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EFFICACY OF A NEW DEVICE FOR PASSIVE CONTINUOUS PATELLAR MOBILIZATION.

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Abstract

Patellafemoral joint diseases are commonly treated from physiotherapists. Patellar mobilisations can be performed either manually, but automated, passive continuous mobilisation devices are popular and frequently used in the clinical practice. The Patello device is a new developed product, but its effectiveness has not been verified yet. The purpose of this pilot-study was to investigate the effects of this passive continuous motion device (CPMD) on patellar cranial-caudal translation.

Nine healthy participants (mean age: 36.0±10.74 yrs, mean height: 172.7±8.1 cm, mean mass: 72.4±8.6 kg) volunteered for this study. The participants' right knee was investigated and placed at a flexion angle of 45° inside the device. The Patella bone was fixed to the device with two pincers to ensure full contact. A total of 50 repetitions, with a constant mobilisation speed, was conducted and the degree of translation was assessed after 1, 10, 20, 30 and 50 repetitions.

The results of this pilot-study indicate, that the CPMD was effective to translate the patella within the trochlear groove after 1 (mean translation: 0.819cm, $p<0.001$), up to 50 repetitions (mean translation: 0.774 cm, $p<0.001$) compared to baseline. No significant differences ($p>0.05$) were observed between the repetitions.

In conclusion, the CPMD proved to be effective to mobilize the patellar bone in a healthy population. Further studies should investigate the possible effects of passive continuous mobilisations in a clinical setting.

Keywords: automatization, effectiveness, knee, rehabilitation, translation

Introduction

Epidemiological studies indicate that knee Osteoarthritis (OA) is a highly prevalent joint disease, affecting one-third of the elderly population [1, 2]. Patellofemoral joint (PFJ) OA is an important source of symptoms in knee OA. Beside the tibia femoral joint (TFJ), the PFJ is one of the most commonly knee compartment where pain occurs [3]. Additionally to degenerative processes in the elderly, in a younger population the PFJ can be injured by blunt traumas, especially in contact sports such as rugby or American football or appear as an outcome after anterior cruciate ligament reconstruction [4]. In an early stage knee OA is treated conservatively, in a later stage often surgically. Independent of initial treatment the predominant symptoms are reduced range of motion (ROM) and pain leading to functional disability and impaired daily living activities [5].

A patient's ability to perform activities of daily living (ADL's), highly depends on the degree of knee motion, particularly for high-flexion activities such as stair climbing, kneeling or putting on shoes [6], whereas a knee flexion of ≥120° is adequate for most ADL's [7]. Within these high-flexion ADL activities the PFJ plays a crucial role since the patella moves on the femoral trochlear groove during knee flexion and extension. The patella lies within the quadriceps tendon and acts as hypomochlion increasing the mechanical advantage of the quadriceps muscle, providing stability and minimizing friction on the femoral condyle.

In the first line management of knee OA and PFJ OA symptoms, the current clinical guidelines recommend

individualized non-pharmacological treatment strategies, like physiotherapy [8].

Evaluating the effectiveness for conservative therapy in the treatment of knee OA and PFJ OA, there is moderate evidence in the literature that physical therapy, consisting of active and passive manual mobilization techniques of the TFJ and PFJ have a beneficial effect on self-reported pain and dysfunction in participants with knee OA [9, 10].

In the past, several studies examined the effects of early continuous passive mobilization (CPM) techniques after knee surgery, to improve the ROM in flexion and extension of the TFJ [11-14], However, a recent Cochrane review reported that CPM after total knee arthroplasty has no clinically important effects on active knee flexion ROM, pain, function or quality of life to justify its routine use [15]. Despite the lack of evidence, the use of CPM is quite common as a component of the physical therapy program in hospitals and rehabilitation centers.

CPM is performed by a motorized device, that passively and repeatedly moves the patient's knee through a predefined ROM, with the aim to increase knee joint mobility and post-operative recovery [15]. Recently a new continuous passive motion device (CPMD; Patello; SRM-projects GmbH, Chur, Switzerland) was developed to increase the range of motion of the patella over the femoral trochlear groove. This CPMD is a novel mechatronic rehabilitation device. Electronic and pneumatic components are integrated in the leg support structure. The mobilization unit can be adjusted to individual patient anthropometrics easily and intuitively. The user sets individual parameters for mobilization pressure at the start of each session. Additionally, the CPMD mobile app acquires and displays the data as well as the pressure values on a mobile device.

The aim of the present study was to evaluate whether the CPMD is effective to increase the functional ROM of the patella within the femoral trochlear groove. This feasibility study aims to be the bases for further clinical investigations.

Material and methods

A total of n=9 participants (age: 36.0±10.74 yrs, height: 172.7±8.1 cm, mass: 72.4±8.6 kg) volunteered for this pilot-study. All participants were free of any actual pain symptoms and did not have a history of patellar surgery or any diagnosed pathology. All participants were instructed to refrain from exhaustive exercise which might induce any symptoms of delayed-onset of muscle soreness of tendon stiffness of the quadriceps femoris muscles. The participants were informed related to all possible discomforts that might occur due to the procedure. This study was approved by the local ethical committee of Zurich (2018-00234) in accordance with the Declaration of Helsinki (ICH-GCP), and the study is registered in the clinicaltrials.gov registry (NCT03512652).

Patellafemoral translation inside the CPMD

The participant's right knee was placed inside the CPMD at a knee angle of 45°, with the participant in a supine position. Then the moving, top-part of the CPMD was fixated to the lower-part of the device (Figure 1). After successful locking of the two parts, the researchers manually adjusted the pincer grip to the patella. The pincer grip then was lowered with the patella into the patellafemoral groove just before the participants subjectively reported a "uncomfortable feeling" due to the compression. In this position, the researcher manually adjusted and saved the degree of patellafemoral movement on the handheld remote control till uncomfortable feelings were reported. After the adjustments, the CPMD performed patellafemoral translation in five mobilization sessions up to 50 repetitions. The participants could interrupt the treatment at any time with the handheld remote control.

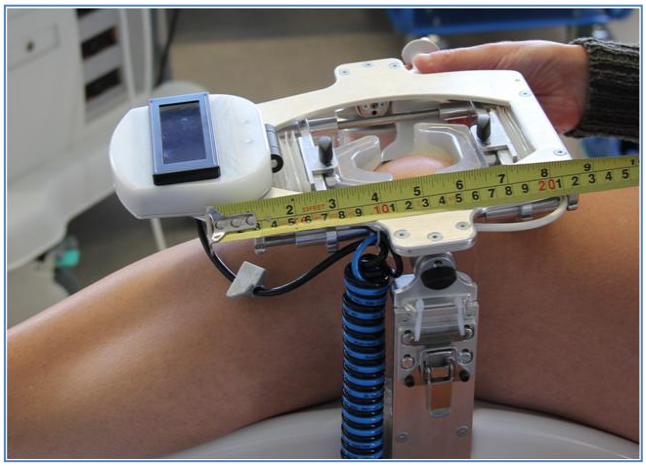

Figure 1: Fixation of the CPMD to the patella.

Measurement of patellar movement

The patellafemoral movement was measured in B-Mode by ultrasound (MyLabClassC, Esaote, Genoa, Italy) during the CPM of the patella. A custom effective device to mobilize the patella within the femoral trochlear groove made frame (HSR University of Applied Sciences, Rapperswil, Switzerland) was attached to the CPMD and used to monitor potential movements of the patella over the femur. The translation of the patella was measured from the lateral aspect of the leg. A video sequence was created, which was then imported into a DICOM viewer (OsiriX Lite, Pixmeo SARL, Geneva, Switzerland) and further processed. Using the most prominent point of the patella in the lateral view, enabled us to measure the extent of patellar translation compared to a reference point during

the imported video sequence. Video sequences were conducted after 10, 20, 30 and 50 repetitions.

Data analysis

The mean translation of patellar movement at 1, 10, 20, 30 and 50 repetitions were analysed using absolute values (cm mean ± SD). Repeated measure ANOVA mixed design for treatment (CPMD) and time (0, 1, 10, 20, 30 and 50 repetitions) were conducted for the translation of the patella.

Then, patellar translation between repetitions (0 to 1, 0 to 10, 0 to 20, 0 to 30, 0 to 50) was analysed using dependent t-test, for which alpha error was corrected to 0.01.

The observed effect size was expressed as partial eta-squared ($\eta^2_{partial}$) values, with 0.01, 0.06, and 0.14 being considered as small, medium and large, respectively [16]. All statistical analyses were performed using the statistical package for the social sciences (SPSS Inc., Chicago, USA), version 25.0.

Results

For the patellar translation, a large and significant time effect ($F_{4,5}$=12.71, p=0.014, $\eta^2_{partial}$=0.94, 1-ß=0.91) was found. The translation of the patella was significantly different (p < 0.001 for all) to the reference point after 1 repetition (mean difference: 0.819 cm), 10 repetitions (mean difference: 0.734 cm), 20 repetitions (mean difference: 0.776 cm), 30 repetitions (mean difference: 0.771 cm) and 50 repetitions (mean difference: 0.774 cm). No significant differences were found between the number of repetitions and the translation of the patella.

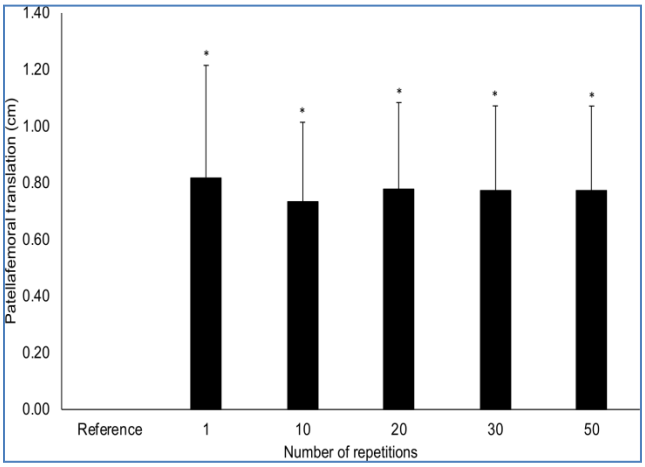

Figure 2: Patellafemoral translation (cm) in function of time. * indicates p<0.001 compared to reference.

Discussion

The aim of the present study was to evaluate if the CPMD is effective in mobilizing the patella within the femoral trochlear groove. Using the ultrasound assessment, we were able to objectify the mobilizing effect of the CPMD. The results of this study showed that the automated mobilization with the CPMD results in a significant caudal displacement of the patella within the femoral trochlear groove, in young and healthy participants. However, the number of mobilizing repetitions (1, 10, 20, 30 and 50 repetition) had no significant effect on the increase of patella displacement in function of time. Now these results should be interpreted carefully. The chosen pressure values for the alternating proximal and distal mobilization movement of the patella were not standardized but adapted to the participant´s sensitivity. However, from a practical view, clinical guidelines for knee osteoarthritis recommend to individualize the treatment, based on the site of joint damage.[17] The amplitude of mobilization movement, as well as the direction (cranial-caudal) were kept constant over time to answer the research question. In contrast, therapeutical mobilization techniques normally varies in grade, frequency, repetitions and duration of the mobilization session, taking the irritability of the joint complex into account [18]. Therefore, in a normal therapeutic setting, it would be appropriate to constantly adapt entire mobilization technique, to achieve a potential maximal mobilization effect. Although CPMD is different to manually applied techniques (i.e. Maitland mobilisation) both are based on similar mechanisms of pain relief like mechanical effect base pain inhibition by reducing the slow conducting articular nociceptor afferents due to activation of the fast conducting mechanoreceptor afferents [19]. To further induce an analgesic effect, the CPMD should be able to adapt the intensity of the mobilization to be able to stimulate the descending pain inhibition by activation of opioid receptors at spinal dorsal horn [20]. Because all participants were healthy, it is not possible to say if the CPMD is able to stimulate the above-mentioned mechanisms for pain reduction. Further research should focus on the mobilizing effect of the CPMD in a realistic therapeutic setting. Although a Cochrane study showed limited evidence for the use of CPMD in knee mobilization [15], the effect of manual passive mobilization techniques in comparison to the automated passive mobilization of the CPMD needs to be investigated. In addition, the authors suggest including patients with limited ROM of the TFJ or PFJ and to adjust the pressure settings of the device during the mobilization sessions in order to obtain an optimal mobilizing effect.

Conclusion

The results of this feasibility study showed that the CPMD is able to increase the functional ROM of the patella within the trochlear groove in healthy participants. CPMD devices probably need more setting options to be able to individually adjust the therapy. The beneficial mobilizing

effect of the CPMD on a patient population with limited knee ROM requires further investigation.

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