effectiveness of these two procedures with standardized outcome measures, such as the Likert scale, Numeric Rating Scale (NRS) and Bothersomeness Index (BSI). The use of these scales not only makes it possible to compare the results after the different surgical procedures, but also to investigate outcome by comparison to preoperative scores. In this study we used the NRS instead of the

Table 3
Patient baseline characteristics.

Mean (±SD)	Neurolysis (8)	Neurectomy (14[a])	*P*-value
Age (years)	50 (±17)	59 (±14)	0.15
Male/female	5/3	9/5	0.97
Right/left	3/5	8/7	0.55
BMI	27.1 (±5.1)	31.8 (±5.6)	0.06
Duration symptoms (years)	2.9 (±2.2)	4.6 (±5.0)	0.0983
Preop NRS	7.0 (±1.8)	8.4 (±1.2)	0.0634
Preop BSI pain	5.1 (±1.4)	5.6 (±1.0)	0.7616

[a] 14 patients, one bilateral case, so a total of 15 neurectomy cases.

VAS, because this scale can be more easily obtained. In addition to the NRS, we used the Bothersomeness Index, an index that has been previously used for various pain syndromes including sciatica [8]. In our opinion this scale is especially useful to score the postoperative numbness in the neurectomy group. In our prospective study we did not score the BSI numbness in both groups, because patients were not blinded for the procedure, but in the STOMP trial, the scale will be applied in both groups. Additional advantage of the scale is that it can also be used to compare results to other pain studies such as the sciatica trial [9], although in sciatica the BSI is scored for three categories of symptoms (pain intensity, motor weakness and numbness) and in meralgia paresthetica obviously only two categories can be scored (pain and numbness).

Shortcoming of our prospective study obviously still is that patients were not randomized and blinded for the two surgical procedures. Instead, patients were asked preoperatively to decide on the type of surgical treatment after discussing the different advantages and disadvantages of the neurolysis and neurectomy procedures. One would expect that most patients initially choose for the neurolysis procedure, because of the disadvantage of numbness after the neurectomy procedure. However, in our prospective study most patients in fact chose the neurectomy procedure. This fact can be explained by a referral bias. After the publication of our retrospective study in 2012 [4], a number of patients with relatively severe and long duration of symptoms were referred to our clinic. It seems that these patients more frequently opted for the neurectomy procedure (see Table 3: although the baseline characteristics were not significantly different between the two groups, the mean duration of symptoms tended to be longer for the neurectomy group with also a higher mean NRS). Moreover, the same referral bias could also explain the relatively low percentage pain relief observed in this study after neurolysis (37.5%), compared to for example in our previous retrospective study (60%). Three out of five failed neurolysis cases had experienced symptoms for more than 4 years. A potential explanation for failure of neurolysis namely is that long duration of nerve compression leads to several intraneural changes that could be irreversible, as for example the collagenous nodules shown in Fig. 2. This influence of duration of symptoms will be further investigated in the STOMP trial (see protocol below). Although the possibility for the patient to decide on his or her own treatment may thus have affected the results of this prospective study, we believe that this bias cannot be completely resolved in a RCT, because the latter has the disadvantage that patients with a strong preference for either treatment will not participate in the trial, which also will result a selection bias. On the other hand, advantage of a RCT is that the results will not be affected by expectations of either treatment, because the patient is blinded for the procedure. In our prospective study these expectations could have influenced results (for example knowing that there is a lower chance on successful pain relief after the neurolysis procedure).

Other factors that might have influenced results of our prospective study are the body-mass index and sports activity. The reason that these factors might influence results is that the mechanism for nerve compression in these cases might be different from other idiopathic cases. As for BMI, in obese patients nerve compression might be caused indirectly by traction of the abdominal fat on the inguinal ligament. The explanation for this is that the abdominal fascia of Scarpa inserts onto the inguinal ligament [10]. This influence of BMI will be further investigated in the STOMP trial. Although the BMI in the group of failed neurolysis tended to be slightly higher than for the successful cases, this difference did not reach statistical significance.

Sports activity might influence results, because in these patients nerve injury might not be caused by direct compression, but by repetitive motion in the hip. This might lead to stretching of the nerve, analogous to the theory for nerve injury in ulnar neuropathy with flexion and extension of the elbow [10]. In the STOMP trial the above parameters will therefore be recorded.

4.2. Protocol STOMP trial

This trial has been approved by the Medical Ethical Committee (NL46074.098.13).

From April 1 2014 all patients with persistent symptoms of meralgia paresthetica that meet the inclusion and exclusion criteria listed in Table 5 will be asked to participate in the STOMP trial after discussion of advantages and disadvantages of both surgical procedures. Important inclusion criterium (as in our prospective study) is that the diagnosis has to be confirmed by either temporarily relief of symptoms after injection of local anaesthetic and/or interside difference in nerve conduction or somatosensory evoked potentials (SSEPs) of the LFCN.

The aim of this trial is to compare the effectiveness of the neurolysis and neurectomy procedure in a randomized double blind fashion. Surgery will be performed within 6 weeks after the first visit. A separate randomization list with envelopes for type of treatment (stating either 'neurolysis' or 'neurectomy') will be prepared for every participating centre. Variable sized blocks of random numbers are formed to ensure equal distribution of the randomization treatments over the various hospitals. Both the patient and the research nurse will be kept blinded for the allocated treatment for the total duration of one year. The surgeon will not know what type of surgery will be performed in which patient, until right before the surgery, when the surgeon opens the envelope. The following data

Table 5
inclusion and exclusion criteria for the STOMP trial.

Inclusion criteria	Exclusion criteria
• Age >18 years. • Diagnosis of resistant idiopathic meralgia paresthetica, which must include: ◦ Symptoms of a burning or tingling sensation in the anterolateral part of one or two thighs. ◦ At least 3 months of conservative treatment consisting of weight reduction (in case of overweight), avoiding wear of tight cloths, reducing repetitive motion (for example cycling), pain medication and local injection of corticosteroids. ◦ Preferably also electrophysiologic exam showing dysfunction of the lateral femoral cutaneous nerve and/or positive nerve block (local injection of lidocaine). • No abnormalities on MRI scan of the lumbar spine (f.e. no herniated disc) which could resemble symptoms of meralgia paresthetica. • Ability and willingness to comply with project requirements. • Written informed consent given by the subject.	• Previous surgery for meralgia paresthetica • Nerve root compression on MRI of the lumbar spine • Intra-abdominal lesion or previous abdominal surgery, including gynecologic surgery, surgery for inguinal herniation, hip surgery • No other previous trauma to the inguinal area, which may have caused symptoms of meralgia paresthetica, including fe seat-belt injury • Severe mental or psychiatric disorder • Inadequate Dutch or English language • Planned (e)migration abroad in the year after inclusion

from all the participating patients will be collected: date of birth, sex, body-mass index (BMI), nationality, highest education, profession, previous trauma, hobbies, sport and previous leg pain. Medical history, concomitant medication, weight and length will be collected as well. A general physical examination (cardiopulmonary, pulse, blood pressure) will be performed with abdominal palpation to exclude intrapelvic mass lesion. In case of doubt a sonography of the abdomen will be performed. Neurologic examination will focus on sensation in the anterolateral part of the thigh and will be graded as normal, hypesthesia, anaesthesia or dysesthesia. Finally, a MRI scan of the lumbar spine will be made to exclude lumbar nerve root compression.

Patients will be evaluated by the treating surgeon 6 weeks after the surgery. After that the patient will be contacted by the research nurse at 12, 26 and 52 weeks after the surgery. At every follow-up moment, the Likert score will be noted and the patient will be asked to fill in forms to score the VAS pain, BSI pain and BSI numbness.

Primary outcome measure is the Likert scale. Successful pain reduction (similarly to the prospective study) is defined as Likert 1 and 2. Our null-hypothesis is that the effect on pain relief after both the neurolysis and neurectomy procedure will be equal 3 months after the surgery. We choose this time-point, because after failure of neurolysis we wait for at least 3 months before offering a neurectomy procedure. After this time-point patients may thus have shifted from the neurolysis to the neurectomy group. We also did not choose the 6-week period, as in the prospective study, because at this time-point the patient scoring may be influenced by the visit to the treating surgeon in the outpatient clinic.

The sample size for our trial is based on the difference found in complete or partial pain relief (Likert scores 1–2) after both procedures in our retrospective study [4]: 60% for neurolysis vs 87.5% for the neurectomy procedure. Based on this difference (power 80%, alpha 5%) 78 patients in total will be needed. Because of a potential loss to follow-up (15%) we aim to include 90 patients.

In addition to difference in outcome between the two groups, subgroup analysis will be performed for duration of symptoms, BMI and sports activity. Our hypotheses are that (1) patients with symptoms for more than one year benefit less from neurolysis procedure than patients with symptoms less than one year, (2) patients with BMI > 30 have less benefit from a neurolysis procedure than patients with BMI < 30 and (3) patients with extreme sport activity/repetitive motion at the hip (>3 h per week of f.e. cycling) have less benefit from neurolysis procedure.

In the neurectomy group histological analysis will be performed similarly to the procedure described above for the prospective study. Moreover, intraneural changes will be quantified at the three different levels (proximal, at, and distal to the inguinal ligament). Results will be compared for the different subgroups mentioned above (related to duration of symptoms, BMI, and extreme sports activity).

5. Conclusions

This prospective study on outcome after neurolysis and neurectomy for idiopathic meralgia paresthetica confirms previous results from retrospective studies. The percentage successful pain relief after 6 weeks was significantly higher in the neurectomy than in the neurolysis group. A double blind RCT is needed to further investigate potential differences in effectiveness, especially for different subgroups based on duration of symptoms, BMI, and extreme sports activity. The protocol for such a trial was presented in this article.

Acknowledgements

This study was supported by a grant from the Landsteiner Institute in The Hague. Pathology was reviewed by Dr. Sjoerd van Duinen from the Leiden University Medical Center. The RCT will be performed together with research nurses (Joyce Videler-Pitlo and Lidwien Smakman-Hageman) from the Landsteiner Institute and the Spine Intervention Prognostic Study Group from Leiden – The Hague.

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