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Efficacy of Treatment Based on the Movement System Impairment Classification in People with Knee Pain: A Study Protocol

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Abstract

Background: Detection of abnormal movement patterns and disorders and their classification into specific sub-categories may result in effective therapeutic choices. Classification of movement system impairments has provided seven sub-categories for movement disorders in the knee joint with specific treatment recommendations for each.

Objectives: This study aimed to investigate the effectiveness of specific treatments proposed by this classification method and compare the effectiveness of this treatment method with routine ones.

Methods: Participants who met the inclusion criterion were randomly assigned into control and experimental groups after the diagnosis of their movement impairment. Subcategories including patellar lateral glide syndrome and tibiofemoral rotation syndrome were recruited. Experimental groups were treated specifically based on their impairment; however, all control groups received the same routine physiotherapy, regardless of their movement impairment. Two knee function and disability instruments were used, including Knee Injury and Osteoarthritis Outcome Score and the Lower Extremity Functional Scale. Eventually, each experimental group's outcome scores on the visual analog scale and frontal plane projection angles were compared with those in the control group.

Results: Movement system impairments could be one of the contributing factors for disabilities in people with knee pain. Treatment based on the classification of these movement impairments would lead to better outcome.

Conclusion: We assumed that the specific treatments based on the movement impairment classification have beneficiary over the routine treatment. This would also give clues about the validity of this classification in knee pain. If this is the case, detecting the movement impairment and giving treatment on this basis could be used as a comprehensive guideline.

Keywords: Classification, Knee pain, Movement impairment

1. Background

Knee pain is among the most common causes of referral to physical therapy clinics with a prevalence of about 29%-30% as reported in 2016 for Iranian adults (1). Although in the elderly, the degenerative changes in joint surfaces are the most cause of knee pain, in the younger population, knee pain can be attributed to different reasons, such as overuse, postural malalignment, and impaired movement patterns (2). The identification and diagnosis of abnormal movement patterns and disorders, as well as their classification into specific sub-categories, may be among the models that can lead us to effective therapeutic choices. Based on substantial evidence, movement disorders have a major role to play in knee problems, such as osteoarthritis (2, 3).

The body follows the law of biomechanics and takes the specific path of least resistance to motion (2, 4). The path of least resistance is affected by variation in the stiffness or relative flexibility of tissues. Based on this theory, the predisposition of a joint to move readily in a specific direction contributes to the development of abnormal movement patterns, thereby resulting in degenerative changes in tissues (2,3). Since the specific attention of physical therapy is on movement disorder, there is a belief that classification based on primary movement impairment may have a more crucial role in an effective treatment approach (2). Based on the movement system impairment theory, the existing defect in every section of movement systems and incorrect movement patterns must be diagnosed at the first step. Subsequently, the movement pattern impairment in each joint should be categorized into some concrete sub-categories, and finally, suitable treatment and correction options could be suggested for each of these diagnostic sub-categories(2).

Based on the movement system impairment theory proposed by Sahrmann, a standardized clinical examination for each joint is performed to determine the movement system syndrome and its contributing factors(5). This theory has provided seven sub-classifications for movement disorders in knee joint, including 1) tibiofemoral rotation syndrome with varus and tibiofemoral rotation with the valgus syndrome, 2) tibiofemoral hypomobility syndrome, 3) knee extension syndrome and knee extension with patellar superior glide syndrome, 4) knee hyperextension syndrome, 5) patellar lateral

glide syndrome, 6) tibiofemoral hypermobility syndrome, and 7) knee impairment. Moreover, a specific treatment recommendation has been proposed for each of these sub-categories (2).

The reliability and validity of this classification model have been assessed and the validity of three of the seven sub-categories, including patellar lateral glide syndrome (PLG), tibia-femoral rotation syndrome (TFR), and tibiofemoral hypomobility (TFLHypo), was confirmed (6,7). The TFR and PLG syndromes are more commonly detected in physical therapy outpatient facilities; therefore, these subcategories were selected for the study. Nonetheless, the only experimental study based on the movement defect classification in the knee joint is a case study that reported complete recovery from pain in one patient with knee rotation syndrome after a one-year follow-up (8).

No clinical trial has demonstrated the effectiveness of specific treatments in knee pain based on this diagnostic classification proposed by Sahrmann or compared the effectiveness of this treatment protocol with the routine treatment protocol. Therefore, more investigations are necessary to determine the efficacy of classification-based treatment in people with knee pain and compare it with the routine method in the treatment of knee pain. Our main hypothesis is that the classification of knee impairments into subcategories and giving specific treatments to each group based on the existing movement impairment would improve the main causes of pain and dysfunction. It was also hypothesized that the impact of this specific treatment based on classification could be more significant than the routine methods.

2. Objectives

This study aimed to evaluate the impact of specific knee pain treatments based on Sharmann's movement impairment classification and compare the effectiveness of this method with routine ones.

3. Methods

3.1. Study design

This double-blinded-randomized clinical trial aimed to evaluate the efficacy of knee pain treatment based on the model of movement impairment system classification on experimental and control group. The study received ethical approval from Shahid Beheshti University of Medical Science, Iran, Tehran (ethical code: IR.AJUMS.REC.1397.744). The trial registration number of this study is IRCT20190222042801N1.

3.2. Participants

A total of 60 patients with knee pain referring to the School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, were evaluated by two experienced physical therapists. They were classified by two evaluators, and the patients that fall into two main categories, including the tibiofemoral rotation syndrome group and patellar lateral glide syndrome, were recruited. Since the tibiofemoral rotation syndrome group was composed of two other sub-groups, including tibiofemoral rotation syndrome with varus and tibiofemoral rotation with the valgus syndrome, patients were classified into each of these subgroups and studied separately in order to make a better analysis. All of the groups under study were matched for age and gender. Finally, they were randomly assigned to control and experimental groups.

3.2.1. Inclusion Criteria

The individuals recruited in this study were with knee rotation syndrome (2, 6) (with valgus or varus) and the lateral patellar glide patients with VAS (Visual Analogue Scale) pain scores of 3 mm or higher (9). In addition, the presence of knee pain in two of the following situations was considered the inclusion criteria, namely long-time sitting position, running, going upstairs, kneeling, and jumping (9), as well as no history of past trauma (4).

3.2.2. Exclusion Criteria

The exclusion criteria entailed pregnancy, reluctance to cooperate in the study, or absence from two consecutive treatment sessions or three sessions as a whole.

3.3. Sample Size Calculation

The participants were selected via the convenience sampling method. Since no similar study was found in the literature, we performed a pilot study on five patients in each sub-group of the experimental and control groups. The number of participants of each two-parallel subgroup in the study was calculated based on the result of the pilot study by the following formula with a power of 80 % and a significance level of 0.05:

$$n = \frac{(s_1^2 + s_2^2)\ (z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2}{(\bar{x}_1 - \bar{x}_2)^2}$$

Finally, a total of three groups, including the tibiofemoral rotation syndrome with varus syndrome, the tibiofemoral rotation with valgus Syndrome, and a Patellar Lateral Glide Syndrome, were formed (n=10 in each group). Moreover, there were three parallel control groups, similar in age and gender and the number of participants, comprising a total of 60 patients for the present study.

3.4. Procedure

The patients were briefed about the study procedures and signed a written consent form. The inclusion/exclusion criteria were carefully assessed by an experienced physical therapist, and the

participants were then assigned to their specific groups. The demographic information 3was collected and recorded, including age, gender, height, and weight. The patients then completed both the Knee Injury and Osteoarthritis Outcome Score (KOOS) and Lower Extremity Functional Scale (LEFS) Questionnaires. The knee frontal plane projection angels (FPPA) for the tibiofemoral rotation syndrome groups were recorded by a digital camera while stepping down a step with a height of 20cm(10).

The FPPA is a 2-dimensional (2-D) representation of the lower extremity position used to detect dynamic changes in the movement pattern. The FPPA represents the angle connecting the leg and the thigh in the frontal plane, with its normal value being 175 degrees. This angle is formed between a line that bisects the thigh and the line which bisects the lower leg. During the three phases of the movement test, the tester recorded the FPPA to evaluate the differences observed in FPPA. The Kinovea Open Source Project Model Software (Version 0.8.15)(11) was employed to measure the angles. This angle was recorded for all participants with tibiofemoral rotation syndrome, in both the test and control groups, three times, including before treatment, after accomplishment of 10-session treatment, and at the end of the 12th week of the follow-up period.

We used a standardized method to collect the videos of stepping down. A digital camera (Cyber-Shot DSC-w100; Sony Corporation, Tokyo, Japan) was placed on a tripod at the level of the participant's knee and approximately 2 m anterior to the participant. A research assistant instructed the participant in the movement and performed the video capture. After instruction, participants were allowed to practice the task until they felt comfortable with their performance. The second research assistant, who was not involved in the original video recordings or the visual assessment, analyzed the videos for inter-tester reliability evaluation. This research assistant had minimal knowledge of the movement patterns of interest. It should be noted that each participant performed this activity three times. Therefore, the data intra-tester reliability was also calculated.

To record the angle, the participant was asked to stand on a stair and come down with the command (Figure1).

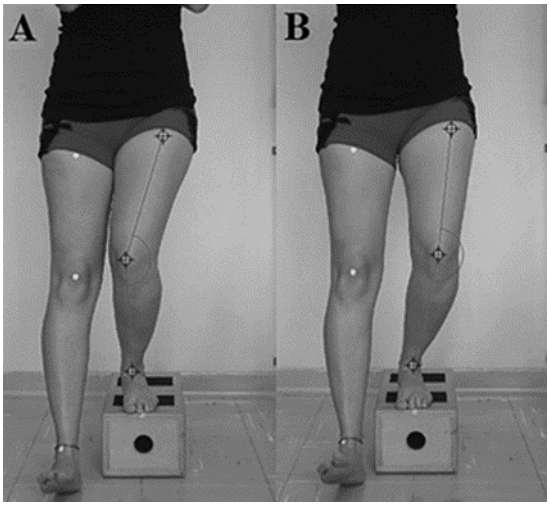

Figure 1. Step down frontal plane projection angle

The exact models of his/her standing position and climbing down the stairs were recorded. At the time of complete contact of the foot with the ground, the angle was recorded using Kinovea Open Source Project Model Software(version 0.8.15), and the FPPA was determined. To eliminate the effect of shoe wear on limb movement, participants remove their shoes before testing (10). Angle changes from the static position to the dynamic position were calculated. The difference between the minimum and maximum of the FPPA angle while coming down the stairs was used for our analysis. We used Sketch Up (version 7.1; Google Inc, Mountain View, CA) to measure the angles on the captured snapshots. For each position, two lines were drawn to represent the FPPA, one that bisected the thigh and the other that bisected the lower leg (Figure1), and determine the angle formed with the 360-degree protractor function (10).

Prior to treatment and at the end of the 3rd, 6th, and 12th weeks, the patients were asked to fill out the KOOS and LEFS Questionnaires and determine their VASs.

3.5. Randomization and Blinding

To follow a double-blind procedure, the evaluations were performed by an experienced and well-trained physical therapist, and the treatment procedures (12) were conducted by another experienced physical therapist.

3.6. Intervention

Regardless of the classification, the control group received the same routine treatment protocols based on the general clinical physiotherapy recommendations (13,14). Nevertheless, based on the movement system impairment classifications, each experimental group received specific treatments (4), including the rehabilitation of the involved muscle segment with the help of the practices relative to the patients' potential, along with a gradual increase till reaching the desired function and the reduction of the pain, as well as saving the correct pattern and taking the necessary precautions while walking and moving(4). The treatment period included 10 sessions conducted in six weeks. There were two treatment sessions during the first four treatment weeks, and during the other two weeks, there was only one treatment session for the patients (15). Each treatment session continued for 45-60 min (12). In all experimental sub-groups, the treatment protocols were as follows: Passive correction with taping (Figures 2 and 3), training and treatments inside the clinic, correcting the body alignment and functional activities (Table 1), and explaining the practices that should be carried out at home. A written instruction was also handed over to the patients(2).

Figure 2. Taping to correct varus impairment

Figure 3. Taping to correct valgus impairment

Table 1. Specific instructions for functional activities for experimental groups (tibiofemoral rotation syndrome)

Activity	Do	Do Not
Alignment	Keep knees over foot	Allow the knees to roll in (hip medial rotation) for the valgus group and to roll out (hip lateral rotation) for varus one
Sitting	Position knee over the foot	Point foot outwardly for valgus and inwardly for varus one
Standing	Keep weight distributed evenly over both feet	
Sit to stand	Slide to the front of the chair Keep knees over the foot	Stand from the back of the chair
Ambulation	Squeeze buttock muscles to keep knees over the foot. Squeeze the left seat when stepping on the left foot and vice versa	Allow the knees to roll in for valgus group and roll out for varus one
Stair ambulation	Squeeze buttock muscles to keep the knees over valgus group and to roll out for Varus one	Allow the knees to roll in for the foot

Abbreviation: MSI: movement system impairment

3.7. Statistical Analysis

Statistical analysis was carried out using SPSS software (version 20). Shapiro-Wilk test was used to evaluate the normal distribution of the data. Repeated-measures ANOVA and longitudinal models, such as the marginal model and random-effect model, were used for hypothesis testing. Nonparametric tests were utilized for non-normal data.

4. Results

4.1. Summary of the Study Protocol

Bearing in mind the movement system impairment classification, there is a movement system disorder through which the movement per se can be a reason for the onset of the disease in the movement system. Based on this theory, existing disorders in any of the segments of the movement system, as well as the incorrect movement systems, were diagnosed. Thereafter, the sub-classifications were determined, and finally, a specific treatment protocol was advised for each of the groups.

Since the offering of the theory is not solely adequate for clinical usage, each theory has to be approved through experimental evidence in order

to be used in therapeutic protocols. The only study performed on the effectiveness of movement disorder classification in the treatment of knee disorders is a case study performed only on one patient who was inflicted with knee rotation syndrome and treated in a one-year follow-up treatment protocol (8). The question here is that in case of a clinical trial for a large scale, can this theory prove itself to be sufficient in different movement disorder sub-categories and whether this treatment model is more effective than the routine physical therapy treatment format.

If this is the case, this theory may be used as a comprehensive guideline in physical therapy. However, no clinical trial has proven the efficiency of this trial based on the classifications offered by Sahrmann on knee pain or compared this model with other treatment models (2,14). In the present study, we sought to figure out the specific treatments for knee pain caused by movement impairments with proven validity and reliability in the literature. If such specific treatments proved to be more effective, they could validate the classifications.

5. Discussion

We presumed that the treatments based on the movement system impairments, could have better efficacy over the routine treatment protocols. If this is the case, detecting the movement impairment and giving treatment on this basis could be used as a comprehensive guideline. There has been no clinical trial to prove the efficiency of this trail based on the classifications offered by Sahrmann on knee pain, or to compare this model with other treatment models (2,14). In this study we will try to figure out the specific treatments of the knee pain whose validity and reliability have been proved. If such specific treatments proved to be more effective, they could validate the classifications, and also may suggest that similar treatment approach for all knee pain syndromes and ignoring the specific movement impairment classifications could be the main reason for insufficiency of treatment procedures in these patients.

6. Conclusion

Moreover, they suggest that a similar treatment approach for all knee pain syndromes and ignoring the specific movement impairment classifications could be the main reason for the insufficiency of treatment procedures in these patients

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Footnotes

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