European Journal of Physical and Rehabilitation Medicine
EDIZIONI MINERVA MEDICA

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European Journal of Physical and Rehabilitation Medicine 2020 Mar 10
DOI: 10.23736/S1973-9087.20.06152-3

Article type: Original Article

Article first published online: March 10, 2020
Manuscript accepted: March 9, 2020
Manuscript revised: February 21, 2020
Manuscript received: December 21, 2019

Therapeutic exercise and radiofrequency in the rehabilitation project for hip osteoarthritis pain: a case series

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ABSTRACT

BACKGROUND: Severe hip osteoarthritis is responsible for disabling pain and functional impairment of the joint. Although total hip arthroplasty (THA) is a successful treatment, some patients have multiple comorbidities that represent contraindications for THA. Conventional drug therapies are often ineffective or responsible for numerous side effects. For these patients, it is difficult to draw up an acceptable rehabilitation path, as the main limitation is intense pain. New rehabilitation strategies need to be developed that relieve pain and improve articular function. The combination of traditional treatments such as education and therapeutic exercise with innovative, minimally-invasive therapies such as continuous radiofrequency (CRF) appears to reduce hip pain by determining the neurolysis of the joint.

AIM: The aim of our study was to describe the reduction in pain and improvements in joint function when CRF is combined with the therapeutic exercise in rehabilitation of patients with severe hip osteoarthritis.

DESIGN: Case series study.

SETTING: Rehabilitation service outpatients.

POPULATION: Twenty-five patients with severe hip osteoarthritis causing disabling pain and with contraindications to THA, and for whom conventional drug therapies were ineffective or responsible for numerous side effects.

METHODS: The study design included: initial clinical-functional assessment using the Harris Hip Score (HHS), the Numeric Rating Scale (NRS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC); a pre-lesion anaesthetic block; hip neuroablation with CRF; a three-week kinesitherapy protocol (3 sessions per week); two further assessments using the same scales one month (T1) and six months (T2) after CRF.

RESULTS: Improvements at T1 and T2 follow-ups, after CRF (p=0.000) were recorded for articular pain and function. However, results at T2 were worse than those at T1 (p=0.000).

CONCLUSIONS: CRF combined with therapeutic exercise in rehabilitation of severe hip osteoarthritis is an attractive option for significant pain relief as it allows patients to carry out kinesitherapy more easily.

CLINICAL REHABILITATION IMPACT: CRF could represent a valid alternative in the rehabilitation of patients with severe hip osteoarthritis especially when other therapeutic approaches are unworkable.

Key words: hip joint pain - hip osteoarthritis – hip joint denervation - lesioning radiofrequency – hip rehabilitation

Introduction

Severe hip osteoarthritis is one of the main causes of disabling pain, functional impairment and reduced quality of life in elderly patients[1]. This pathology is increasingly becoming widespread even in younger patients, aged under 65[2]. Total hip arthroplasty (THA) represents a successful therapeutic measure[3], which guarantees excellent clinical and functional results both in elderly[1] and in younger patients, a high percentage of whom are able to resume regular work and sport activities after undergoing the treatment[4,5]. However, some patients have multiple comorbidities that are contraindications to THA, and conventional drug therapies prove ineffective or are responsible for numerous side effects[6]. For these patients, the percutaneous continuous radiofrequency (CRF), consisting in the thermal ablation of the sensitive branches of the femoral nerve and of the obturator nerve[7], represents a valid therapeutic option.

The hip joint is innervated by the articular branches of the obturator nerve in its anteromedial portion, by the articular branches of the femoral nerve anteriorly, by the articular branches of the sciatic nerve posteromedially and by the articular branches of the gluteus nerve posterolaterally[7]. Patients with hip osteoarthritis may therefore experience pain in the inguinal, crural, trochanteric or gluteal region. However, the most frequently reported symptom is inguinal pain, which is attributed to the sensitive branches of the obturator nerve[8], while the sensory component of the femoral nerve is responsible for trochanteric pain.

In patients with symptomatic hip osteoarthritis, for whom the surgical procedure is contraindicated due to the presence of comorbidities, the hip neurolysis with CRF represents a form of pain therapy with which to start an individual rehabilitation project, which also aims at the improvement of joint function[9].

The aim of our study is to describe the effects of the combined treatment with CRF and kinesitherapy in order to reduce pain and improve the functionality of the hip joint in patients with severe hip osteoarthritis.

Materials and methods

The study model is that of a case series. The study design included an initial clinical-functional evaluation by the Harris Hip Score (HHS)[10], the Numeric Rating Scale (NRS)[11] and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[12]; the execution of a pre-lesion anaesthetic block; the hip neuroablation with CRF; a three-week rehabilitative kinesitherapy protocol (3 sessions per week); two further evaluations, by the same scales used in the initial evaluation, after a month and six months respectively from the radiofrequency procedure (figure 1).

The recruitment took place at Humanitas Gradenigo of Turin –Department of Rehabilitation Sciences, in the period between February 2008 and October 2014. Patients with severe hip osteoarthritis, inoperable and responsible for disabling pain were enrolled. All procedures conformed to the World Medical Association Declaration of Helsinki. Each patient provided written informed consent. The inclusion criteria were the following: grade III and IV of hip osteoarthritis according to the radiographic classification of Kellgren-Lawrence[13,14]; presence of contraindications to THA intervention, namely, the comorbidities shown in figure 2; age under 85, so as the rehabilitation program is joined more easily[15]; ability to walk and perform simple physical exercises; severe pain in the trochanteric and/or inguinal region; poor tolerance to pain medication or poor efficacy; no rehabilitative and infiltrative hip treatments in the previous 3 months; good response to the block test of the sensitive articular branches of the femoral and obturator nerve. The exclusion criteria were: the presence of septic or autoimmune inflammatory processes; coagulopathies; the presence of electrotherapeutic devices (pacemaker, medullary stimulator, cochlear implant); the presence of cognitive impairment. The anaesthetic block was performed under fluoroscopic guidance by inoculating 5-7 ml of ropivacaine hydrochloride (10 mg/ml) in each of the two landmarks, corresponding to the sensitive articular branches of the two aforementioned nerves, following the same radiofrequency denervation technique described below. The response to the test was considered positive if the patients showed an immediate relief from pain, with reappearance after anaesthetic effect exhaustion. The neuroablation via CRF was performed after 3-5 days from the block test. The procedure requires the patient to be placed on the back of the operating table; the femoral artery is palpated and the sterile field is prepared with iodine solution, at the hip joint being treated. To reach the sensory branch of the femoral nerve, the spinal needle-cannula (21 Gauge, 3.5 IN) is inserted under fluoroscopic guidance with an anterolateral approach, below the anterior-superior iliac spine, so as to reach the anterolateral region of the acetabular rim. For the injury of the sensory branch of the obturator nerve, the needle-cannula is inserted laterally to the femoral artery, below the level of the inguinal ligament, at an angle of about 70°, to reach the lower portion of the ischio-pubic junction; the target for the needle-electrode is close to the anteromedial part of the extra-articular portion of the joint (the anteroposterior radiographic image of this district is similar to a drop) (figure 3 and 4). A 22 Gauge electrode (Baylis Medical Company Inc., Montreal, Quebec, Canada), with an exposed tip of 5 mm, was used for the denervation of each of the two sensitive branches, using the radiofrequency current generator (Baylis Medical Company Inc.). Before denervation, an electrical stimulation is performed to verify the correct achievement of each of the two nerves that make up the target. Firstly, a sensory stimulation at 50 Hz up to 0.7 V is performed, eliciting paraesthesia and inguinal and trochanteric pain similar to those usually perceived by the patient. Then, an increasing motor stimulation is carried out at 2 Hz up to 0.9 V, in order to exclude that motor nerve branches are involved. This would cause muscular contractions. Once the correct positioning has been established, each of the two target nerves is inoculated with 1 cc of 10% lidocaine, and subsequently thermocoagulation with radiofrequency at 80° for 90 seconds is performed. The procedure was carried out by a physiatrist with ten years of experience in the use of CRF.

All patients were initiated into an individual rehabilitation protocol within 3-7 days from the CRF procedure. The program included three weekly individual sessions of therapeutic exercise for three consecutive weeks. They consisted of:

- Passive and active joint mobilization exercises in order to improve the joint excursion;

- Reinforcement exercises of pelvic girdle muscles;
- gait training;
- Proprioceptive and postural exercises.

Furthermore, all patients were informed about hip osteoarthritis and educated to the behavioural rules to be adopted in order to optimize and prolong treatment results[9] over time.

In the six months following radiofrequency, patients were allowed to take paracetamol as needed (maximum 3 g/day) and were asked to report the frequency and dosage on an intake diary.

Patients were evaluated by means of the NRS, HHS and WOMAC scales. These evaluations were carried out before the radiofrequency procedure of the hip (T0), after one month (i.e. at the end of the kinesitherapy cycle -T1) and after six months (T2). Due to the reduced sample size (n <30), only non-parametric tests were used; in order to compare categorical gender variables, the Wilcoxon rank sum test was used; the Friedman test was used to compare the same variables in multiple times, and the Wilcoxon signed rank test to compare them between single timings. To evaluate the association between NRS, HHP and WOMAC at T1 and the respective variable at T0, the treated hip side, BMI, gender and age, the correlation by Spearman ranks was used; Spearman's rho has been indicated, calculating the 95% confidence interval using bootstrap. For all tests, a value of p <0.05 was considered significant.

Results

The study sample consists of 25 subjects treated, the 18/25 (72.0%) of which are of female gender, with an average age of 74.8 ± 10.7 years (range = 50.0 - 85.0). The average weight of the sample is 77.7 ± 29.3 kg (range = 42.0 – 160.0), the average height is 164 ± 95.3 cm (range = 150.0 – 184.0), the BMI average value is 28.4 ± 8.0 (range = 18.7 – 47.3). For all subjects there was evidence of one or more comorbidities, as described in figure 2.

A total of 28 hip were treated, as three patients were treated for both; 18/28 (64.3%) of these were right hips. A statistically significant difference is observed when comparing the values of NRS, HHP and WOMAC between detection times (p<0.05; table I, figures 5, 6, 7). The comparison of variables between individual times is described in table II and there is a statistically significant difference (p<0.05).

From Spearman analysis, it is possible to observe a statistically significant association between:

- HHP value at T1 and value of HHP at T0 (rho = 0.4; 95% CI = 0.2 - 0.6; p = 0.016)

- WOMAC value at T1 and:

- WOMAC value at T0 (rho = 0.6; 95% CI = 0.5 - 0.7; p = 0.002)

- BMI (rho = -0.4; 95% CI = -0.6 - 0.2; p = 0.042).

No adverse effects have been reported resulting from the procedure. From the analysis of analgesic intake diaries in six months following the neuroablation procedure with CRF, only an extemporaneous intake emerged, which settled on an average of 2 g/week.

Discussion

According to our knowledge, this is the first study that analyses the combined effect of a minimally invasive percutaneous procedure such as CRF and the therapeutic exercise in the rehabilitation of severe inoperable hip osteoarthritis. We chose to perform CRF before rehabilitation just to take advantage of the immediate reduction of pain it guarantees for the treated joint. This allows patients to overcome the permanent motor limitations associated with the pain that osteoarthritis causes to active and passive mobilization of the hip. The sample of our study is certainly small, but the researches on radiofrequencies of hip already published have sample sizes mostly below 25 cases[16]. This happens because the clinical indications for performing radiofrequency are extremely selective (as already mentioned, we enrolled patients who cannot undergo hip replacement and who cannot tolerate/have benefits from long therapies with common pain medication). For the same reason, our recruitment period was very long, if compared to the final number of enrolled patients. Compared to T0, we observed an improvement in all outcome measures after one month (T1) and six months (T2) from treatment. Therefore, both pain reduction and functional improvement of the treated hip were observed. CRF determines a sensory denervation of the joint, leading to a reduction of pain caused by osteoarthritis, as already demonstrated in the literature[16,17]. Although the precise mechanism of action has not yet been clarified, CRF is used as a neurolysis procedure through thermocoagulation[18]. The high frequency alternating current moves from the electrode into the surrounding tissue, causing the oscillation of the ions and consequently the production of heat, which involves a coagulated necrosis of the affected cells[19]. Additionally, CRF produces a local electrical field which is thought to promote neuromodulation by inhibiting the excitatory c-fibre[20,21] which is one of the mechanisms through which pulsed radiofrequency (PRF) induces pain relief, as explained also by Ewertowska et al in a recent article dating back to 2018[22]. Indeed, PRF involves lower temperatures (below 42–44°C), which is considered to be the limit value at which no thermally induced necrosis is observed[23,24]. Different effects of exposure to PRF electrical fields have already been reported. Some studies have revealed evidence of morphological changes in the neuronal cells that affect the inner structures of axons, after PRF treatment[25,26,27,28]. These structural changes consist of mitochondria swelling and disruption of the normal organization of the microtubules and microfilaments, which preferentially affect C-fibers and to a lesser extent Aδ fibers. In addition, transient ultra-structural changes such as endoneurial oedema and collagen deposition have also been found[29]. Besides structural changes, the effects on cellular activity and gene expression have also been observed[30,31], as well as an increase in the expression of inflammatory proteins[28]. All these effects could potentially inhibit the transmission of nerve signals through C-fibers, which would lead to pain relief[32]. We chose to use CRF instead of PRF because, according to the existing literature, CRF provides greater improvements in long-term outcomes referred to relief of pain and increase of joint function[33].

The antalgic effect of CRF is not permanent, as the injured nerve branches tend to regenerate progressively due to the sprouting phenomenon starting from the basal lamina of Schwann cells[20, 34, 35]. The duration of this effect is therefore variable. In a review of Bhatia et al (2018), 14 publications were analysed: all reported reduction in pain following RF procedures, although with significant variation in the length of follow-up, which ranged from 8 days to 3 years[36]. On the other hand, these are minimally invasive techniques that require extreme precision in reaching the anatomical targets in order to obtain long-lasting and reproducible antalgic effects in all patients. However, an average duration ranging from 6 and 12 months emerges, in line with our results. The rehabilitation of the hip osteoarthritis is based on several principles. Among these, education and patient information represent the core treatment[37]. The therapeutic exercise, aimed at recovering the joint motion range and at proper muscle reactivation, guarantees good results not only in terms of pain control but also and particularly in terms of joint function, which is then implemented by rehabilitation[38]. The current guidelines for the rehabilitation of the hip osteoarthritis of the Veteran's Affairs/Department of Defence and of the National Health Medical Research Council recommend therapeutic exercise and muscle strengthening with B-level of evidence[39,40]; the same rehabilitation procedures are similarly recommended by the guidelines developed by the American College of Rheumatology and by the European League Against Rheumatism with a strong level of evidence[41,42]. The recorded improvement in the outcomes compared to T0 is also confirmed after a six-month follow-up, although in this last evaluation an overall decrease is visible, compared to T1. Such decrease is attributable to the interruption of the rehabilitation treatment, in combination with the likely reversibility of the pain reduction effect obtained by CRF, resulting in a restoration of the initial impairment due to the algic-functional picture induced by hip osteoarthritis. Therefore, it would be desirable for patients with hip osteoarthritis cyclically undergo therapies aimed at counteracting their clinical effects. On the other hand, the purpose of the rehabilitation of osteoarthritis in general is precisely that of preventing the motor and functional degradation to which this joint degeneration would lead, and the cyclical nature of the treatments is necessary to oppose this progression, or at least to slow it down. We must ask ourselves whether to program the cyclic repetition of the treatment is also useful for the CRF, as it is for kinesitherapy. With regard to this possibility, the currently available data in the literature are too scarce. However, based on small case series evaluating serial RF ablation procedures on the lumbar and cervical facet joints, more than 80% of patients who undergo repeated denervation will experience similar benefit[43, 44, 45]. However, on the basis of the data available, it is not possible to demonstrate the effectiveness of repeat hip RF ablation, and further studies are needed[17]. The study cannot establish which between CRF and kinesitherapy affects the improvement of pain and joint function, nor was it the scope of the present researchers. Nevertheless, it is possible to affirm that the two treatments complement each other, since the pain reduction obtained after CRF allows the patient to have access to a range of exercises that improve joint function, which are more easily performed, due to a "reduced algic load", compared to the baseline. In this perspective, CRF is no longer just a palliative pain therapy, but it is part of a complex and individualized rehabilitative path that amplifies its effectiveness. The results also showed that patients with a higher score on the HHS and WOMAC scales at T0 achieved better results on the same scales at T1. This suggests that pre-CRF rehabilitation sessions may be useful to improve joint function and to achieve better results in post-treatment follow-up. Finally, better results were achieved on WOMAC at T1 by patients presenting a lower BMI at T0, which demonstrates the importance of educating patients to the correct life style[37].

Limitations of the study

The study is not free from limitations. The sample size is small, even if it supports the extension of the data available to researchers in this interesting field, still little beaten. Furthermore, the follow-up period does not exceed six months, and therefore for future studies it is desirable to monitor the duration of the effect, with longer follow-up periods.

Conclusions

In conclusion, the CRF procedure for the control of pain in hip osteoarthritis has proven to be a selective antalgic rehabilitative technique, also well tolerated by patients. Therefore, we can affirm that the combined treatment with CRF and therapeutic exercise in rehabilitation of patients with severe hip osteoarthritis offers a valid opportunity when other therapeutic solutions are not workable. This CRF can be considered as the first phase of an individual rehabilitation project for this type of patient.

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NOTES

Conflicts of interest. The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript

Funding. This research did not receive any funding

Authors' contributions. CM, GF and CC were responsible for setting up the study, acquiring the data and writing the manuscript. MM, FPB, FP and PF contributed in analyzing the data and editing/reviewing the manuscript.

Acknowledgements. none

TABLES

Table I. Mean ± standard deviation and range of the variables NRS, HHP e WOMAC, per detection time.

	T0	T1	T2	Fr	P
NRS	8.3±0.5 (7.0 – 9.0)	3.9±2.0 (1.0 – 8.0)	4.9±2.1 (1.0 – 9.0)	48.4	0.007
HHP	25.1±7.8 (12.0 – 50.8)	52.4±15.1 (22.0 – 75.0)	44.5±14.7 (20.0 – 72.1)	57.4	0.001
WOMAC	27.9±7.2 (16.0 – 52.3)	54.1±13.3 (26.0 – 74.8)	47.8±12.8 (23.5 – 69.0)	60.0	0.000

Table II. Comparison between single times of the variables NRS, HHP e WOMAC.

	T0 vs T1	T0 vs T2	T1 vs T2
NRS	z=4.6; p=0.000	z=4.6; p=0.000	z=4.2; p=0.000
HHP	z=4.6; p=0.000	z=4.6; p=0.000	z=4.6; p=0.000
WOMAC	z=4.6; p=0.000	z=4.6; p=0.000	z=4.5; p=0.000

TITLES OF FIGURES

Figure 1. Study design

Figure 2. Prevalence (%) of comorbidity, per single condition.

Figure 3. Anatomical targets of hip CRF

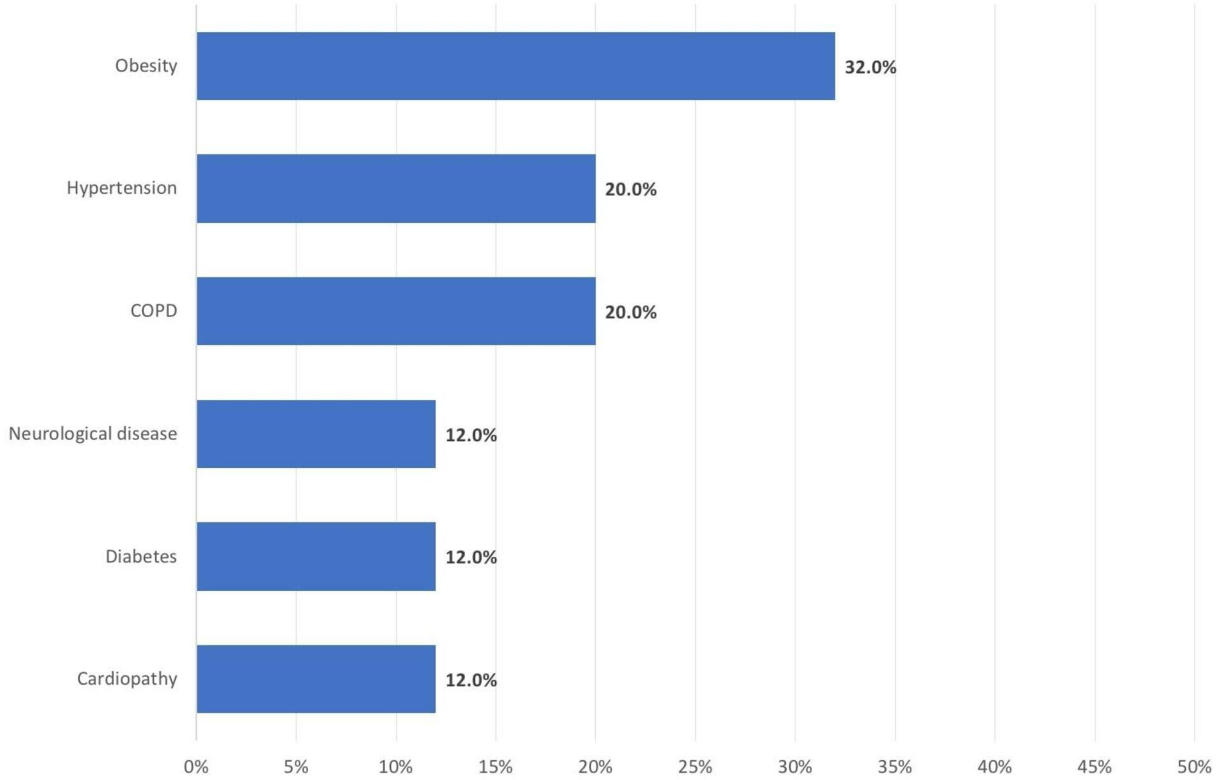
Figure 4. Radiographical vision of hip CRF

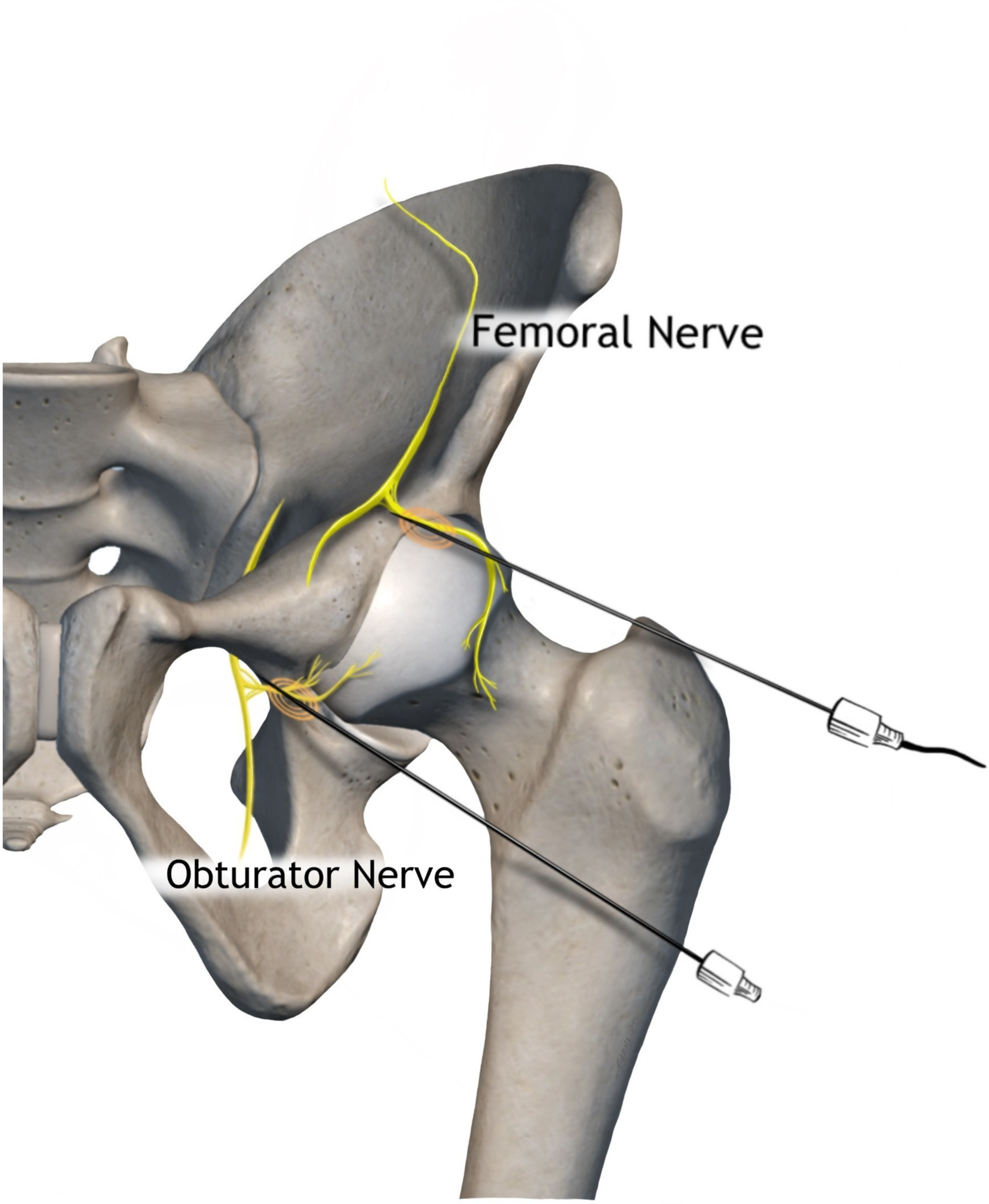
Figure 5. Median, IQ range and range of the variable NRS, per detection time.

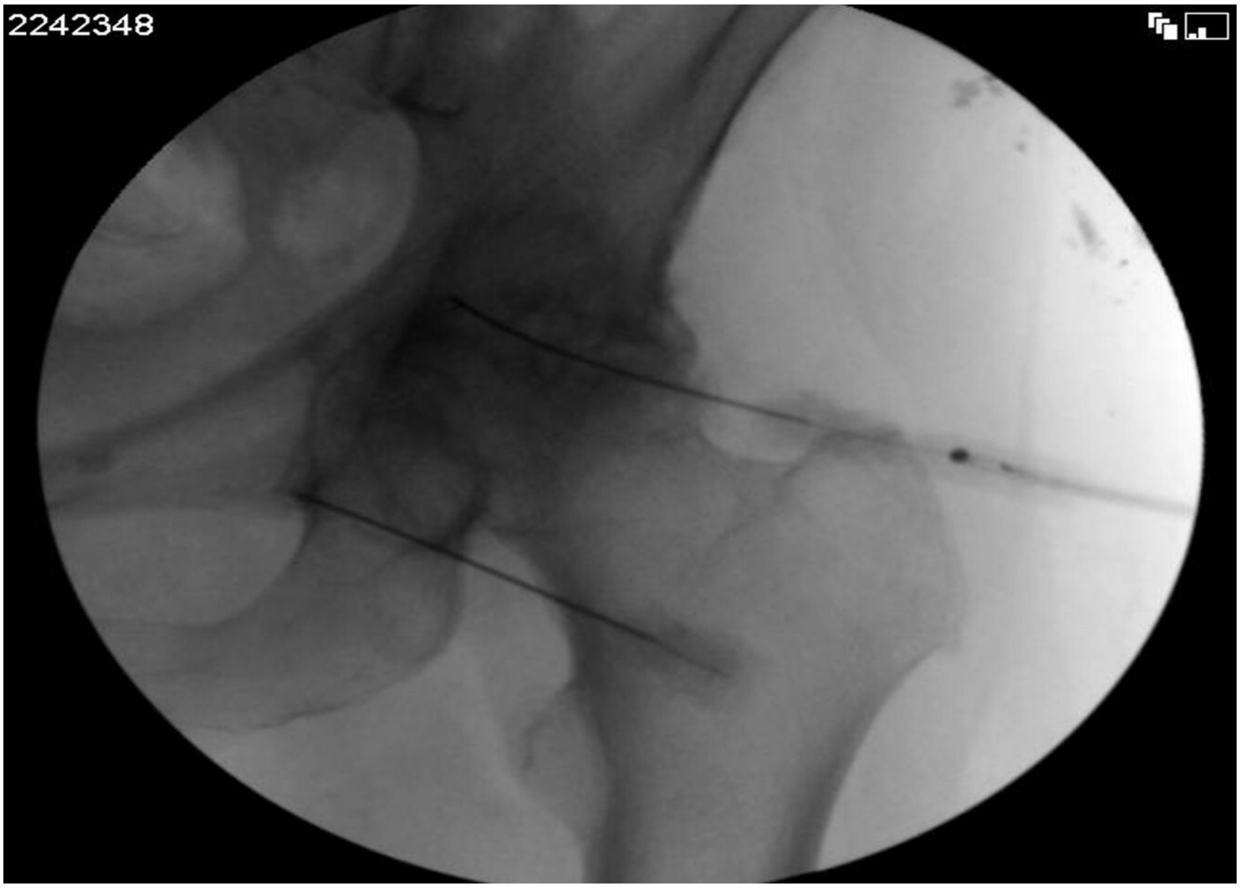
Figure 6. Median, IQ range and range of the variable HHP, per detection time.

Figure 7. Median, IQ range and range of the variable WOMAC, per detection time.


3 weeks
1 month
after CRF
6 month
after CRF
T 0
T 1
T 2
I evaluation
Block
test
Hip
CRF
Rehabilitation
II evaluation
III evaluation


Obesity
32.0%
Hypertension
20.0%
COPD
20.0%
Neurological disease
12.0%
Diabetes
12.0%
Cardiopathy
12.0%
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%


Femoral Nerve
Obturator Nerve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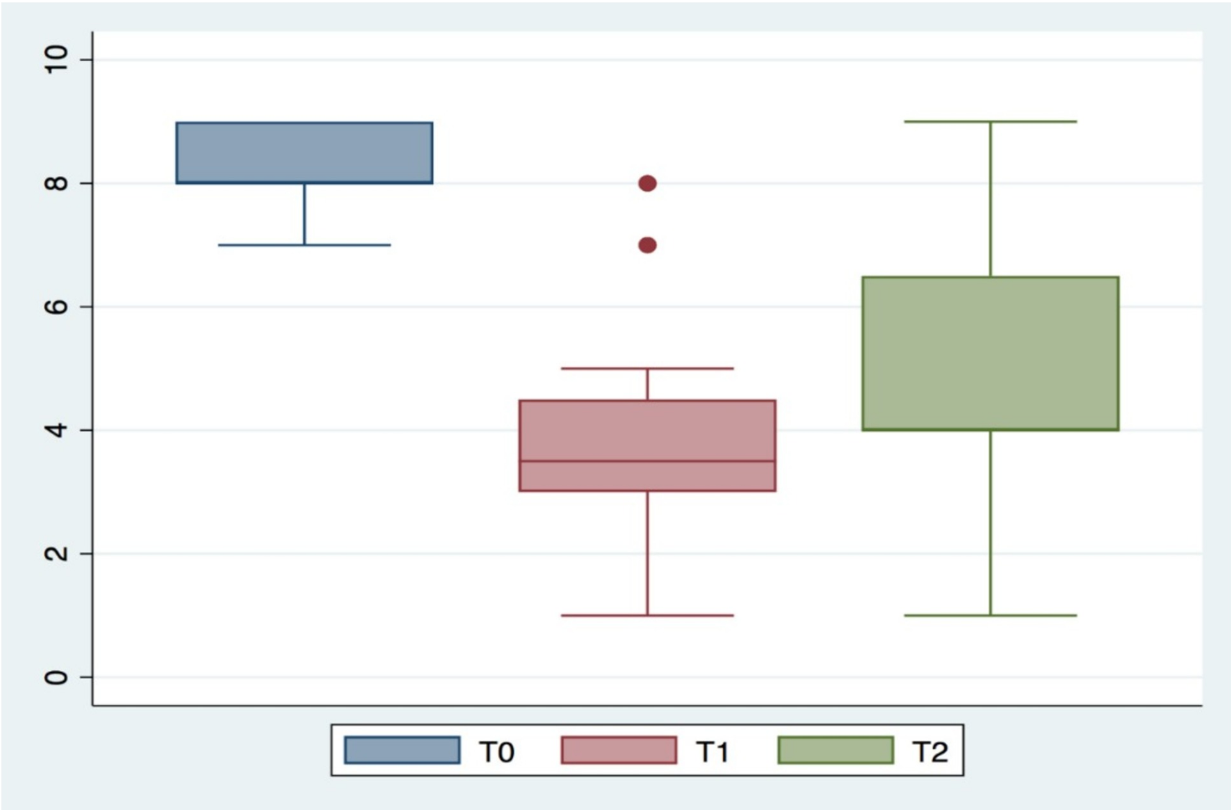
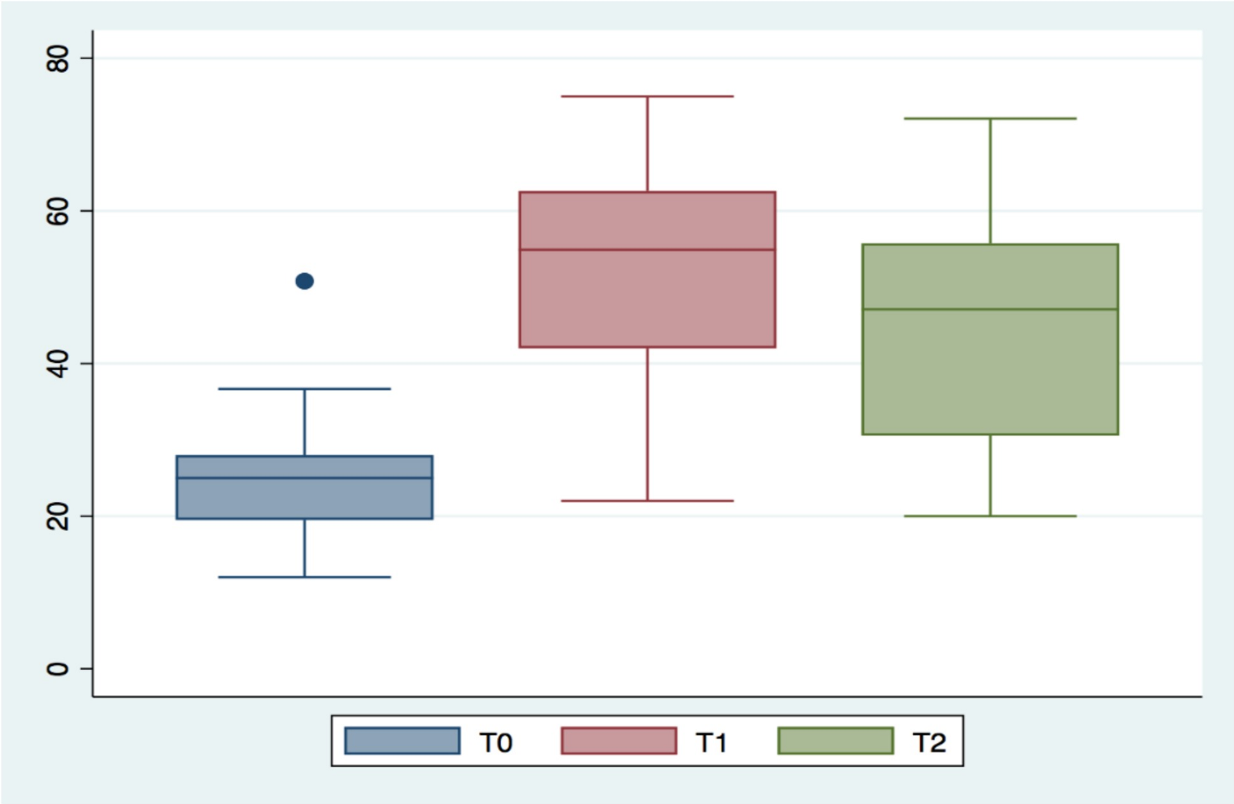
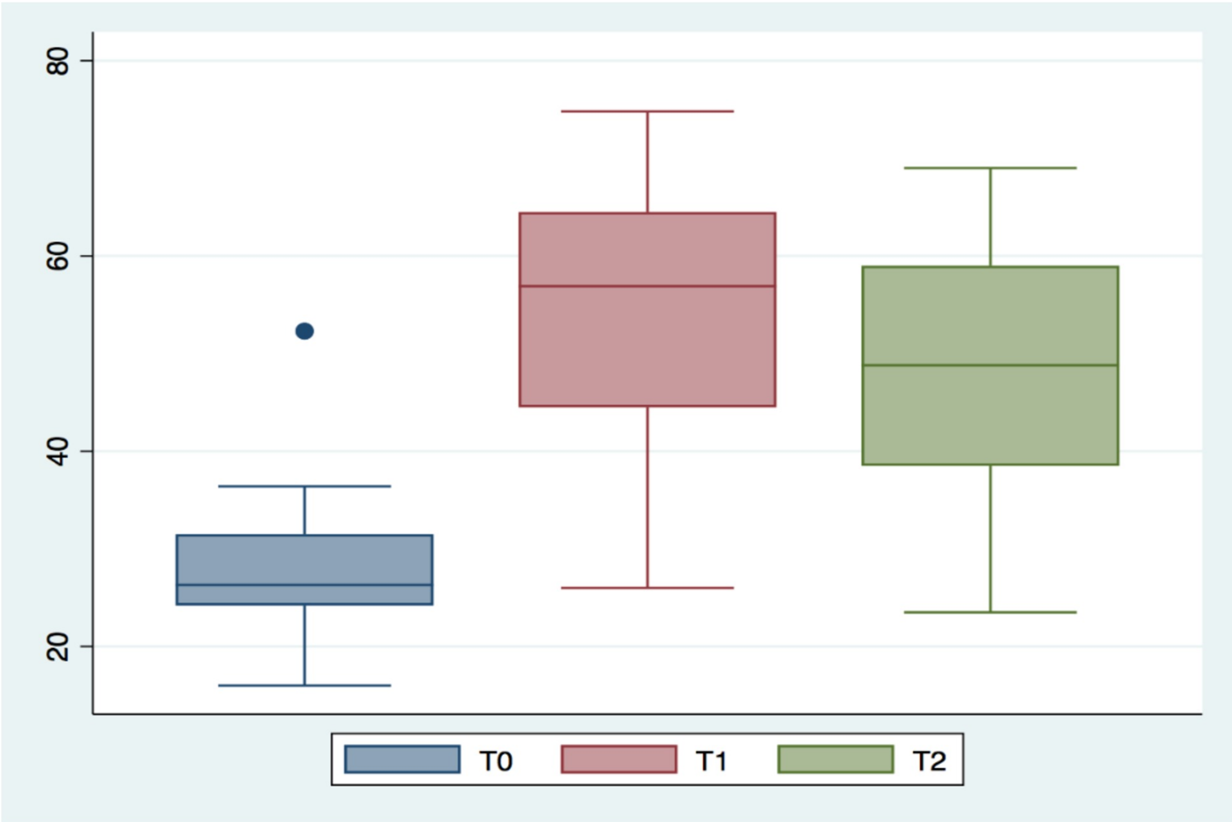

0
2
4
6
8
10
T0
T1
T2


80
60
40
20
0
T0
T1
T2


80
60
40
20
T0
T1
T2