Comparative Study of The Effects of Proprioceptive Exercises Versus Ultrasound Therapy in the Management of Knee Osteoarthritis

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Abstract

Proprioceptive exercises have been shown to be one of the ways of alleviating pain and improving disability in patients with osteoarthritis. This study investigates the effectiveness of proprioceptive exercises and ultrasound therapy in the management of osteoarthritis of knee. The methods used for this studies were; 20 participants with clinical diagnosis of osteoarthritis of the knee were randomly allocated to control and experimental group. The participants in the experimental group received proprioceptive exercises and static quadriceps exercises while the participants in the control group received static quadriceps exercises and ultrasound therapy using continuous mode of 3 MHz and intensity of 2.0W/cm2 for 5 minutes. The variables measured are; Quality of Life, Active Range of Motion (AROM) and Intensity of Pain. Data obtained was summarised using descriptive statistics of mean and standard deviation and analysed using inferential statistics of independent t-test and paired t-test. The result obtained were: The results did not show significant differences between the two groups in pain intensity (t= -0.22, p= 0.83), quality of life (t= -0.03, p=0.98), and AROM (t= 0.06, p= 0.95) p>0.05. However, a significant change within the group difference was seen in the experimental group in pain intensity (t=13.500, p<0.05), quality of life (t=3.965, p<0.05) and AROM (t=-9.000, p<0.05). Similarly, a significant difference was seen in the control group in the terms of pain intensity, quality of life and AROM at 0.05α level. In conclusion, it was concluded that, either proprioceptive exercises or ultrasound therapy, in addition to static quadriceps exercises can be useful to decrease pain, stiffness, increase AROM and physical function in patient with knee osteoarthritis.

Keywords: *Proprioceptive Exercises, Ultrasound Therapy, Knee Osteoarthritis, Static Quadriceps Exercise*

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Introduction

Osteoarthritis is considered to be the most common of joints rheumatologic diseases which affects more than 80% of the population above 55 years (Lawrence et al, 1998). It is a complex, multi-faceted condition that has been characterised by various criteria including pathogenesis (mechanical, biological), morphology (articular cartilage, subchondral bone) and clinical features (joint pain, stiffness, tenderness, loss of ROM, crepitus and inflammation/effusion). This ensembles of clinical and pathologic entities is often referred to as the osteoarthritis complex (OAC) (Hinton et al, 2002). Knee pain is one of the most common musculoskeletal complaints that bring people to their physician (Arya and Jain 2013). With today's increasingly active society, the number of knee problems is increasing. Knee pain has a wide variety of causes and treatments (Arya and Jain 2013). Causes of knee pain include injury, degeneration, arthritis, infrequently infection and rarely bone tumours (Arya and Jain 2013).

Therapeutic ultrasound is one of the physical therapy modalities suggested for the management of pain and loss of joint function due to OA (Arya and Jain 2013). Ultrasound is a form of mechanical energy consisting of high-frequency vibrations that can be continuous or pulsed. Pulsed ultrasound produces non-thermal effects whereas continuous ultrasound generates thermal effects (Richette et al, 2011; Jordan, 2002).Therapeutic ultrasound is also reputed to reduce oedema, relieve pain and accelerate tissue repair (Karlson et al, 2003).

The quadriceps muscle strength in patient with osteoarthritis of knee has also been seen to be consistently lower due to disuse atrophy secondary to joint pain, quadriceps inhibition, delayed activation of quadriceps onset and muscle impaired proprioceptive activity (Baker et al, 2001). Decline in the mass and strength is one prominent characteristics of natural ageing, strength loss can limit the activities of daily living, mobility, increase the chance of falling and possibly even cause a loss of mechanoreceptors that can further decrease proprioception and balance (Zazulak et al, 2007).

Proprioception is the process by which the body can vary muscle contraction in immediate response to incoming information regarding external force. Any pathology that adversely affects muscle function may impair force generation. Proprioceptive activity system are essential for maintenance of balance and production of smooth stable gait (David et al, 2009).

The intent of proprioceptive exercises is to expose people to activities that challenge the stability of the knee and balance in a controlled manner during rehabilitation (Zazulak et al, 2007). Current physical therapy interventions for knee osteoarthritis focuses on decreasing pain and improving knee range

of motion, muscle strength, balance, and functional mobility (David et al, 2009). Therefore, this study was designed to compare the effect of proprioceptive exercises versus ultrasound therapy in the management of knee osteoarthritis.

Methods

The research design was pretest-posttest experimental design. The population for this study comprised of patient with knee OA attending Muhammad Abdullahi Wase Specialist Hospital and Murtala Muhammad Specialist Hospital (MMSH) both in Kano State. Twenty ambulatory knee OA patients were recruited using judgemental sampling technique and then randomly assigned to any of two groups as either Control group or Experimental group, using computer generated random numbers.

Data Collection Instruments

The following instruments were used in the collection of the data:

1. The Ultrasound Therapy Unit 3MHz: (Sonicator 740, Mettler, USA.)
2. Universal goniometer 180 degree (model G30) was used to measure range of motion.
3. Standard bathroom weighing scale (Harson, China) was used to measure weight of the patients
4. Western Ontario McMaster Universities Arthritis Index (WOMAC) score sheet was used to measure the quality of life of the participants. This instrument assesses pain, stiffness and physical function in persons with hip and/or knee Osteoarthritis. It has a test re-test reliability of 0.95, 0.90 and 0.92 for pain, stiffness and function respectively and a validity of 0.67, 0.63 and 0.64 for for pain, stiffness and function respectively (McConell et al, 2001).
5. Visual Analogue Scale (VAS) was used to measure pain intensity. This is a 10cm calibrated line with zero (0) point indicating no pain and ten (10) point indicating unbearable pain. It was used to assess the level of pain of the patients. It has a reliability of 0.90 using ICC (Brosseu et al, 2003).

Data Collection Procedure

The entire participants with pain in the knee joint and who were clinically diagnosed as having Osteoarthritis of knee were screened.

Screening for Inclusion Criteria: Subjects were screened for the following inclusion criteria:

i. Primary Osteoarthritis
ii. Symptoms more than three months; who can walk heel and toes
iii. Age between 35 to 55 years

Randomisation
Randomisation into groups was done using computer generated numbers.

Collection of Demographic Information
Participants' age, body mass, height and body mass index was determined and documented.

Pre-intervention Assessment
Participants were evaluated for their pain intensity using VAS, quality of life using WOMAC index scores and active range of motion before intervention.

Range of Motion (ROM)
Knee range of motion was measured with participants in prone lying and the goniometer axis coinciding with knee joint axis at the lateral aspect of the knee flexion and extension to the maximum range available and ranges were noted.

Pain Intensity
Participants were asked to mark their pain intensity on a 10 cm long line marked with numbers 0 on one side and 10 on the other side where 0 indicates no pain and 10 indicates maximum pain.

Quality of Life (QoL)
Using WOMAC QoL was measured. WOMAC Score was calculated after asking the questions to the subjects on three sections A, B, and C. Section A for pain, section B for stiffness and section C for functional difficulty. Participants were asked to rate their score out of five grades of severity.

Intervention
The intervention comprised of 2 groups. Participants in group 1 received isometric quadriceps exercises and ultrasound treatment. Those in group 2 received static quadriceps exercises and proprioceptive exercises.

GROUP 1:
Isometric quadriceps exercise
Isometric quadriceps exercises was given with participants in long sitting position, hands at sides and a role of towel placed below affected knee. The participants were asked to press the towel down and hold it till count of ten then relax. Ten repetitions were carried out per session, one session per day for 14 days of treatment (Topp et al, 2002). This was repeated again for 10 repetitions followed by other side knee. This was repeated again for the other knee.

Ultrasound Treatment
The continues ultrasound mode of 3 MHz and intensity of 2.0W/cm2 was applied to the patients' knee. The ultrasound probe was applied for 5 minutes at each session of the treatment. (Chamberlain et al, 1982).

Patients' preparation: The knee was well cleaned and participants were seated comfortably on a treatment couch with adequate pillow support at the back of the head. The treatment procedure was explained to the participants before commencement of the treatment.

Equipment preparation: The ultrasound therapy machine was cleaned before administering the treatment and was tested under water to ensure it is working properly before using it on the participants.

Treatment: The continuous ultrasound mode was used. Frequency of 3 MHz and intensity of 2.0W/cm2. The total time of application was 5 minutes at each session of the treatment for a period of four (Chamberlain et al, 1982). The probe was applied to the medial and lateral aspect of the patient's knee.

GROUP 2:

Isometric quadriceps exercise

Isometric quadriceps exercises were given with participant in long sitting position as described above. A role of towel was placed below the affected knee. The participants were then asked to press the towel down and hold it to a count of ten (in seconds) and then relax. Ten repetitions were carried out per session, one session per day for 14 days of treatment (Topp et al, 2002). This was repeated again for 10 repetitions followed by other side of the knee. This was repeated again for the other knee.

Proprioceptive exercises

This was carried out according to the protocol of Mondam et al (2012). It comprises of the following:

a. One Leg Balance: The participants were instructed to stand on affected foot in a relaxed upright posture and the other leg flexed to 90^{o} at the knee, hip and ankle. This position was held for one minute, followed by a rest period for 10-20 seconds, and was repeated twice. After a brief rest of 20-30 seconds same procedure was carried out on the unaffected leg.

b. Blind Advanced One Leg Balance: It was same as one leg balance, except that the participants were asked to close their eyes while performing the routine, and it was repeated twice.

c. Toe Walking: Participants were made to walk for 20 meter distance up on the toes. After a short rest, the procedure was repeated once again.

d. Cross Body Leg Swings: Participants were instructed to lean lightly forward with hands on a wall for support and to place their body weight on the affected leg while the other leg swing in front of the body. This was repeated for 15 times and after a brief rest of about

20-30 seconds the same procedure was carried out on the opposite leg. These exercises were done three times in a week for a period of four weeks.

Post Intervention Assessment

After four weeks treatment, participants were evaluated for their pain intensity using VAS, Quality of life, using WOMAC scores and Active range of motion.

Data Analysis Procedure

Data collected was summarised using descriptive statistics of mean and standard deviation. Inferential statistical analysis was carried out using paired and independent 't' test. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS), version 16. All statistical analysis were set at a confidence level of 0.05.

Results

The descriptive statistics of the participants' physical characteristics is shown in Table 1. Table 2 presented the comparison of the means of the pre and post scores of treatment outcomes between the experiment and control group. The result did not show significant difference between the two outcomes at $P<0.05$. Table 3 shows the inferential statistics of paired student t-test comparing the means of pre and post treatment outcomes within the experimental group. The result indicated significant difference between the two outcomes at $P<0.05$. The Inferential statistics of paired student t-test comparing the means of pre and post treatment outcomes within the control group is shown in Table 4. The result also indicated significant difference between the two outcomes at $P<0.05$ (Table 4).

***Table 1**: Anthropometric characteristics of participants*

Variables	Experimental group X ±SD	Control group X ±SD
BMI ($kg/m^{2)}$	30.74 ± 2.25	30.72±2.29
WEIGHT(kg)	81.30 ± 10.53	78.18± 2.29
HEIGHT(m)	1.62 ± 0.06	1.59±0.08

BMI = Body mass index, SD= Standard deviation, X= Mean.

Table 2: *Comparison of pre and post treatment VAS scores within the Control and Experimental groups.*

	Pretreatment X ±SD	Post treatment X ±SD	T	P
Experimental VAS Scores	6.40±1.17	2.80±1.15	13.50	0.000
Control VAS Scores	5.50±0.85	2.90±0.88	15.92	0.000

Table 3: *Comparison of pre and post treatment WOMAC score within the Control and Experimental group*

	Pre treatment X ±SD	Post treatment X±SD	t	P
Experimental WOMAC Scores	60.3±11.80	45.4±5.58	3.96	0.003
Control	48.40±9.58	45.50±9.41	6.69	0.000

Table 4: *Comparison of pre and post treatment AROM within the Control and Experimental group*

	Pre treatment X ±SD	Post treatment X ±SD	t	P
Experimental AROM	119.00±3.53	127.10±4.12	-9.00	0.000
Control AROM	119.60±5.15	127.00±3.48	-7.384	0.000

Table 5: *Comparison of between group mean difference in the Experimental and Control Group.*

Variable	Experimental	Control	t	p
X±SD	X±SD			
VAS	2.80±1.14	2.90±0.88	-0.22	0.83
Scores				
WOMAC	45.40±5.58	45.50±9.41	-0.03	0.98
Scores				
ROM	127.10±4.12	127.00±3.43	0.06	0.95

T (18) = 2.101 ($p<0.05$)

Discussion

The result from this study shows that either a combination of proprioceptive exercises with static quadriceps exercises or ultrasound therapy with static quadriceps exercises can both significantly decrease pain, stiffness, and increase ROM and physical function in patient with knee osteoarthritis.

The findings of Topp, et al. (2002) study were on the same line with the finding of this study which suggests positive effects of an exercises regime on quadriceps strength and proprioceptive acuity and disability in patient with knee osteoarthritis. The exercises in Topp et al's (2002) include isometric quadriceps contraction, a static exercises cycle, isotonic knee exercises using therapeutic resistance bands, functional sit-stand, and step-down and balance co-ordination exercises unilateral stance and balance board. Following five weeks of training they found that quadriceps strength, joint position sense, aggregate functional performance time and Lequesne index improved significantly in the exercise group. The result of this study is also supported by the work of Duman, et al. (2012) in which they found that in osteoarthritis, proprioceptive exercises have beneficial effects on static balance and to some extent on proprioceptive accuracy.

Furthermore, the conclusion of Da-Hon Lin, et al. (2009) study to a greater extent agree with the findings of this study. Da-Hon Lin, et al. (2009) found out that both types of non-weight bearing exercises (proprioceptive training and strength training) significantly improved outcomes in patient with knee osteoarthritis. In the study, 108 patients were randomly assigned to proprioceptive training, strength training, or no exercise (control) group for an 8-week intervention. WOMAC pain and function scores, walking time on three different terrains, knee strength, and absolute knee reposition error

were assessed before and after intervention. The result revealed both proprioceptive and strength training significantly improved WOMAC pain and function scores. The proprioceptive training demonstrated greater improvement in walking time on a spongy surface and knee reposition error than the other two groups. They therefore concluded that Proprioceptive training led to greater improvements in proprioceptive function, while strength training resulted in a greater increase in knee extensor muscle strength.

A systematic review by Loyola-sanchez, Richardson and Maclntyre (2010) yielded findings that support the finding from this study. In the review, randomised control trials with the aim of determining the efficacy of ultrasound for decreasing pain and improving physical function, patients' perception of disease severity and cartilage repair in people with knee osteoarthritis were searched. They concluded that ultrasound could be efficacious for decreasing pain and may improve physical function in patients with knee osteoarthritis. Similarly, the result of this study was also supported by the study of Falconer, Hayes and Chang (1992) in which they found twelve treatments of exercise preceded by ultrasound for eight weeks significantly improve ROM, pain and gait velocity in patient with knee osteoarthritis.

However, the result of this study is not in line with that of Mondam, et al. (2012) in which they found out that proprioceptive exercises appeared to be more beneficial than other conventional treatment in the management of patient with knee osteoarthritis. This may be attributed to the fact that the above study used adequate sample size more than this study that is 50, and they excluded elderly patient (all patient >55 years) from their study. Similarly, the result of this study is at variance with findings from a systematic review by Smith, King and Hing (2012) in which they found that eight weeks proprioceptive exercises significantly improved functional outcomes in people with knee OA. In the review, seven randomised control trials were identified from the literature with the aim of determining the effectiveness of proprioceptive exercises in the management of knee OA. They concluded that when compared to non-proprioceptive exercise, proprioceptive exercises significantly improved the functional outcomes, joint position sense and joint position angulation error in patient with knee OA. This might be as a result of enough time the has patient to show significant improvement in the performance of activities and it might be attributed to the fact that the above study used large sample size of five hundred and sixty in contrast to this study.

Conclusion

Proprioceptive exercises or ultrasound therapy, in addition to static quadriceps exercises can both significantly decrease pain; stiffness, increase ROM and physical function in patient with knee osteoarthritis.

Recommendations

Based on the finding of this study, The following recommendations were made:

1. Proprioceptive exercises and ultrasound therapy can be used alternatively or together in the management of patient with knee OA.
2. Prospective clinical trials of this nature should be carried out with larger number of patients and more extensive time to determine the different in the efficacy between the modalities.

Limitation

The researcher ensured the correct frequency and duration of exercise during the intervention, however whether participants do the exercise at home or not could not be ascertained.

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