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MANAGEMENT OF PHYSIOTHERAPY TO INCREASE GAIT SPEED IN PATIENTS WITH KNEE OSTEOARTHRITIS: SINGLE CASE STUDY

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Abstract

Introduction: Osteoarthritis(OA) is a musculoskeletal disorder that causes changes in the joints progressively slowly and intermittently. Usually, in the field, muscle strengthening exercises are often found that only focus on the agonist's muscle. Whereas antagonistic muscles also play a role and are even more dominant. The most recommended intervention to be able to activate the two muscles is in the form of task-specific exercises. The basic concept of task-specific exercise itself is muscle co-activation. To be able to see muscle activity being activated, task-specific exercises are combined with visual surface electromyography (SEMG) biofeedback.

Case Presentation: the patient is 57-years old woman and works as a housewife. Patient from Solo, Central Java. Examination of the patient was found to have 3 types of causes such as age more than 45 years or more, morning stiffness for less than 30 minutes, and pain when doing activities.

Management and Outcomes: Given treatment in the form of task-specific training combined with visual surface electromyography (SEMG) biofeedback to increase the walking speed and functional activity of the patient. Furthermore, the measuring instrument used for walking speed is the 10-meter walking test and WOMAC

Discussion: A study revealed that the addition of a visual surface EMG biofeedback component in task-specific functional training had a positive effect on increasing muscle function and strength. The authors assume that the addition of visual biofeedback can have a positive impact on the rehabilitation process.

Conclusion: Giving this intervention can provide a statistically significant improvement and can be implemented clinically to increase walking speed in individual patients and this can provide a significant improvement in functional ability in patients with osteoarthritis of the knee.

Keywords: Osteoarthritis, Task-specific Training, visual surface EMG-biofeedback, 10-meter walking test, WOMAC.

Introduction

Osteoarthritis is a degenerative disease that results in abnormal changes in the joints, characterized by the gradual destruction of joint cartilage, thickening of the subchondral bone, formation of new bone (osteophytes) at the joint edges, and loss of joint function. (Manoharan et al., 2018).

Task-specific exercises are techniques for combining functional movements in real situations to help patients find optimal control strategies to improve motor control and receive some feedback (Teasell et al.,2008). The concept of task-specific exercise itself is to activate the muscles together. Muscle co-activation or muscle co-contraction is the activation of agonist and antagonist muscle stimulants. Usually, agonist activation and antagonist coactivation occur in different on/off cycles. However, in those with severe tibiofemoral OA, coactivation occurs throughout the gait. Phase (Hubley et al., 2008). Co-activation occurs when the flexor activates during the moment of extension (Frey et al., 2013).

Visual Surface Electromyography (SEMG) Biofeedback is a tool that can see the activity of muscles that are being activated. SEMG biofeedback visual devices can convert muscle action potentials into visual or sound signals that are easy for the patient to understand so that patients can increase or decrease the level of voluntary activity, and are effective in increasing the patient's active participation during treatment.(Merletti & Farina, 2016). The goal is for muscle relaxation, reduction in overuse and/or in proper muscle activity, or learning and relearning muscle control.

The 10-meter walking test is a measuring instrument used to assess walking speed in meters per second over short distances (Palmer, 2015). The 10-meter walking test can be used to determine functional mobility, gait, and vestibular function.

The measurement instrument related to functional ability uses WOMAC (Western Ontario and McMaster Osteoarthritis Index). Because the WOMAC index is the best validated and most widely used outcome measure in subjects with knee osteoarthritis (Sathiyanarayanan et al., 2017). Thus, the authors want to provide treatment task-specific training combined with visual surface electromyography (SEMG) which aims to improve walking ability and functional ability in individuals with osteoarthritis.

Case Presentation

Subject named Mrs. X is 57 years old and works as a housewife. The research subjects were females from Solo, Central Java. Examination of the subject was found to have 3 types of causes such as age more than 45 years or more, morning stiffness for less than 30 minutes, and pain when doing activities. According to Dutch, UK, and American guidelines, knee OA can be diagnosed clinically. Meanwhile, other signs such as deformity, crepitus, joint tenderness, and local edema were not found in the study subjects and there were no periarticular soft tissue disorders that co-exist in the study subjects such as anserine bursitis, iliotibial band syndrome, and other soft tissue disorders. The activity level status of the research subjects was high as evidenced by the patient still diligently attending aerobic classes with a frequency of 1 week 3 times with a duration of 60 minutes per meeting. Swimming is a closing activity carried out on the weekends. The subject also has a good social status. It is proven by the patients routinely doing recreation at the end of the month and always planning a vacation at the end of the year. Finally, the patient's sleep quality can be categorized as good, where the patient sleeps more than 8 hours per day.

Management and Outcome

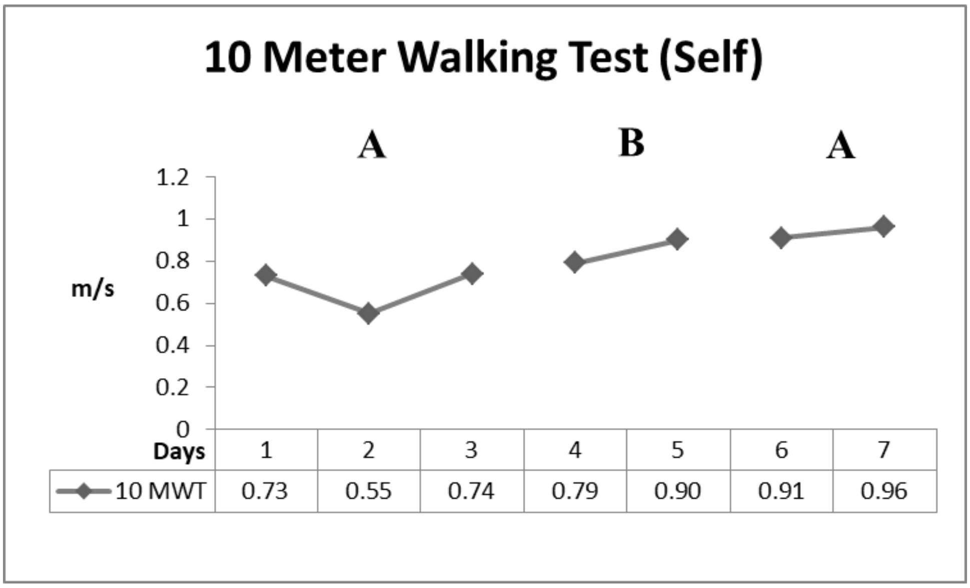
Patients underwent treatment, namely task-specific training combined with visual surface electromyography twice a week. The patient is in a standing position, instructed to walk in the correct gait pattern on the treadmill. Then the patient is given orders to activate certain muscles. The patient knows that his muscles have been activated by using a tool provided on a computer screen, namely Visual Surface Electromyography biofeedback. Visual Surface Electromyography biofeedback was placed on the quadriceps muscle group (Vastus Medial Oblique). Before electrode placement, the skin area should be cleaned and sterilized. If there are hairs, they must be shaved first. Surface electrodes attached to the skin are used to record muscle activity.

A strength dynamometer (TSD121C, Biopac Systems Inc., Holliston, MA, USA) was used to obtain MVIC results of the quadriceps muscle group in particular the vastus medial oblique (VMO). In the biofeedback training process, the determination of the contraction threshold is an important component in the success of the training process. Determination of the threshold for the use of muscle activation is 80% of the maximum voluntary isometric contraction

Muscle activation was recorded at 1000 Hz bandwidth with a 4-channel surface electromyography system (Telemyo® telemetric hardware system, Noraxon USA) [27,28]. The differential amplifier has a gain of 2000, an input impedance of 10 MΩ, and a common-mode rejection ratio of 130 dB. In addition, accurate electrode placement was verified during the normalization process. If a good signal is not obtained when the individual performs maximal isometric contraction of the muscle, the electrode is repositioned. Then the subjects were asked to walk barefoot with electrodes attached and surface muscle activity to be assessed for each muscle using the Myo-research XP Clinical Edition software (version 1.07.09).

Instruments were measured in the form of walking speed using the 10-meter walking test and functional ability using womac.The 10 meters (10MWT) walking test measures walking speed in meters per second over a short time (Palmer, 2015). The WOMAC scale was designed to measure dysfunction and pain associated with OA of the lower extremities by assessing 17 functional activities, 5 pain-related activities, and 2 stiffness categories. (Salaffi et al., 2003).

The following is a graph of the 10-meter walking test and WOMAC obtained:a. 10 meters walking test



10m Walking Test Self-Pace Results Image

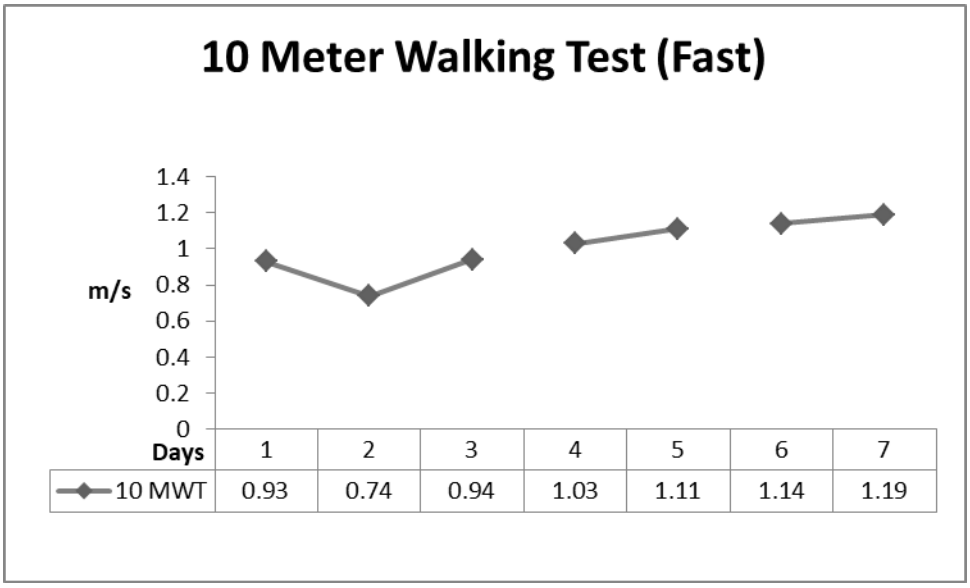
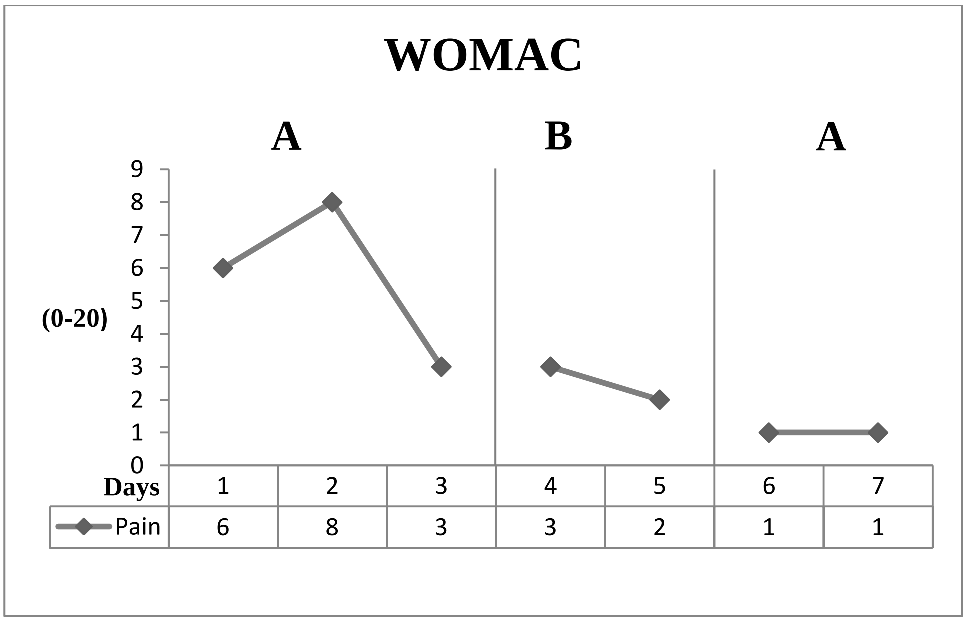


Figure 10m Walking Test Fast Walking

In the calculation of self-pace walking speed, the overall results showed an increase from the first day to the seventh day. The average walking speed is 0.79 m/s. Where the lowest speed was found on the second day of 0.55 m/s, down 0.23 m/s from the first day because on that day the patient's condition was not fit. Starting from the third day until the last day there was a progressive increase. The highest speed is reached on the seventh day. The highest speed increase occurred on the third day which was an increase of 0.21 m/s from the second day. Meanwhile, the lowest speed increase was calculated on the fourth day to the fifth day of 0.01 m/s. The average speed increase is 0.86 m/s.

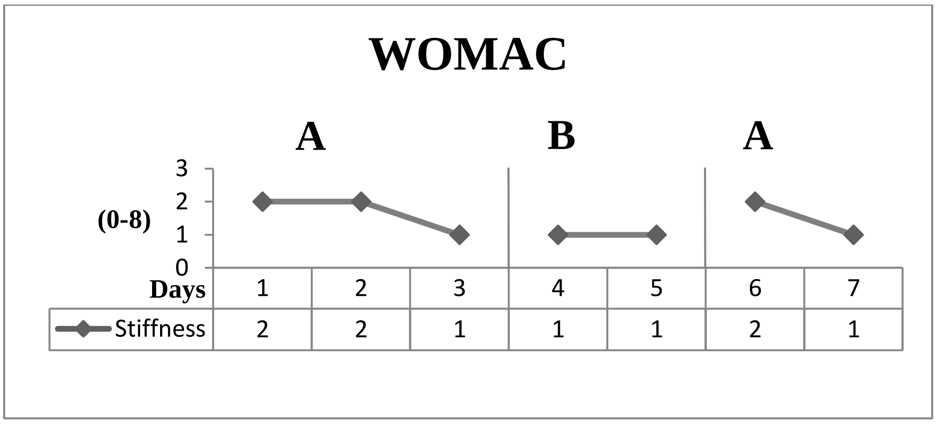
In addition, the calculation of fast walking speed obtained overall results increased from the first day to the seventh day. The average walking speed is 1.01 m/s. On the second day, there was the lowest speed of 0.74 m/s, a decrease of 0.19 m/s from the initial value of 0.93 m/s.

b. WOMAC



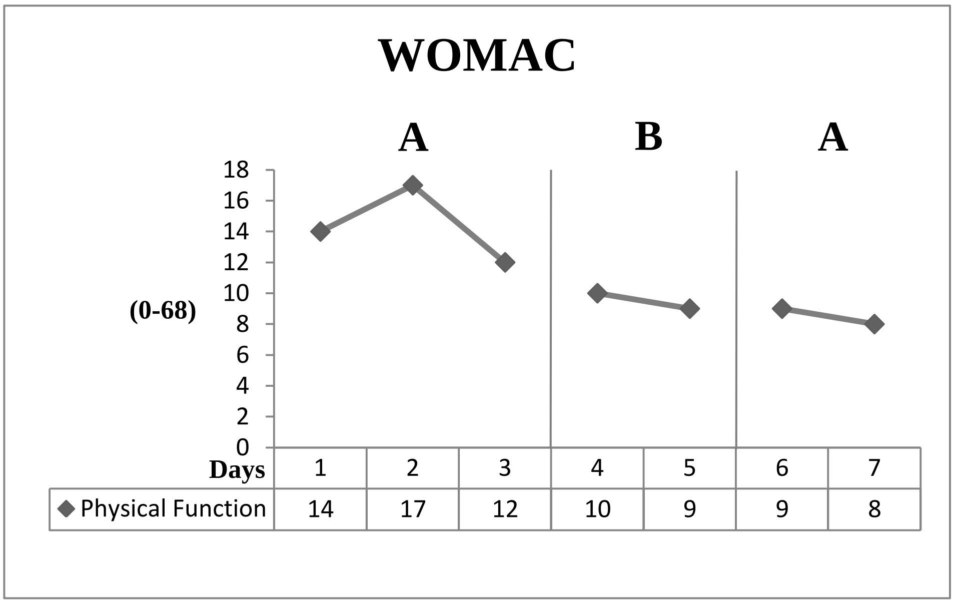
WOMAC Pain Graphics Image

On the pain subscale on the WOMAC questionnaire for the first to the third day, only a questionnaire was given showing results, namely 6 on the first day, 8 on the second day, and 3 on the third day. Then on the fourth day and five respondents were given intervention and WOMAC measurement, the results were 3 on the fourth day and 2 on the fifth day. Furthermore, on the sixth and seventh days, only a questionnaire was given with the results of 1 on the sixth day and 1 on the seventh day. Total pain score on WOMAC (0-20), 0 is mild, and 20 is severe. The graphic score on WOMAC also shows a decrease, this can also be related to the SEM data showing results 7 and MCID 7. These results indicate a statistical change but no clinical change.



WOMAC Stiffness Graphics Images

On the Stiffness subscale on the WOMAC questionnaire for the first to third days, only a questionnaire was given showing results, namely 2 on the first day, 2 on the second day, and 1 on the third day. Then the fourth day and five respondents were given intervention and WOMAC measurements obtained results, namely 1 on the fourth day and 1 on the fifth day. Furthermore, on the sixth and seventh days, only a questionnaire was given with the results of 2 on the sixth day and 1 on the seventh day. Total stiffness score on WOMAC (0-8), 0 if light and 8 are severe. The graphic score on WOMAC also shows a change, this can also be related to the SEM data showing result 1 and MCID 1. These results indicate no statistical and clinical change.



Graphics of WOMAC Physical Functions

On the physical function subscale on the WOMAC questionnaire for the first to third days, only the questionnaires were given showing results, namely 14 on the first day, 17 on the second day, and 12 on the third day. Then on the fourth day and five respondents were given intervention and WOMAC measurement, the results were 10 on the fourth day and 9 on the fifth day. Furthermore, on the sixth and seventh days, only a questionnaire was given with the results of 9 on the sixth day and 8 on the seventh day. Total physical function score on WOMAC (0-68), 0 if light and 68 if heavy. The graphic score on WOMAC also shows a decrease, this can also be related to the SEM data showing results 9 and MCID 9. These results indicate statistical and clinical changes.

Table 4.1 EMG results

Average Voltage		Normal Walking	EMG-biofeedback assisted
Peak	Day 1	+53.8 ± 11.5 V	+110 ± 10.3 V
mean		- 1.12 ± 0.57 V	- 0.22 ± 1.07 V
Peak	Day 2	+79.5 ± 4.26 V	+125 ± 24 V
mean		- 0.04 ± 0.757 V	- 0.348 ± 1.08

The table above is the result of the activation of the quadriceps muscle, especially the vastus medial oblique. From the data above, it can be seen that there was an average increase when walking on the activation of the quadriceps muscle, especially the vastus medial oblique on the 2nd day of the intervention.

Discussion

Statistically, the Standard Error of Measurement (SEM) 10-meter walking test in individuals with knee OA is 0.08 m/s. Meanwhile, the results showed that the speed changes in self-paced and fast walking were 0.41 m/s and 0.45 m/s, respectively. This means that there is a significant increase in walking speed after the exercise intervention is given. This statement is supported (Peters, Fritz, & Krotish, 2013) which explains that the change is said to be meaningful if it exceeds the SEM value.

On the other hand, the Minimally Clinically Important Difference (MCID) on the 10-meter walking test in individuals with knee OA was 0.13 m/s. This result is smaller than the value of the increase in walking speed during self-paced and fast walking. So it can be concluded that the intervention given by the researcher can be implemented in clinical practice. This is in line with the results of research from(Palmer, 2015) which states that an intervention can be implemented in clinical practice if it exceeds the MCID value.

Statistically, the Standard Error of Measurement (SEM) in WOMAC can be determined if the SEM value of 5.1 can be achieved from the WOMAC results. SEM is the minimum value, if it exceeds this value, the change can be claimed that the WOMAC measurement or questionnaire changes significantly in the form of statistics or data. This statement is supported by(McManus, 2012). For stiffness, there is no significant change because the SEM value is not achieved, which is 1 and the MCID is 1. Furthermore, for pain, the SEM value is reached, which is 7 but and the MCID value is 7. However, the MCID number is not achieved, so it cannot be implemented clinically.

Then the Minimally Clinically Important Difference (MCID) on WOMAC can be determined if the MCID value of 8.8 can be achieved from the WOMAC results. MCID is a minimal value if it exceeds this value the change can be claimed that this WOMAC measurement can change significantly and can be implemented in clinical practice. This statement is supported by (Rai et al., 2015). In physical function, the SEM value is 9 and the MCID is 9, so this intervention can be proven statistically and can be implemented clinically for use in improving the physical function of knee OA patients.

International clinical guidelines state that land-based exercises are highly recommended for all individuals with knee OA to reduce pain, improve function regardless of age, the severity of structural disease, functional status, or pain level. Added by (Qurat-ul-Ain et al.,2018) which proves that functional task-specific exercise is more effective than conventional therapy in increasing walking speed and mobility. This explanation of the importance of exercise is supported by an RCT study which states that functional task-specific exercises were developed specifically for individuals with knee OA, it is important to know which functional tasks are most problematic for those with knee OA so that task-specific functional exercises are designed to target this task (Tate et al., 2010). So we can conclude that functional task-specific exercises can be implemented for mobility improvement exercises in individuals with knee OA.

(Yılmaz et al., 2010) a study revealed that the addition of a visual surface EMG biofeedback component in task-specific functional training had a positive effect on increasing muscle function and strength. This is also supported by research from Weakley (2019) which states that in the musculoskeletal rehabilitation process, visual biofeedback is needed to reduce patient saturation. In other words, the authors assume that the addition of visual biofeedback can have a positive impact on the rehabilitation process.

Conclusion

Giving task-specific exercises combined with visual surface electromyography (SEMG) biofeedback can provide a significant improvement and can be implemented clinically to increase walking speed in individuals with knee osteoarthritis and this can provide a significant increase in functional ability in patients with knee osteoarthritis. However, no significant results were obtained for patients with pain and stiffness disorders, so this exercise is only intended for individuals who have mild pain and stiffness but the main goal is for physical function in osteoarthritis patients.

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