



EFFECTS OF KINESIOTAPING OF GASTROCNEMIUS ON PAIN AND FUNCTION IN PARTICIPANTS WITH MILD TO MODERATE OSTEOARTHRITIS KNEE

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Abstract: Background: OA is chronic degenerative disorder. It occurs in old age mainly in the weight bearing joints. Muscle weakness is important determinant of pain and disability of OA. Kinesiotape is a physiotherapeutic technique, which reduce pain & increase muscular strength. Objective: To find out effectiveness of Gastrocnemius Taping on pain and function in participants with mild to moderate OA knee. Methods: In this study, total 32 participants with mild to moderate OA knee with age between 45-60 years were included. They were divided into two groups: Experimental group (n=16) & control group (n=16). Both groups received conventional physiotherapy & experimental received Gastrocnemius Taping. They were evaluated pre-intervention (0 week), 1st week, 4th week for pain intensity (NPRS) & for function (WOMAC). Results: Wilcoxon test & Mann Whitney U test were applied for within group comparison & between groups comparison. Comparison of NPRS & Comparison of WOMAC showed that mean \pm SD of pre, at 1week, at 4 weeks of Group A were 6.00 ± 0.894 , 5.00 ± 0.816 , 3.75 ± 0.683 and Group B were 5.13 ± 1.258 , 4.25 ± 0.856 , 3.56 ± 1.094 . Group A were 46.81 ± 9.152 , 34.44 ± 7.966 , 24.06 ± 6.698 & Group B were 35.50 ± 11.81 , 27.75 ± 9.532 , 21.50 ± 7.483 . Conclusions: Kinesio Taping technique along with conventional physiotherapy is more effective for reducing pain & improve the function than conventional physiotherapy alone in participants with mild to moderate OA knee

Keywords: Kinesio Taping, Gastrocnemius, OA knee, Knee pain, WOMAC.

Introduction

Osteoarthritis is chronic degenerative disorder.[1] It is one of the joint diseases that lead to degeneration of joint cartilage & degenerative changes in the areas surrounding the joints & subchondral bones.[2] It affecting the articular cartilage of synovial joint with eventually resulting in bony remodeling & overgrowth at margin of the joint.[3] Arthritis begins when cartilage is severely worn because the muscle & ligaments.[2] Osteoarthritis is one of most frequent musculoskeletal disorder in adults. The current global prevalence rate OA is 29% for men, 47% for women. OA is also defined as clinical syndrome of joint pain accompanied by varying degree of functional limitation and reduced quality of life.[4] There are two types of Osteoarthritis. 1.Primary Osteoarthritis 2.Secondary Osteoarthritis 1.Primary Osteoarthritis It occurs in old age mainly in the weight bearing joints (Hip & Knee). Primary OA is commoner than the secondary OA.[5] Joint is due to abnormalities of its materials & biomechanical faulty joint structure. [6] 2.Secondary Osteoarthritis There is an underlying primary disease of joint which leads to degeneration. It may occur at any age after adolescence [5]. It is due to risk factor. [6] OA is one of the most prevalent conditions resulting to disability particularly in old age. [7] In OA knee, there is progressive loss of periarticular muscle mass and function has consequences on joint stability and health. Muscle wasting is inevitably associated with ageing, and more recently, it has been demonstrated in participants with OA. The reduction in muscle mass and strength is attributed to myofiber atrophy, reduction of muscle quality and defective muscle regeneration. Muscle weakness is an important determinant of pain and disability during OA. The affected muscles are - Hamstring group muscle, Anterior tibialis, Quadriceps group muscle and Gastrocnemius muscle.[8] OA of knee diagnosed by radiography, Physical examination, Laboratory findings. It confirmed with X-Ray or MRI. They show findings like osteophytes, Joint space narrowing, Cartilage abnormality, and subchondral sclerosis. [9] Treatment of option OA may be drugs, chondroprotective agents, viscosupplementation, supportive therapy, surgical treatment, Bracing and orthosis.[9] Drugs like NSAIDs, intraarticular corticosteroid, topical treatment. Supportive therapy like weight reduction and physiotherapy.[1] Physiotherapy treatment like exercise, electrotherapy, kinesio Taping, orthosis. This all methods are used for relieve pain, Muscle, joint function improvement, enhancement and improve daily activity.[3] This all method is used for relieve pain, muscle and joint function improvement, enhancement and improve all daily activity. Taping therapy is used in now days. There are many purposed effects which can be gained from using the kinesio taping. Kinesio Taping was created by Dr Kenzo Kase in 1970s in Japan, also made it to the US in

1990s. According to Dr Kase, the kinesio taping method provides multi days benefits for 3-4 days. Kinesio tape method is rehabilitative taping technique to facilitate the body's natural healing process. Kinesio tape is one kind of threptic tool. It has been used for prevention and treatment of injury. Kinesio Taping can be used to normalize muscle function, improve blood flow, reduce pain, muscle fatigue, muscle facilitation, correct joint alignment & improve proprioception. Kinesio Taping is used for muscle, ligament, tendon, also in numerous professional sports. Kinesio treatment to be used alongside other treatment such as manual therapy, modalities & Therapeutic exercise. [11] Kinesio Taping is 100% cotton, porous fabric with acrylic adhesive that is non medicate, latex free, heat activated. The tape can be using various shapes such as an "I", "Y", "X", "Web", "donut". The "Y" is the most common used when inhibition or facilitation of muscle is desired. [11] Tape can be applied from insertion to origin of the muscle for inhibition purpose and applied from origin to insertion for facilitation purpose. The mechanism of taping: when muscles are inflamed, swollen, weak or stiff the space between skin and muscle are compressed lead to constriction of lymphatic flow. The compression applies pressure, to pain receptor located between the skin and muscle which discomfort signals to brain result is pain. Basic application of tape to be applied when muscle is in stretched position. Tape cause microscopic lifting of the skin which aids in blood & lymphatic flow. These effects help to decrease the pain by lifting the pressure of the pain receptor. [12] Applying kinesio Tape leads to improvement in function through muscle facilitation/ inhibition in indexed knee. This is because kinesio tape effectively stimulated the proprioceptive sense, muscle spindles, Golgi tendons etc. and strengthen muscle in affected parts. These results were in agreement with the results of previous studies which reported that kinesio tape increase muscle activities, reduce pain, restricted excessive movement of the joint, increase joint speed and improve quality of life. [13] Gastrocnemius muscle is also affected in OA knee patient which lead to pain and decrease daily activity. Gastrocnemius muscle is largest and most superficial muscle of posterior compartment. Its function is plantarflex the foot at the ankle joint and flexing the leg at knee joint. [14] Gastrocnemius muscle is one of varus/ valgus stabilizer. It works synergistically with Quadriceps. So, if quadriceps muscle had any kind of pathology Gastrocnemius will also have pathology. [15] Gastrocnemius muscle producing the greatest knee flexion torque when the knee is in full extension. But because of weak Quadriceps, Gastrocnemius muscle will produce less force/ torque, which disturbs the varus/ valgus stability of knee. However, varus/ valgus alignment is associated with the progression of medial or lateral compartment of OA knee. This is the reason why gastrocnemius muscle weakness is responsible for OA knee. [16] There are a number of studies done about Kinesio taping in group of the quadriceps muscles, hamstring muscles and calf muscles are alone or together in OA knee. There is lack of quality evidence on the effect of kinesio taping of Gastrocnemius muscle. Hence the purpose of this study is to find out the effectiveness of Gastrocnemius on pain and function in mild to moderate OA knee.

Need Of Study

Exercise is meant to improve musculoskeletal function. Kinesio taping has also been found to be useful in improving function and relieving pain in OA knee participants. Facilitatory and Inhibitory taping techniques on various muscles are used as an adjunct to treating OA knee. Gastrocnemius, a postural muscle which works synergistically with Quadriceps so when the quadriceps muscle become weak gastrocnemius muscle weakness as well as. There is lack of quality evidence on the effect of Kinesio taping of Gastrocnemius muscle. 6 Introduction Hence, the present study aims to find out effects of gastrocnemius taping in mild to moderate OA knee participants.

Population and Sample

Pilot study was conducted to calculate sample size, with use of g power total 32 sample size were collected. convenient sampling was used & samples were divided in two group. Each group having 16 samples. One group was control & control & another group was experimental. WOMAC & NPRS scale were used as a outcome measure & data were taken pre & post treatment session at baseline & after 4 weeks.

Data and Sources of Data

From various OPDs in and around Surat, bardoli data were collected. Who were Diagnosed with unilateral OA of knee were included.

Theoretical framework

The project was submitted to the local research committee. After ethical approval from committee and university, the data collection was started. All participants were screened based on the inclusion and exclusion criteria and 32 participants who met with inclusion and exclusion were participating in the study. Participants were divided into two groups: Group A experimental group (n=16) and Group B control group (n=16). Participants already had x ray were included in the study. Selected participants were diagnosed with mild to moderate unilateral OA of knee. The participants were from Various physiotherapy OPDs/ clinics in and around Surat & Bardoli. The methods and procedures were explained to participants before starting the procedure. The participants were informed regarding the side effect of Kinesio taping before the procedure. • The Inform consent were signed by each participant after screening and explanations of all methods. Demographic data (Name, Age, Gender, Address, contact no.) and baseline 17 Materials and Method assessment were done. All participants were pre-assessed for knee pain using NPRS scale and function of knee by using WOMAC index. Both groups were received treatment for 4 weeks. (three sessions per week) NPRS and WOMAC were assessed pre-test, 1st week, 4th week in both groups. Group: A Participants were undergone Gastrocnemius Inhibitory Taping and conventional physiotherapy in OA knee. Group: B Participants were undergone conventional physiotherapy in OA knee. Kinesiology tape was used as experimental protocol. Patient position and procedure: The subject was instructed to take prone position and a Y- shape tape was fixed to the heel after bending the knee joint to 90 degree. The tap was attached around the Achilles tendon after extending the knee straight and maintaining the ankle in anatomical posture at 90 degree and the two tips of the split end were attached on both sides, along the gastrocnemius up to the centreline of the back of the knee. [2]



Statistical tools and econometric models

Following data analysis was done using SPSS software version 20.

Descriptive Statistics

Descriptive analysis including mean, standard deviation was done. Wilcoxon Test was used to assess the within groups (NPRS at 1st week-Pre-NPRS, NPRS at 4thweek-Pre-NPRS, WOMAC at 1stweek-Pre-WOMAC, WOMAC at 4th week-Pre-WOMAC).Mann-Whitney Test was used to assess the between groups (Difference between pre NPRS-NPRS at 1STweek, Difference between Pre NPRS-NPRS at 4th week, Difference between Pre NPRS – WOMAC at 1stweek, Difference between pre WOMAC-WOMAC AT 4TH WEEK). The level significance for all data analysis was set at 0.05.

Result & Discussion

Results of Descriptive Statics of Study Variables

Thirty-two participants were enrolled in the study and divides into two groups 16 in experimental group (group A) and 16 in control group (group B). The outcome measures were pain measured on NPRS (Numeric pain rate scale), functional measurement by WOMAC (The western Ontario and McMaster Universities Osteoarthritis Index) taken on the 1st day, 1st week & 4thweek. Data analysis was performed manually as well as by using SPSS software version 20.

	Mean/ Frequency	SD/ Percentage
Age (Years)	52.06	5.591
Sex (n, %)		
Male	2	87.5
Female	14	12.5
Side (n, %)		
Right	9	56.3
Left	7	43.8
Duration (Months)	10.00	4.546

This table shows the Gender Distribution of the 32 participants participated in the study. Both the groups, i.e. the group where in the participants underwent Conventional therapy + kinsiotape (group A) had females and males and those underwent Conventional Therapy (group B) had females and males.

	Mean/ Frequency	SD/ Percentage
Age (Years)	54.13	4.787
Sex (n, %)		
Male	12	75.0
Female	4	25.0
Side (n, %)		
Right	11	68.8
Left	5	31.3
Duration (Months)	9.63	2.156

Both table displays the group statistics of Age Distribution among the 32 participants the mean age of the 16 participants in group A was 52.06 years with standard deviation 5.591. In the Group B, the mean age was 54.13 with standard deviation 4.787. And group statistics of Duration of Problem in months among the 32 participants.

NPRS SCORE	PRE-TEST		1 ST WEEK		4 TH WEEK	
	GROUP A	GROUP B	GROUP A	GROUP B	GROUP A	GROUP B
MEAN	6.00	5.13	5.00	4.25	3.75	3.56
SD	0.894	1.258	0.816	0.856	0.683	1.094

Upper Table shows that mean ± SD of Pre NPRS, Post NPRS at 1st week, Post NPRS at 4th week of group A were 6.00 ± 0.894, 5.00 ± 0.816, 3.75 ± 0.683 respectively and mean ± SD of Pre NPRS, Post NPRS at 1st week, Post NPRS at 4th week of group B were 5.13 ± 1.258, 4.25 ± 0.856, 3.56 ± 1.094 respectively.

WOMAC SCORE	PRE-TEST		1 ST WEEK		4 TH WEEK	
	GROUP A	GROUP B	GROUP A	GROUP B	GROUP A	GROUP B
MEAN	46.81	35.50	34.44	27.75	24.06	21.50
SD	9.152	11.810	7.966	9.532	6.698	7.483

Upper Tables shows that mean ± SD of Pre WOMAC, Post WOMAC at 1st week, Post WOMAC at 4th week of group A were 46.81 ± 9.152, 34.44 ± 7.966, 24.06 ± 6.698 respectively and mean ± SD of Pre WOMAC, Post WOMAC at 1st week, Post WOMAC at 4th week of group B were 35.5 ± 11.810, 27.75 ± 9.532, 21.50 ± 7.483 respectively.

Measure	Pair	W value		Sig	
		Group A	Group B	Group A	Group B
NPRS WOMAC	NPRS at 1 st week- Pre NPRS	120.00	66.00	0.000162	0.002136
	NPRS at 4 th week- Pre NPRS	136.00	136.00	0.000332	0.000290
	WOMAC at 1 st week-Pre WOMAC	136.00	136.00	0.000424	0.000430
	WOMAC at 4 th week-Pre WOMAC	136.00	136.00	0.000432	0.000432

This table shows Since the data was not normally distributed, Wilcoxon matched pairs signed test was applied for comparison of Pre-treatment, treatment at 1ST WEEK and Treatment at 4th week NPRS score & WOMAC SCORE within Group A and Group B. • For group A, the NPRS at 1st week- Pre NPRS-W = 120.00, NPRS at 4th week- Pre NPRS-W = 136.00, WOMAC at 1st week-Pre WOMAC-W=136.00, WOMAC at 4th week-Pre WOMAC-W= 136.00 and the two-tailed p value is <0.00001, consider extremely significant. For group B, the NPRS at 1st week- Pre NPRS-W = 66.00, NPRS at 4th week- Pre NPRS-W = 136.00, WOMAC at 1st week-Pre WOMAC-W=136.00, WOMAC at 4th week-Pre WOMAC-W= 136.00 and the two-tailed p value is<0.0001 extremely significant.

Measure	Pair	U value	Sig
NPRS WOMAC	Difference between pre NPRS-NPRS at 1 st week	113.000	0.488852
	Difference between pre NPRS-NPRS at 4 th week	63.000	0.009208
	Difference between pre WOMAC- WOMAC at 1 st week	49.500	0.002927
	Difference between pre WOMAC- WOMAC at 4 th week	37.000	0.000590

This table shows Since the data was not normally distributed, Mann Whitney U signed test was applied for comparison of Pre-Treatment, Treatment at 1ST WEEK and Treatment at 4th week NPRS score & WOMAC SCORE between Group A and Group B. Difference between pre NPRS-NPRS at 1st week $U = 113.0000$, Difference between pre NPRS-NPRS at 4th week $U = 63.000$, Difference between pre WOMAC-WOMAC at 1st week $U = 49.500$, Difference between pre WOMAC .WOMAC at 4th week $U = 37.00$ and the two-tailed p value is <0.0001 extremely significant.

Discussion

The aim of present study was to find out effectiveness of Gastrocnemius taping on pain and function in participants with mild to moderate OA knee. In present study, there were 2 males, 14 females in group A and there were 12 males, 4 females in group B community dwelling elderly participants were recruited in the study and their ages range from 45 to 60 years. In this study, subject's pain intensity & WOMAC improved in the majority of participants with both kinds of treatment. The data showed an improvement was statistically significant in group A than in group B in terms of pain & WOMAC. With respect to pain intensity in Numeric pain rating scale (NPRS), both groups showed statistically significant reduction after 4 weeks of treatment with statistically significant difference when compared between the groups. However, both the groups i.e., Group A & Group B showed better results but Group A shows much better recovery. The improvement in Group A could be attributed rationale that knee taping is believed to ease pain by improving alignment of joints and/ or unloading inflamed soft tissues. With respect to the western Ontario and McMaster universities osteoarthritis Index (WOMAC), both groups showed statistically significant improvement after 4 weeks of treatment with statistically significant difference when compared between the groups. However, both the groups i.e., Group A & Group B showed better results but Group A shows much better recovery. In OA knee, Gastrocnemius muscle area might be reduced, tonus, shortening and wasting of muscle may also happen. Low graded inflammation is also the possibility. When muscle is inflamed, swollen, tonus or stiff then the space between skin and muscle may get compressed and constriction of lymphatic fluid and circulation also gets affected. Ajeet Kumar et al reported that there were shortening and tonus occurred in Gastrocnemius muscle in OA knee which leads to pain and functional difficulty occurred.^[10] Emily et al (2019) shows that there were wasting occurred in OA knee patient due to immobility or less use of affected knee.^[8] This compression applies pressure to pain receptor located between skin & muscle which sends discomfort signals to brain about patient suffering from pain. Method of applying - tape to be applied when muscle is in stretched position. Tape causes microscope lifting of skin which creates space between skin and muscle resulting in increased blood and lymphatic flow resulting in considerable relief in pain. Bharti et al (2017) reported that kinesiology taping is to assist and improve the body's natural healing process and has a number of methods of application and benefits of use, it is proposed to improve blood circulation, decrease pain, provide anatomical support, enhance joint range of motion and assist proprioception.^[20] Ajeet et al (2017) also reported that kinesio taping is well accepted and recognized methods of treatment of participants with knee osteoarthritis which indicated that combination of kinesio taping along with supervised exercise programme was helpful in reduction of pain and increasing functional status of participants with knee osteoarthritis.^[10] Kwansub Lee et al (2016) shows that WOMAC score was improved in OA knee participants and attributable to the fact that the stimuli of the kinesiology tape attached to the muscle around the knee joint, where abnormal muscle tonus appeared due to wear and degeneration of joint cartilage, helped the homeostasis of muscles and gradually reduced pain and stiffness, thereby preventing aggravation of the muscle tonus state so that knee joint function was improved.^[2] A Teichtahl et al (2003) shows that Gastrocnemius muscle producing the greatest knee flexion torque when the knee is in full extension. But because of weak quadriceps Gastrocnemius muscle will produce less force/ torque, which disturbs the varus/ valgus stability of knee. However, varus/ valgus alignment is associated with the progression of medial or lateral compartment of OA knee.^[16]

References

1. MI Hag, E Murphy, J Dacre. Osteoarthritis Post Graduate Medical Journal, 2003, 79: 377-383.
2. Kwansub Lee, Chae Woo, Sangyong Lee. The effect of kinesio Taping therapy on degenerative knee arthritis participants' pain, function and joint range of motion. The journal of physical therapy science. 2018; 28 (1): 63-66.
3. Carolyn Kinser, Lynn Allen Colby. Therapeutic Exercise. 5th Edition. New Delhi. Jaypee brothers medical publisher; 2013.
4. Patel Krishna Kumari, Bid Divyendurayan. Effectiveness of yoga asanas over conventional physiotherapy treatment on functional outcome in patients with osteoarthritis yoga physical therapy. 2018; 3(3): 54-57.
5. Maheshwari, M Haskar. Essential Orthopedics: 5th edition: 2015, 295.
6. Rolend W Makiwitz. Osteoarthritis Diagnosis & Medical Surgical Management: 4th edition, 2017, 27.
7. Behazd Heidari. Knee osteoarthritis prevalence risk factors, pathogenesis and features: part 1. Caspian Journal of Internal Medicine, 2011, 2(2): 205-212.
8. Emily Shorter, Anthony Sannicandro. Skeletal Muscle Wasting and its relationship with osteoarthritis: Mini review of mechanisms and current intervention. Current Rheumatology reports. 2019: 21(8): 40.
9. Brain T Feeley, Robert A Gallo, Seth Sherman, Riley Williams. Management of osteoarthritis of knee in the active participants. The journal of American Academy Orthopedic Surgeries, 2010, 18(7): 406-416.
10. Ajeet Kumar Tiwari, Bibhuti Sarkar. Efficiency of kinesio taping in management of knee osteoarthritis. International journal of health science and research, 2017, 7(10): 107-119.
11. Elizabeth A Davison, Christopher T Anderson, Blake H Ponist, Adam J, Mary E Jacobs. Inhibitory effect of the kinesio taping method on the gastrocnemius muscle. American Journal of sports science and medicine, 2014, 4(2):

33-38.

12. Database on internet [edited 31 march 2020] Open database, available from <https://physio-pedia.com/Taping#sts=Kinesio%20Taping>
13. Kleida Tani, Irena Kola, Fregen Dhamaj, Vjollca Skapta, Kiri Zallari. Physiotherapy effects in gait speed in participants with osteoarthritis. Open access Macedonian Journal of Medical Science, 2018, 6(3): 493-497.
14. Database on internet [edited 31 march 2020] Open database available from: https://en.wikipedia.org/wiki/GASTROCNEMIUS_muscle
15. Cyntyia Norki. Joint structure and function: 5th edition: New Delhi: Jaypee Brothers medical publisher; 2011.
16. A teichtahl, A Wluka. Abnormal Biomechanics: A precursor or result of knee osteoarthritis?. Br J sports med, 2003: 289-290.
17. Parisa Taheri, Babar Vahadatpour. Effect of taping on pain & functional outcome of participants with knee osteoarthritis. Advanced Biomedical Research Journal, 2016, 6(139): 1-6.
18. Cho H, Kim E, Kim J, Yoon YW. Kinesio Taping improve pain, range of motion & proprioception in older participants with knee osteoarthritis. American Journal of Physical Medicine & Rehabilitation, 2015, 94(3): 192-200.
19. Annalina Rahlf, Klaus Michel, Brumann, Astrid Zech. Kinesio Taping improve pain & function of participants with knee osteoarthritis. Journal of Sports Rehabilitation, 2017: 1-5.
20. Bharti Tripathi, Dr Deepali Hande. Effect of kinesio taping on osteoarthritis of knee in geriatric population. International Journal of Applied Research, 2017, 3(2): 301-305.
21. M Harshita, K Senthil Kumar, K Madhvi. Effect of kinesio taping along with quadriceps strengthening exercise on pain, joint range of motion & functional activities of knee in subjects with patellofemoral osteoarthritis. International Journal of Physiotherapy, 5th edition, (2007): 234, 314.
22. Dr. Magda Gaid, S Sedhom. Effect of kinesio taping versus aescin die salicylate gel phonophoresis on level, range of motion & accuracy on mild to moderate osteoarthritis participants. International Journal of Physiotherapy, 2016, 3(4): 494-499.
23. Mansi Thakar, Sathiyavani Dhanakotti, R Samual, Shreya Doshi, Kajal Vasol. To determine the effectiveness of kinesio taping over the conventional physiotherapy on pain, quadriceps & functional disability in knee osteoarthritis participants. International Journal for Scientific Research, 2016, 6(1): 221-229.
24. Kim H, Byunghee Lee. To conduct a scientific analysis of the effectiveness of kinesio taping at preventing injury and improving horse racing jockey performance, by studying the effects on iso-kinetic muscular function of kinesiotaping applied to the knee joint muscle. Journal of Physiotherapy Science, 2013, 25(10): 1273-1277.
25. Tanasu Birinci. The effect of kinesio taping on the functionality, pain, range of motion, and muscle strength in the participants with knee osteoarthritis compared with a placebo kinesio tape application. Journal of Physical Medicine & Rehabilitation, 2016, 96(1): 1-8.
26. David J Magee. Orthopedic Physical Assessment: 6th edition, 2014: 745.
27. Jagmohan Singh. Textbook of Electrotherapy. 2nd edition: New Delhi: Jaypee Brothers Medical Publisher; 2012.
28. Rodriguez CS. Pain measurement in the elderly: A review. Pain manag nurs, 2001; 2: 38-46.
29. Ahmad H Alghadir, Shah Nawaz Anwer, Amir Iqbal. Test-retest reliability, validity and minimum detectable changes of visual analogue, numerical rating, and verbal rating scales for measurement of osteoarthritic knee pain. Journal of Pain Research, 2018, (11): 851-856.
30. Mcconnell S, Kolopack P, Davis AM. The Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC): A review of its utility & measurement properties. Arthritis Rheum 2001, 45(5): 453-461.