Application Of Knee Continuous Passive Motion Device After Total Endoprosthesis – Does Speed Of Continuous Passive Motion Device Influence The Therapeutic Effect?

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SUMMARY

Background: Continuous passive motion (CPM) therapy is a method of choice especially after implantation of total knee or hip joint replacement. It is the application of continuous passive motion on the affected limb.

Objective: Verification of the CPM device velocity for therapeutic effect. Particular range of motion and subjective perception of pain (at rest).

Methods: The therapy was performed with 50 randomly selected patients following arthroplasty of the knee joint in the form of prosthesis. Patients received 10 therapies, 5 times per week, for 20 minutes according to the doctor’s prescription. 26 patients completed therapy on the BTL device, 24 on Ormed device. To determine the range of motion we used SFTR method. We used the combination of Visual Analog Scale (VAS) and Verbal Numerical Rating Scale (VNRS) to determine the analgesic effect.

Results: Increased range of motion and pain reduction was significant in both groups. A greater range of motion (on average 20%) and pain reduction (average 15%) in patients was reached with the BTL-CPMotion device. 2 patients were excluded from the study.

Conclusion: We have demonstrated the positive impact of higher CPM speed on increasing range of motion in the knee joint and reducing pain.

Keywords: CPM, passive motion, range of motion, knee joint.

INTRODUCTION

Continuous Passive Motion (CPM) therapy is used in therapy of lower and upper limbs. Most common indication is post-arthroplasty states of major joints using endoprosthesis and knee cruciate ligaments plastic reconstruction. For purpose of this study we focus only on states after arthroplasty of the knee joint using total endoprosthesis. Taken into account that the range of motion limitation is a major complication after surgery and commonly also a condition for release from the hospital, it is in place to search for solutions that speed up increase of range of motion. So far there has been no study published focusing on the influence of speed of different CPM devices (meaning various manufacturers) on the effect of the therapy. We have estimated a working hypothesis that the higher speed of CPM the better therapeutic results we get in comparison with slower devices.

Several studies focus on financial effect of CPM use (16, 24), effect on the chondrocyte metabolism (18, 22), comparison of conservative physiotherapy with and without the use of CPM devices (11, 12, 25). Systematic reviews can also be found (3, 7, 17) specifically on the effectiveness of CPM device use and other.
APPLICATION IN MEDICINE

Since the 1970’s the biological effect of the CPM on joint cartilage has been researched (22, 23). The development of the very first CPM designed for people in year 1978 included participation of Robert Bruce Salter (21), famous Canadian professor and orthopedist. CPM therapy has since then become an essential part of mainly orthopedic departments and curative rehabilitation departments. As has been already mentioned, very common indication is post-arthroplasty states of knee joint using total endoprosthesis. For example Bennet et al. researched different settings of the CPM and its effect on the range of flexion of the knee joint (2). Another study shows increase of range of motion and decrease of pain (8). From other indications a study focusing on the effects of CPM after anterior cruciate ligament reconstruction – using grafts from the patellar ligament (13,14). Faso and Stills (6) present an interesting article about incorporation of the CPM device into the therapy after orthopedic surgeries.

From OECD statistics (20) we can see that in the year 2012 there has been 1,000,000 knee replacements among the population of EU. Almost 154,000 of replacements of the knee or hip joint in year 2011 in Germany (26), in Canada almost 50,000 knee replacements and nearly 60,000 hip replacement (5). These numbers increase year by year and in terms of demographic development in the future we can expect that post-surgery rehabilitation using CPM will be utilized more.

INFLUENCE OF PASSIVE MOTION ON PAIN DECREASE AND CONSEQUENT RANGE OF MOTION INCREASE

Perceptions perceived primarily by free nerve endings, which are diffusely distributed in skin over the whole body, are transferred through non-myelinated C fibers into the posterior horns of the spinal cord. Here they are connected into spinothalamic pathways at interneurons. Spinothalamic pathways lead painful information into the thalamic nuclei of the brain. This process though is considered ideal as on the level of the posterior horns of the spinal cord we encounter a competitive relation between not only nociceptive information, but all the somatosensitive information from other extero-, proprio- and interoreceptors. Number of information from these other receptors is carried by myelinated fibers, which can come into the posterior horns of the spinal cord earlier than nonciceptive information and hence block its entrance into the central nervous system. If the information is restricted from entering it is not further evaluated. This mechanism was described by the gate control theory, which explains pain reduction by competitive relationship on the spinal and thalamic level, where emotional relationships enter the process management (10).

From the above mentioned perspective, it’s clear, that heightened afferent flow of information during movement will lower the amount of painful perceptions already on the spinal level (10).

METHODS

Methodology

Two knee CPM devices from different manufacturers were used for the therapy (BTL-CPMotion K PRO, manufacturer BTL Industries Ltd. and Artromot K1 from Ormed). Effectiveness of the therapy was evaluated in Mělník Hospital at the in-patient rehabilitation department. Mělník Hospital is accredited as an educational department of the Ministry of Health in the field of rehabilitation and physical medicine. It also collaborates with the Clinic of Therapeutic Rehabilitation and Rehabilitation Clinic of the Faculty Hospital Motol.

Experimental group

The study was conducted from the 1st of October 2015 to the 30th of October 2015 on randomly selected patients after knee arthroplasty by total endoprosthesis. Patients were randomly divided into two groups, one of which was treated with CPMotion K PRO (Group 1) and the second with Artromot K1 (Group 2). We didn’t compare the effect with a control group treated with placebo or other type of physical therapy. Before the therapy, we carefully took the patients’ history with regard to the contraindications and carefully conducted clinical entrance examination according to the standard of the clinic. The inclusion criteria were as follows: age over 50 years, diagnosed gonarthrosis of the 4th type, X-ray classification according to Kellgren-Lawrence, non-infection,
Data collection

Range of motion was recorded by SFMR into the patient’s log. Pain was evaluated by patients’ subjective statement before each therapy. Values were recorded in the patient’s protocol.

Data analysis

The analysis was performed by calculating the mean and median values of individual data sets. Range of motion in the joint was divided into active and passive values. Overall range of motion increase in all therapies and following each therapy was observed. Besides the above-mentioned values of pain, its average decline, average number of therapies performed and an overall decrease in pain on the entire sample of patients was measured.

RESULTS

A total of 490 therapies were performed on 50 patients. After excluding 2 patients who received less than 10 therapies, the total number of therapies reduced to 480.

The variance between minimum and maximum active range of motion in flexion of the knee before the first and after the last therapy for Group 1 was on average 44.83 ° and for Group 2 on average 21.66 ° (see graph 1 and 2).
The variance between minimum and maximum passive range of motion in flexion of the knee before the first and after the last therapy for Group 1 was on average 38.30° and for Group 2 on average 20.87° (see graph 2).

The variance between minimum and maximum value set on the CPM to move into flexion of the knee before the first and after the last therapy for Group 1 was on average 36.83° and for Group 2 on average 22.83° (see graph 2).

The variance between minimum and maximum range of motion for active, passive and CPM device motion in flexion of the knee before the first and after the last therapy was for Group 1 average of 4.66 and a Group 2 average of 3.33 (see graph 3).
Overall average pain value before the first therapy for both groups was 5.92 (median 5), the total percentage of average decrease in pain after the last therapy for Group 1 was 77.50%, for Group 2 62.5% (see table 1). None of the patients was impaired. Besides decrease in pain and increase in range of motion and we observed regression of edema and improvement of scar shifting.

<table>
<thead>
<tr>
<th></th>
<th>CP Motion K Pro</th>
<th>Artromot K1</th>
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<tbody>
<tr>
<td>( \bar{x} ) pain before the first therapy</td>
<td>6.16</td>
<td>5.33</td>
</tr>
<tr>
<td>( \bar{x} ) pain after the last therapy</td>
<td>1.50</td>
<td>2.00</td>
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<tr>
<td>% decrease in pain</td>
<td>75.65</td>
<td>62.48</td>
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Tab. 1: Comparison average decrease in pain according VNRS before the first and after the last therapy.

DISCUSSION

In this pilot study comparing the effect of CPM speed to increase range of motion and reduce pain in shorter time we have confirmed our working hypothesis. Improved range of motion and analgesic effect were observed in most patients. During therapy, which lasted two weeks, there was an increase in range of both active and passive range of motion and a linear decrease of pain in all patients.

In both groups, the speed of the CPM was set to maximum. For Group 1 380°/min, for Group 2 210°/min. In study by Johnson and Eastwood (11) they worked with a CPM with maximum speed of 155°/min. Unlike our study, however, they did not address the speed setting of the CPM and therapy time was different from our standard. We have demonstrated the positive effect of the CPM therapy compared with immobilization. CPM speed impact on therapeutic effect is also being investigated by a team from the Faculty of Physical Education and Sport. The pre-testing in 28 healthy subjects (age 22-24) shows that the highest speed (in this study, 525°/min) is seen in all tested subjects as subjectively most pleasant. The test speed is approximately 27% higher than the speed of the CPM in Group 1 in our study. However, it was tested on healthy subjects. It can therefore be assumed that in Group 1 the top speed is fully sufficient. Conversely speeds approaching 200°/min were subjectively perceived as the least pleasant. It can therefore be assumed that the therapeutic effect will be worse in Group 2 due to the very slow movement of the CPM compared to the one in Group 1, in which the CPM ran at higher speeds. This is what we confirmed in this study. Wasilevski (25) compared CPM therapy with active-assisted exercise. In the CPM treated group result amounted to better range of motion in flexion of the knee and in other aspects (pain, straight leg raising test). The study didn’t pay any attention to the impact of CPM speed. In our study, we used range of motion from 0° to 110° depending on the doctor’s prescription. Johnson and Eastwood worked with a range from 0° to 90°. Beuapré et al. (1) started in the 0-30° range and increased the range according to individual tolerance of the probands. Lenssen et al. (12) describe standard for dismissal the passive range of 10° - 80°. Bennet et al. (2) started with a range from 0° to 40° with a gradual increase of 10° per day, and compared it with group with indicated range from 10° to 50°. McDonald et al. (15) compared their group with the set range from 0° to 50° and from 70° to 110° with a group that did not undergo CPM therapy. Chen et al. (9) adjusted the range from 0° to a value of 10° less than was the measured value of passive range of motion at the first examination. The average of the input value was 71°. We didn’t observe significant reduction in the extension and the aforementioned ranges from other studies correspond more or less to applied ranges of motion by us.

A study devoted to the analgesic effect of CPM therapy in terms of the reduced need for painkillers
was conducted by McCarthy (13, 14). Bruun-Olsen noted pain reduction according to VAS from 52 before the therapy to 20 after 3 months of therapy (4).

As an additional effect, we recorded reduction in swelling. The mechanism of influence of the outward motion to reduce swelling describes e.g. O’Driscoll and Giori (19).

Of the available studies it cannot be determined, what the general standard in terms of the reached extension of range of motion of the knee is. The ability to walk independently after the CPM therapy into a flight of stairs and other daily activities, such as sitting down on the toilet, etc. were important. Frequent conclusion of comparative and other studies is that CPM therapy brings no benefit, although the results are comparable. It is clear, however, on the contrary, that if the use of CPM is comparable with the effect of manual techniques provided by the therapist, it is actually a great contribution to the therapist’s work, which saves their physical and mental strength. Or if the therapist adds CPM to their manual techniques the results achieved are even better.

CONCLUSION

In our pilot study, we demonstrated a positive effect of the CPM speed on the therapeutic result in post-arthroplasty of the knee joint through the prosthesis states. A greater range of motion and pain reduction was recorded in Group 1, which received the BTL-CPMotion therapy. Faster CPM can do more repetitions of the movement in the prescribed therapeutic time. More frequent movement leads to faster healing and earlier return home, which has significant social and economic impact. Theoretically, with the higher speed devices more patients can be treated than with the slower device. However, this must be confirmed by further studies. This therapy, brings a distinct advantage in ease of use for both the therapist and the patient. It is safe. The patient can continue the therapy at home. It does not require great physical activity of the patient.

No side effects were observed throughout the study. To confirm the results, and other effects, it is necessary to carry out further studies.

LITERATURE

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