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# Effects of Physical Therapy Modalities on Osteoarthritis Patients

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**ABSTRACT**

Osteoarthritis is a chronic degenerative disorder characterized by pain, swelling and decrease willingness to move. The purpose of this study was to determine the effectiveness of physical therapy modalities on alleviating the primary complaints of patients suffering from Osteoarthritis of the knee such as pain and functional disabilities. An experimental method was used composing of twenty elderly patients diagnosed with Osteoarthritis, ten joined the experimental group and another ten for the control group all of whom were treated with Transcutaneous Electrical Nerve Stimulator for fifteen minutes, Hydrocollator packs for fifteen minutes and Active Range of Motion exercise for ten repetitions in three sets at their respective homes. To test the modalities effectiveness after sixteen treatment sessions, the Numeric Pain Scale and Lequesne Algofunctional Index standardized tools were utilized which was subjected to correlation frequency for interpretation. All pertinent data of patients and procedures done were regarded with utmost confidentiality and sensitivity. The results indicated that patients who underwent Physical Therapy sessions had reduced pain scale and improved Lequesne Algofunctional Index scores according to the pre and post evaluation done after every four treatments thereby concluding that such form of treatments can decrease the symptoms felt.

**KEYWORDS**

Physical therapy modalities, osteoarthritis, Numeric Pain Scale and Lequesne Algofunctional Index, Tagbilaran City, Philippines

## INTRODUCTION

Osteoarthritis (OA) is defined as a "heterogeneous group of conditions that lead to joint symptoms and signs which are associated with defective integrity of articular cartilage and associated changes in the underlying bone at the margins" (Altman et al., 1986). It is thought to be the most prevalent chronic joint disease and incidence is rising because of the ageing population and the epidemic of obesity (Bijlsma et al., 2011). Although the aetiology is idiopathic, mechanical injury to the joint due to major stress or repetitive minor stresses and poor synovial fluid circulation when the joint is immobilized are possible causes. It can be genetically related, especially in the hands, hips and the knees. Other risk factors are weakness of the quadriceps (*quadricep's*) muscles, joint impact or sports with repetitive impact and twisting and occupational activities such as jobs that require kneeling and squatting with heavy lifting (Kisner et al., 2007).

Knee osteoarthritis contributes greatly to disability in the general population, particularly in the elderly (Thomas et al., 2002). Its clinical manifestations include pain with excessive activity, pain at rest, stiffness after inactivity but the stiffness usually subsides within 30 minutes of moving the joint and limitation of motion (Beers et al., 2003). Other symptoms includes muscle weakness, decreased proprioception and balance and functional limitations in activities of daily living (ADL's) and instrumental activities of daily living (IADL's) (Beers, et al., 2003). According to Kisner and Colby (2007) stressed that the pain, joint stiffness, decreased muscle performance and decrease aerobic capacity affect the quality of life and increase the risk for disability for the individual with OA. The principal treatment objectives are to control pain adequately, improve function, and reduce disability (Sarzi-Puttini P., et al., 2005).

Clinical knee OA usually is managed in primary care with analgesics and non-pharmacological options, such as exercise (Holden et al., 2008). Exercise is the most studied intervention in OA and appears to provide benefits with respect to pain, function, and disability. Clinical and professional practice guidelines have been developed based on expert opinion and have identified exercise as a main component of OA management (Iversen, 2012). Osteoarthritis Research Society International recommends that patients with symptomatic Osteoarthritis

of the knee (OA-K) should be referred to a physical therapist for evaluation and instruction in exercise and encouraged to engage in regular aerobic, strengthening, and range-of-motion exercises. Between September 2008 and January 2010, the Royal Dutch Society for Physiotherapy Guideline in patients with Hip and Knee Osteoarthritis was revised. It showed that exercises are recommended, but no specific intensity of exercises could be defined (Peter et al., 2011).

Transcutaneous Electrical Nerve Stimulator (TENS) is a complementary and adjunctive therapy to control symptomatic and non-malignant chronic pain (Watson, 2009). These are small, battery-operated machines with two electrodes attached that send electrical current, usually attached to the skin on the painful area. The application of any electrical current through the skin with the aim of pain modulation is a frequently used modality in knee osteoarthritis (Rutjes et al., 2009). It is based on the 'Gate-Control Theory' of pain perception as described by Melzack and Wall (1965). The theory suggests that the stimulation of large diameter, (A-beta) primary sensory afferent cutaneous fibres activates inhibitory interneurons in the spinal cord dorsal horn and, thereby, may attenuate the transmission of nociceptive signals from small diameter A-delta and C-fibres (Watson, 2009). Adedoyin and associates (2008) evaluated the effects of TENS, when used in conjunction with exercise, on pain and function in patients with OA-K. It further showed that all treatment protocols led to significant improvements in pain and function over time. On the other hand, Sluka (2003) in a study on Knee Osteoarthritis and TENS, concluded that conventional TENS were more effective for pain relief. Conventional TENS uses moderate to high frequency current of 40 to 150 Hz and 50 to 100µsecpulses width, typically at a low intensity, to stimulate sensory fibres (Rutjes et al., 2009). In a study conducted by Rutjes, et al. (2009) showed that people who used electro-stimulation had improvement in their pain of about 2 on the pain scale after 4 weeks.

The ACR also suggested non-pharmacologic modalities for treatment of knee OA such as thermal modalities (Hochberg, 2011). Superficial heat such as hydrocollator packs (HCP) is believed to increase the pain threshold, reduce muscle spasm, and relieve pain by acting on free nerve endings (Iversen, 2012). When therapeutic heat is used, the thermal stimuli provide input to the spinal gating mechanism, which in effect overrides the painful stimuli (Behrens, 2006).

In the University of Bohol Medical Rehabilitation Center (UBMRC) since the time of operation in 1995 had catered to 4,653 patients who have diverse pathologies. Thirty percent of them were diagnosed by the resident physiatrist to be OA, and twenty percent of these OA patients were elderly with OA-K who had irregular attendance during therapy. Accordingly, in an interview it revealed that

sometimes they cannot attend to their treatment schedules at the rehabilitation center because no one would accompany them. These prompted the researchers to determine the effectiveness of physical therapy modalities to patients with OA-K having complains of pain and functional limitations on a home based program in order to enhance the physical therapy treatment.

## METHODOLOGY

For this specific investigation, the researchers utilized a quantitative method comparing two groups under study. The two groups of respondents were chosen randomly. The first group underwent PT intervention was referred to as the home treatment group and second group without any PT intervention. These patients were from UBMRC who were diagnosed clinically and radiographically as OA-K by the physiatrist, and they underwent PT interventions at the said center for the last 2-3 months. Patients in the control group had voluntarily stopped their treatment sessions in the rehabilitation center for one month before the conduct of the study. After getting the full consent by letting them sign the confidentiality forms, the researchers proceeded with the immersion.

The home treatment group of ten OA-K patients underwent PT sessions at their respective homes every morning for sixteen successive treatment sessions. PT management started with TENS conventional mode at 40 Hz and HCP placed on the painful site for fifteen minutes simultaneously. Patients performed Active Range of Motion (AROM) exercises on the knee in a sitting position with ten repetitions in three sets with two minutes rest periods in between after the electrotherapy modalities application.

The control group did not undergo any PT treatments but they participated in pre and post evaluation surveys.

All conditions were held constant such as physical activity, bilateral affectations and diet with close monitoring 24/7.

Group of researchers led by Faucher et al. assisted the respondents in answering the pre-evaluation survey using Lequesne Algofunctional Index (LAI) and Numeric Rating Scale (NRS) for pain. Every after four treatment sessions, a post evaluation study was done using the same tools.

LAI was firstly published by a group of professor M G Lequesne from Department of Rheumatology, Léopold Bellan Teaching Hospital from Paris, France. They used Lequesne Algofunctional Index to evaluate the severity of osteoarthritis affecting the knee joint and to evaluate the effectiveness of therapeutic interventions applied. The latest version of the index includes three sections of

index namely, Pain or Discomfort, Maximum Distance Walked and Activities of Daily Living with its corresponding parameters. Pain and discomfort assesses on the areas of pain or discomfort during nocturnal bed rest, duration of morning stiffness or pain after getting up, increase pain on standing for 30 minutes, pain on walking and pain or discomfort in sitting position for 2 hours. Two parameters are on the section of Maximum Distance Walked namely the maximum distance walked which is measured in meters and walking aids required. The sections on Activities of Daily Living has four parameters and are scored on putting on socks by bending forward, picking up an object from the floor, going up and down a standard flight of stairs, and getting into and out of a car. All three section scores are added and total score ranged from 0-24. The highest score of each parameter indicates the worst condition. The more decrease the score is, the lesser the severity of OA and the higher the scores are, the more also is the affectation. The relationship of the index will have a description which will be shown as 0: no limitations; 1 – 4: Mild limitations; 5 –7: Moderate limitations; 8 – 10: Severe; 11 –13: Very severe; and > = 14: Extremely severe.

The NRS for pain is a subjective uni-dimensional measure of pain intensity in adults including those with chronic pain due to OA diseases and is considered to be the most common assessment tool clinically. It consists of an 11-point numeric scale (NRS 11) with zero: No pain; 1-3: Slight pain; 4-6: Moderate pain; 7 – 9: Severe pain; and 10: Worst pain.

The data were analysed and interpreted through projections based on the numbers using the t-test formula.

## RESULTS AND DISCUSSION

Table 1. Distribution of Respondents

| Age Groups | Control | Experimental |
|---|---|---|
| 50 to 59 years old | 2 | 1 |
| 60 to 69 years old | 6 | 1 |
| 70 to 79 years old | 1 | 5 |
| 80 to 89 years old | 0 | 3 |
| 90 and Above | 1 | 0 |
| Grand Total | 10 | 10 |

Table 1 is the distribution of respondents in the control and home treatment group that shows that all patients were fifty years old and above.

It is clearly stated in the literature by Bijlsma et al., 2011 that the onset of OA is mostly on aging patients.

Table 2. Pain Scale on Pre-Survey Evaluation

| Pain Scale Categories | Control Group | % | Home Treatment Group | % |
|---|---|---|---|---|
| 0- No pain | 0 | 0 | 0 | 0 |
| 1-3 Slight pain | 7 | 70 | 8 | 80 |
| 4-6 Moderate pain | 2 | 20 | 2 | 20 |
| 7-9 Severe pain | 0 | 0 | 0 | 0 |
| 10-Worst pain | 1 | 10 | 0 | 0 |
| Grand Total | 10 | 100 | 10 | 100 |

Modified from the study of Jones et al. 2007 from Journal of Rehabilitation Research and Development

Table 2 depicts the pain scale on pre-evaluation survey. It was in the control group that 70% had slight pain and 20% had moderate pain and 10% indicated worst pain. While in the home treatment group, 80% showed slight pain and 20% had moderate pain.

Table 3. Comparison between the Pain Scale Categories on the Experimental Group

| Index | Pre-survey | % | Post-surveys | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| | # of subjects | | # of subjects | # of subjects | # of subjects | # of subjects |
| 0- No pain | 0 | 0 | 0 | 0 | 1 | 1 |
| 1-3 Slight pain | 8 | 80 | 8 | 10 | 9 | 9 |
| 4-6 Moderate pain | 2 | 20 | 2 | 0 | 0 | 0 |
| 7-9 Severe pain | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-Worst pain | 0 | 0 | 0 | 0 | 0 | 0 |

Table 3 illustrates a comparison between the pre-survey and post-survey scenario in the experimental group. On the successive treatments that were made, post-survey shows that, after the fourth treatment session, pain scale showed no significant changes yet. Subsequently on the eighth treatment session all of the patients felt slight pain already. On the 12th treatment session, one of them did not feel pain anymore during the post-survey evaluation and 9 of them had slight pain. Later on the last treatment sessions, all pain felt by the patients plateau already. The results prove to show that the PT regimen that was advocated were effective in relieving the symptoms of pain whether it is that the causes stem from activity or inactivity. Since the primary symptom of OA decreases, then the patient has more capabilities to do functional activities as assessed by the LAI parameters. This is consistent with the study conducted by Baker et al. (2000) wherein the adverse outcomes in knee osteoarthritis which is the pain, loss of function and disability were treated with physical therapy and evidences showed that treatments showed a notable positive effect on pain and or disability.

Physical therapy holds a prominent position in the treatment of OA that involves principally the use of heat and an appropriate exercise program; it is useful to precede each exercise session with applications of moderate heat for 20 to 30 minutes to relieve pain and diminish stiffness (Khan et al., 2009).

The Philadelphia Panel evidence-based clinical guidelines on musculoskeletal rehabilitation interventions identified two interventions that demonstrated clinically significant benefit for pain in knee osteoarthritis such as therapeutic exercise and TENS (Harris et al., 2002).

Table 4. Pain Scale Control Group

| Index | Pre-survey | % | Post-surveys | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| | # of subjects | | # of subjects | # of subjects | # of subjects | # of subjects |
| 0- No pain | 0 | 0 | 0 | 0 | 0 | 0 |
| 1-3 Slight pain | 7 | 70 | 8 | 7 | 7 | 7 |
| 4-6 Moderate pain | 2 | 20 | 1 | 2 | 2 | 2 |
| 7-9 Severe pain | 0 | 0 | 1 | 1 | 1 | 1 |
| 10-Worst pain | 1 | 10 | 0 | 0 | 0 | 0 |

Table 4 illustrates the pain scale on the control group. The pain scale in the control group before the survey showed that most of the patients which comprised seven of the population experienced slight pain, two felt moderate pain and one had worst pain. During the first post-survey assessment made, eight of them felt slight pain, one had moderate pain and one had severe pain. On post-survey 2, seven had slight pain, two had moderate pain and one had severe pain. The third post-survey results showed that seven had slight pain, two had moderate pain and one had severe pain. On the last post-survey done, seven had slight pain, two had moderate pain and one had severe pain.

Table 5. LAI Score Index of the Home Treatment Group

| Index # of subjects | | Pre-survey 1 | Post-surveys | | | |
|---|---|---|---|---|---|---|
| | | | 2 | 3 | 4 | |
| | | # of subjects | # of subjects | # of subjects | # of subjects | |
| 0 | no limitations | 0 | 0 | 0 | 1 | 1 |
| 1 – 4 | Mild limitations | 3 | 3 | 3 | 2 | 2 |
| 5 –7 | Moderate limitations | 1 | 1 | 2 | 3 | 3 |
| 8 – 10 | Severe | 2 | 2 | 1 | 1 | 1 |
| 11 –13 | Very severe | 1 | 1 | 1 | 0 | 1 |
| > = 14 | Extremely severe | 3 | 3 | 3 | 3 | 2 |

As summarized in Table 5, on the pre-survey evaluation made on the home treatment group using the LAI parameters showed that three of them had extremely severe symptoms and limitations; one was very severe; two as severe, one has moderate limitations and three of them had mild limitations. What follows after the combined treatment, the post-survey scores showed that eight subjects had a significant reduction by 1.0-2.0 indicating that the limitations had decreased but two of them remained in the same score index. These findings agree with the double crossover study of Kitay et al. (2009), which involves treatment with combined exercise and local heating which significantly improved pain, quality of life and ROM in patients with OA-K (p.1274). Jamtvedt et al. (2007) and company studied on the effects of hot packs, shows that results for pain or function are not consistent, and concluded that the effect of thermotherapy is unclear (p.133). The same study shows a total of 9 reviews that examined the effect of exercise on osteoarthritis of the knee, only this high-quality review

concluded exercise reduced pain and improved function (Jamtvedt, et 2007).

Hawker et al. (2011) made a systematic search of the PUBMED and Cochrane databases from September 2009 to September 2010 to identify articles are reporting on studies examining the safety or efficacy of non-pharmacologic therapies in the management of OA. It included two articles evaluating TENS, one of thermal modalities and 25 studies of exercise (Hawker et al., 2011 p. 368). Hawker (2011) in this systematic review found little evidence of a significant effect for electrostimulation on pain in knee OA and exercises has shown improvements in symptoms and disability in patients with knee OA.

Pennix et al. (2001) made a study of 439 community-dwelling persons aged 60 years or older with knee osteoarthritis, the cumulative incidence of ADL disability was lower in the exercise groups than in the control group indicating that exercise may be an effective strategy for preventing ADL disability and, consequently, may prolong older persons' autonomy. Modalities are initially incorporated into treatment sessions by PTs, with a goal of educating the patient on appropriate application and use at home and they are also used as part of a daily treatment regimen as a ''rescue'' treatment for ''flare ups.''(Stanos et al., 2007).

Several randomised clinical trials have shown the beneficial effects of exercise in patients with OA-K (Baar et al., 2001) small to moderate beneficial effects on pain and disability can be produced, however, these effects decline over time and finally disappear (Baar et al, 2001). Daily exercise is important in maintaining physical health and has been associated with 25% less self-reported musculoskeletal pain compared with more sedentary control subjects (Stanos et al., 2007. This study of Stanos et al. (2007) further reports that inactivity has been shown to be a predictor of future pain with injury.

Table 6. Control Group's LAI Score Index

| Index # of subjects | | Pre-survey 1 | Post-surveys | | | |
|---|---|---|---|---|---|---|
| | | | 2 | 3 | 4 | |
| | | # of subjects | # of subjects | # of subjects | # of subjects | |
| 0 | no limitations | 0 | 0 | 0 | 0 | 0 |
| 1 – 4 | Mild limitations | 5 | 5 | 5 | 4 | 5 |
| 5 –7 | Moderate limitations | 2 | 3 | 3 | 4 | 3 |
| 8 – 10 | Severe | 0 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11 –13 | Very severe | 1 | 1 | 1 | 1 | 1 |
| > = 14 | Extremely severe | 1 | 1 | 1 | 1 | 1 |

Table 6 shows the comparison between the control group's LAI pre-survey and post survey results. It was indicated that one exhibited extreme severity in the pre-survey and all post surveys; one tallied very severe in both pre survey and all post-surveys; only two experienced moderate limitations in the pre-survey while three had moderate limitations in the first two post-survey and became four in the 3rd post survey and decreased to 3 on the 4th post survey that were classified on moderate limitations. A consistent number of five respondents experienced mild limitations on the pre-survey and post surveys, and five had mild limitations. Without PT treatment made on this particular group, post-survey shows fluctuating index scores to a significant difference of 1.0-2.0 but 1 of them plateau to a very high index of 20.

## CONCLUSION

In a capsule, the home treatment conducted by the researchers yielded to positive results compared to the control group that did not undergo any treatment at all. It was clearly reflected on the results of the LAI and Pain Score Index being tested accordingly wherein, there was the steady decrease of pain in the home treatment group, while the control group resulted to fluctuating pain intensity and LAI scores. These results validated the main goal in the treatment of knee OA that should be directed towards controlling pain, preserving and improving the function of joints, providing functional independence, and increasing the quality of life (Tuncher et al., 2011). This study proved the effectiveness of PT modalities to patients who had OA-K with complains of pain and functional limitations.

## RECOMMENDATION

It is, therefore, recommended that patients who suffered from OA will undergo physical therapy treatments. This consists of hot pack application at home whenever pain is felt on the affected area and a need for maintenance of range of motion exercises for joint integrity.

## LITERATURE CITED

Adedoyin, R. A., Olaogun, M., Oyeyemi, Adewale, L. Transcutaneous electrical nerve stimulation and interferential current combined with exercise for the treatment of knee osteoarthritis: A randomized controlled trial. http://dx.doi.org/10.1016/S1013-7025(09)70054-5. (Accessed last April 24, 2014).

Altman, R., Asch, E., Bloch, D., Bole, G., Borenstein, D., Brandt, K., ... & Wolfe, F. (1986). Development of criteria for the classification and reporting of osteoarthritis: classification of osteoarthritis of the knee. Arthritis & Rheumatism, 29(8), 1039-1049. (Accessed last April 24, 2014).

Baar, M., Dekker, J., Oostendorp, B., Voom.,TB., Bijlsma, JWJ.(2001). Effectiveness of exercise in patients with osteoarthritis of hip or knee: Nine months' follow up Ann Rheum Dis 2001; 60:1123–1130.

Baker, K., McAlindon, T. (2000). Osteoarthritis exercise for knee osteoarthritis current opinion in rheumatology September – Vol. 12 Iss 5 pp. 456-463.

Beers, M., Fletcher, A., Jones, T., Porter, R., Berkwits, M., Kaplan, J. (2003), The merck manual of medical information, 2nd Home edition. Merck & Company, Inc.

Bijlsma, J., Berenbaum, F., Lafeber, F. (2011). Osteoarthritis: An update with relevance for clinical practice. Lancet 2011; 377: 2115–26 Vol 377.

Deyle, G. D., Allison, S. C., Matekel, R. L., Ryder, M. G., Stang, J. M., Gohdes, D. D., Hutton, J. P., Henderson N. E., & Garber, M. B. (2005). Physical therapy treatment effectiveness for osteoarthritis of the knee: A randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program. Physical therapy, 85(12), 1301-1317. http://ptjournal.apta.org/content/85/12/1301.short. (Accessed last April 24, 2014).

Faucher, M., Poiraudeau, S., Lefevre-Colau, M.M., Rannou, F., Fermanian J., Revel, M., (2002). Algo-functional assessment of knee osteoarthritis: comparison of the test–retest reliability and construct validity of the

Womac and Lequesne indexes. Osteoarthritis and cartilage. August 2002 Vol. 10, Iss 8 pp 602-610. DOI: 10.1053/joca.2002.0533. (Accessed last June 23, 2014)

Fitzgerald, K. G. and Oatis, C. (2004). Role of Physical therapy in management of knee osteoarthritis curr opin rheumatol 16:143–147. ©Lippincott Williams & Wilkins.

Harris, G. MD, Susman, J. (2002). MD. Managing musculoskeletal complaints with rehabilitation therapy: Summary of the philadelphia panel evidence-based clinical practice guidelines on musculoskeletal rehabilitation interventions. The Journal of Family Practice. December Vol. 51, No.12 pp. 1042-1046.

Hawker, G.A., Mian, S., Bednis, K and Stanaitis (2011). Osteoarthritis year 2010 in review: Non pharmacologic therapy. Osteoarthritis and Cartilage. Vol. 19, Iss 4, pp. 366–374. http://dx.doi.org/10.1016/j.joca.2011.01.021. (Accessed last April 24, 2014).

Hochberg, M. C. (2011), Proposed 2011 American college of rheumatology recommendations for the use of non-pharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip and knee. http://dx.doi.org/10.1016/j.semarthrit.2011.06.015 Copyright © 2011 Elsevier Inc.

Holden, M., Nicholls, E., Hay, E. and Foste, N. (2008). Physical therapists' use of therapeutic exercise patients with clinical knee osteoarthritis in the united kingdom: In line with current recommendations PHYS THER.; 88:1109-1121.

Iversen, M. D. (2012) Rehabilitation interventions for pain and disability in osteoarthritis american journal of nursing. March 2012 Vol. 112, No. 3.

Jamtvedt, G., Thuve Dahm, K., Christie, A., Moe, R. H., Haavardsholm, E., Holm, I. and Hagen, K. B., (2007). Physical therapy interventions for patients with osteoarthritis of the knee: An overview of systematic reviews. Journal of the American physical therapy association and royal dutch society for physical theraphy; © 2007 American Physical Therapy Association. Originally published online November 6, 2007 doi: 10.2522/

ptj.20070043.

Jones, K.R., Vojir, C.P., Hutt, E., Fink, R. Determining mild, moderate, and severe pain equivalency across pain-intensity tools in nursing home residents. Journal of rehabilitation research and development. Vol. 44 No. 2, 2007 pp. 305-314. Retrieved from http://goo.gl/tSrKPz. (Accessed last April 15, 2014).

Khan, M., Ahmed, S.M., Ferdous, J. (2009). Physical management of patient with osteoarthritis of knee BSMMU J; 2(2): 95-98.

Kisner, C., Colby, L.A., (2007). Therapeutic exercise foundations and techniques 5th ed. FA Davis Company. Retrieved from http://goo.gl/WggUo4. (Accessed last April 15, 2014)

Kitay, G.S, Koren, M.J, Helfet,D.L., Parides, M.K. (2009). Efficacy of combined local mechanical vibrations, continuous passive motion and thermotherapy in the management of osteoarthritis of the knee J.A. MarkensonOsteoarthritis and Cartilage Vol. 17 Iss 10, October 2009, pp. 1269–1274 http://dx.doi.org/10.1016/j.joca.2009.04.015. (Accessed last April 24, 2014).

Melzack, R., Wall, P. D., (1965). Pain mechanisms: A new theory. Science, New Series, Vol. 150, No. 3699 (Nov. 19, 1965) 971-979http://goo.gl/cjALgY. (Accessed last June 22, 2014).

Michlovitz, S. and Behrens, B. (2006). Physical agents theory and practice, 2nd ed. FA Davis Company.

Pennix, B. W. J. H., Messier, S. P., Rejeski, W. J., Williamson, J. D., DiBari, M., Cavazzini, C., Applegate, W. B., and Pahor, M. (2001). Physical exercise and the prevention of disability in activities of daily living in older persons with osteoarthritis. Arch Intern Med. 2001; 161(19):2309-2316. doi:10.1001/archinte.161.19.2309. Retrieved from http://goo.gl/CNRmrH. (Accessed April 7, 2014)

Peter, W.F.H., Jansen, M.J., Hurkmans, E.J., Bloo5, H., Dekker-Bakker, L.M.M.C.J, Dilling, R.G., Hilberdink, W.K.H.A., Kersten-Smit, C., Rooij, M. de,

Veenhof, H.M., Vermeulen, I., de Vos, J.W. Schoones, VlietVlieland, T.P.M. (2011). Physiotherapy in hip and knee osteoarthritis : Development of a practice guideline concerning initial assessment, treatment and evaluation. órgãooficial da sociedadeportuguesa de reumatologia - actareumatolport. 2011; 36:268-281.

Sarzi-Puttini, P., Cimmino, M., Scarpa,R., Caporali,R., Parazzini, F., Zaninelli, A., Atzeni, F. and Canesi, B. (2005). Osteoarthritis: An overview of the disease and its treatment strategies. http://dx.doi.org/10.1016/j.semarthrit.2005.01.013. 4/17/2014.

Rutjes, A.W.S., Nüesch, E., Sterchi R., Kalichman L., Hendriks E., Osiri M., Brosseau L., Reichenbach S., Jüni P. (2009). Transcutaneous electrostimulation for osteoarthritis of the knee (Review) The Cochrane Collaboration and published in The Cochrane Library, Issue 1 http://www.thecochranelibrary.com (Accessed last April 7, 2014).

Sluka, K. A. and Walsh ,D. (2003). Transcutaneous electrical nerve stimulation: Basic science mechanisms and clinical effectiveness critical review by the american pain society. The Journal of Pain. Vol. 4 Iss. 2003. pp. 109-121. Retrieved fromhttp://goo.gl/XUYP8Q (Accessed last April 7, 2014).

Stanos, S., McLean , J., Rader, L. (2007). Physical medicine rehabilitation approach to pain anesthesiology clinics 25 (2007) 721–7591932-2275/07 2007 Elsevier Inc. doi:10.1016/j.anclin.2007.07.008.

Thomas, K. S., Muir K. R., Doherty M., Jones A. C., O'Reilly SC., Bassey EJ., (2002). Home based exercise programme for knee pain and knee osteoarthritis: randomised controlled trial. British Medical Journal; 325(7367): 752.

Tuncher, T., Cay, H.F., Kacar, C. , Altan, L., Atik, O., Aydin A., Ayhan, F., Corekciyanik, B., Durmaz, B. ,Eskiyurt, N., Genc, H., Gokcekutsal, Y., Gunaydin,R., Hepguler, S.,Hizmetli, S., Vos, J.W., Schoones, Vliet Vlieland, T.P.M. (2011). Physiotherapy in hip and knee osteoarthritis: development of a practice guideline concerning initial assessment, treatment and evaluation. órgãooficial da sociedadeportuguesa de reumatologia - actareumatolport. 2011; 36:268-281.

Watson, T. (2009). Electrotherapy evidence-based practice, 12th ed. Elsevier NRS for pain. http://goo.gl/XHcDvc (Accessed last April 7, 2014).