

## A STUDY TO COMPARE THE EFFECTIVENESS OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION WITH RETRO-WALKING VERSUS ULTRASOUND THERAPY WITH RETRO-WALKING IN CHRONIC OSTEOARTHRITIS OF KNEE

Somashekar<sup>1</sup>, R. Raja<sup>2</sup>, J. N. Sridharamurthy<sup>3</sup>, Shrijan Timsina<sup>4</sup>, Vivek Jha<sup>5</sup>

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**ABSTRACT: BACKGROUND AND OBJECTIVES:** Knee osteoarthritis (OA) is a painful and degenerative joint diseases, the pain, joint stiffness associated with this condition have a dramatic impact on physical mobility and function. This study was done to assess the effectiveness of TENS and retro walking versus ultrasound therapy with retro walking in patients suffering from chronic knee osteoarthritis. **METHODS:** All the subjects were clinically diagnosed by orthopaedician with chronic knee osteoarthritis were screened after finding their suitability as per the inclusion criteria and were requested to participate in the study. Participants in the study were briefed about the nature of the study and their intervention. After briefing them about the study, their informed written consent was taken. 60 chronic knee osteoarthritis patient were randomly divided into two groups with n=30 in each group, Group A-received TENS transcutaneous electrical nerve stimulation and retro walking, where group B-received ultrasound therapy with retro walking. The treatment was given 5 days a week. The total duration of treatment was 3 weeks. **OUTCOMES MEASURES:** The patients were evaluated at the beginning of the intervention program, Day 1st, end of 1st week, end of 2nd week and end of 3rd week. All the Patients were requested to come for a follow up measurement after 3rd week of treatment program. All the patients were assessed for pain, functional outcome and range of motion by taking their VAS scale, WOMAC scale and universal goniometer. **RESULTS:** Both the groups showed statistically significant improvement in all three parameters (VAS, WOMAC and Range of motion) by repeated test ANOVA. Independent t-test analysis of outcome measures when compared between the two groups showed that Group B outcome measures were significantly far better than the outcome measures of Group A. **CONCLUSION:** Transcutaneous electrical nerve stimulation TENS with retro walking and therapeutic ultrasound therapy with retro walking showed effectiveness in reducing the pain intensity, improving the functional outcome and range of motion but ultrasound therapy with retro walking showed superior hand over than TENS (transcutaneous electrical nerve stimulation) with retro walking.

**KEYWORDS:** Chronic knee oosteoarthrtis, Transcutaneous electrical nerve stimulation, Ultrasound therapy, Retro walking, Visual analogue scale, Functional outcome.

**INTRODUCTION:** Knee osteoarthritis (OA) is a non-inflammatory, painful and degenerative joint disease, Pathologic changes in OA involve progressive hyaline joint cartilage loss with concomitant changes in the subchondral bone and the development of osteophytes.<sup>1</sup>

Osteoarthritis traditionally was considered as a disease of articular cartilage. Now it is thought to involve the entire joint tissues, synovial, capsule, bone and ligaments leading to

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subchondral bone attrition and remodelling, meniscal degeneration, ligamentous laxity, fat pad extrusion, and impairments of neuromuscular control etc.<sup>2</sup>

The clinical symptoms of OA often include muscle weakness, disability, stiffness, joint deformity, decreased range of motion and chronic pain.

OA is seen mostly in middle and advanced age groups and its frequency increases with age. Although its frequency is similar in both sex below the age of 55, there is an increase in women after the age of 55. Knee OA is common in the elderly population and manifestation of the OA is seen in these patients.<sup>3</sup>

Transcutaneous electrical nerve stimulation (TENS) which is an inexpensive, non-invasive intervention used to manage a wide variety of painful conditions. Transcutaneous electrical nerve stimulation (TENS) is a common treatment modality for musculoskeletal pain and has been demonstrated to be effective for managing chronic Osteoarthritis knee pain.<sup>4</sup> High frequency (100HZ) and low intensity TENS capable of stimulates A beta mechanoreceptors which are effective in reducing pain perception.<sup>5</sup>

The mechanism of pain relief with transcutaneous electrical nerve stimulation (TENS) is explained by the gate-control theory developed by Melzac and Wall. TENS causes facilitation in substantia gelatinosa at the level of medulla spinalis by stimulating A- $\alpha$  and A- $\beta$  fibre, which do not transmit pain sense and reduces pain sense by inhibiting A- $\Delta$  and C fibre which transmit pain sense in presynaptic area. TENS increases muscle strength, and decreases joint stiffness and spasm in muscle as well.<sup>6</sup>

Therapeutic ultrasound treatment. Which is the best physical therapy modality suggested for the management of pain and loss of function due to OA. It is a form of mechanical energy consisting of high-frequency vibrations that can be continuous or pulsed. Pulsed ultrasound produces non-thermal effects and is used to aid in the reduction of inflammation, whereas continuous ultrasound generates thermal effects. Therapeutic ultrasound is also reported to reduce oedema, relieve pain and accelerate tissue repair.<sup>7</sup>

People in daily life mainly move forward to do exercise because it is a habitual moving direction, but there are some different ways to do exercise, and sometimes that will be more efficient and saving strength than the original way. Another option of doing exercise is backward locomotion.

Backward locomotion (Walking or running) has gained popularity as one part of a program to rehabilitate certain knee injuries (Flynn & Soutas-Little 1993; Threlkeld et al. 1989). Backward walking training, or rehabilitation, has been reported to decrease Patellofemorol joint compressive forces (Flynn & Soutas-Little 1995), to protect the anterior cruciate ligament (ACL) from overstretching (Mackie & Dean 1984), and to decrease eccentric loading of the knee extensors (Flynn & Soutas-Little 1993). Backward walking, therefore, has been promoted as a treatment strategy to improve gait. Backward walking appears to create more muscle activity in proportion to effort than forward walking (Grasso et. al, 1998 and Winter et al, 1989).<sup>8,9,10</sup>

The Chinese and Japanese have long practiced backward locomotion (also known as walking backwards or retro-walking), well aware that 100 steps backward walking is equivalent to 1,000 steps in conventional walking. Being able to walk backwards requires balance since our bodies are used to going in a forward motion. As we turn around, our centre of gravity may be slightly thrown off; some of us may experience a little discomfort or instability when we first start walking backwards. With practice, the strangeness or awkwardness quickly wears off, and we may be tempted to walk faster or even jog, once we become accustomed to backward Locomotion.

**OBJECTIVES OF THE STUDY: The Main Objectives of the Study are:**

1. To assess the effectiveness of transcutaneous electrical nerve stimulation (TENS) with Retro walking in chronic Osteoarthritis of Knee.
2. To assess the effectiveness of ultrasound therapy with retro walking in chronic Osteoarthritis of knee.
3. To compare the effect of Transcutaneous electrical nerve stimulation (TENS)
4. With retro walking versus ultrasound therapy with retro walking in chronic Osteoarthritis of knee.

**NULL HYPOTHESIS:** There will be no significant difference in WOMAC (Knee disability index) and the V.A.S (Measure of pain.) in subjects with chronic knee Osteoarthritis treated with transcutaneous electrical nerve stimulation (TENS) with retro walking versus Ultrasound therapy with retro walking.

**ALTERNATE HYPOTHESIS:** There will be significant difference in WOMAC (Knee disability index) and the V.A.S (Measure of pain.) in subjects with chronic knee Osteoarthritis treated with transcutaneous electrical nerve stimulation (TENS) with retro walking versus Ultrasound therapy with retro walking.

**MATERIALS AND METHODS:** The study was conducted at Kempegowda institute of medical sciences, Bangalore in association with Kempegowda institute of Physiotherapy between November 2013 to June 2014.

It was designed to be a comparative study with randomized study design comprising of 60 patients with clinical and radiological diagnosis of primary osteoarthritis of knee.

**Inclusion Criteria:**

- Patient suffering with Osteoarthritis knee for three months without any cognitive deficit.
- Grade-II Kellagren- Lawrence Classification of Knee Osteoarthritis.
- Both sex group.
- Age between 45-65.

**Exclusion Criteria:**

- Traumatic knee pain, fractures or ruptured ligaments, meniscopathy of knee joint.
- Inflammatory and Infectious knee conditions (RA, gout, psoriatic arthritis).
- Any recent surgical intervention of knee joint or those who had undergone arthroplasty surgeries in hip or knee.
- Tumours/malignancy of knee joint.
- Grade I, III, IV Kellagren-Lawrence Classification: Knee Osteoarthritis.
- OA of hip and OA of foot and any previous corticosteroid, hyaluronic acid injection to knee joint.

Intensity of pain, functional outcome and range of motion were the parameters considered for the study. The pain intensity was assessed using Visual Analog Scale (VAS)<sup>11,12,13</sup> the functional outcome was assessed by using Western Ontario McMaster osteoarthritis Index(WOMAC)<sup>14</sup> scale and range of motion by using goniometer.<sup>15</sup>

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**SAMPLING TECHNIQUE AND INTERVENTION:** Using randomized sampling technique, 60 patients meeting the inclusion and exclusion criteria were enrolled in the study after explaining the pros and cons of the study and obtaining written informed consent. The study sample was randomized into two groups with group A being administered TENS with retro-walking while group B patients were administered Ultrasound therapy to the knee with retro-walking.

Baseline measurements of pain intensity, functional outcome and range of motion of all the subjects were measured using VAS, WOMAC scale and goniometer respectively and the outcome measurements were recorded as per pre-test and post-test numerical data for statistical analysis.

**Group A:** 30 subjects in this group were given High (Conventional) TENS in supine lying position. Two channels with 4 electrodes in bracket method were selected, electrode size ranges (5cmx3.5cm) over painful knee region were patient felt tactile sensation threshold Intensity of the current.

**Channel 1:** Two electrodes A'superiorly and A1'inferiorly in the medial aspect of painful knee region.

**Channel 2:** Two electrodes B'superiorly and B1'inferiorly in the lateral aspect of painful knee region. Each session lasted 20 minutes, with Frequency- 80Hz with 10 to 30 mA intensity 5 times a week, for 3 weeks followed by supervised retro walking performed on a plane surface in a straight line with great pace for 10 minutes 3 sessions in a day.<sup>16</sup>

**Group B:** 30 subjects in this group were given ultrasound therapy in supine lying position, over painful knee region with intensity of 1mzh, 1.5watts/cm<sup>2</sup>, with ultrasonic gel in a small concentric circle movements for 5minutes, 5 times a week for 3 weeks Followed by supervised retro walking performed on a plane surface in a straight line with great pace for 10 minutes 3 sessions in a day<sup>16</sup>.

The subjects in both the groups were advised not to stand for longtime and avoid cross leg sitting and squatting activity.

Baseline measurement of pain intensity, functional outcome measure and range of motion were assessed using VAS, WOMAC scale and universal goniometer. The pre and post treatment measurements were taken on day 1st, end of 1st week, end of 2nd week, and end of 3rd week the patient were requested to come back for follow up.

Effectiveness of treatment were calculated by Repeated measure ANOVA.

Independent t-test was used to compare the effectiveness of treatment between group A and B.

### RESULTS:

Age (Years)	Group A (n=30)	Group B (n=30)
45 - 50	30 % (n=9)	36.67 % (n=11)
51 - 55	30 % (n=9)	20 % (n=6)
56 - 60	20 % (n=6)	20 % (n=6)
61 - 65	20 % (n=6)	23.33 % (n=7)
<b>Total</b>	<b>100 % (n=30)</b>	<b>100 % (n=30)</b>

Table No. 1: Frequency and Percentage of distribution of age for Group A and B

#group A- TENS with Retro-walking, group B- UST with retro-walking.

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Gender	Group A (n=30)	Group B(n=30)
Male	40 % (n=12)	33.33 % (n=10)
Female	60 % (n=18)	66.67 % (n=20)

**Table No: 2 Frequency and Percentage of distribution gender for Group A and B**

#group A- TENS with Retro-walking, group B- UST with retro-walking

	Group A		Group B	
	Mean $\pm$ S.D	F Value	Mean $\pm$ S.D	F Value
Day 1st	7.53 $\pm$ 0.86	21.55*	7.67 $\pm$ 0.67	4.639*
End of 1st Week	7.06 $\pm$ 0.86		6.57 $\pm$ 0.68	
End of 2nd Week	6.23 $\pm$ 0.81		5.43 $\pm$ 0.68	
End of 3rd Week	4.9 $\pm$ 0.71		3.8 $\pm$ 0.61	

**Table 3.1(VAS SCORE) calculated by Repeated measure ANOVA for both the groups**

#group A- TENS with Retro-walking, group B- UST with retro-walking.

Above table shows there is a significant decrease in pain scores each week in both the groups (F=21.55 and F=4.639 are both significant).

	Group A		Group B	
	Mean $\pm$ S.D	F Value	Mean $\pm$ S.D	F Value
Day 1st	71.2 $\pm$ 7.56	11.46*	75.53 $\pm$ 5.73	23.33*
End of 1st Week	68.57 $\pm$ 7.62		67.33 $\pm$ 5.99	
End of 2nd Week	65.43 $\pm$ 7.88		61.9 $\pm$ 5.60	
End of 3rd Week	62.4 $\pm$ 7.8		55.4 $\pm$ 5.88	

**Table No. 3.2 WOMAC Score for both the groups**

#group A- TENS with Retro-walking, group B- UST with retro-walking

Above table shows there is a significant decrease in disability scores (WOMAC) each week in both the groups (F=11.46 and F=23.33 are both significant).

	Group A		Group B	
	Mean $\pm$ S.D	F Value	Mean $\pm$ S.D	F Value
Day 1st	104.1 $\pm$ 13.26	31.6*	104.5 $\pm$ 11.13	15.78*
End of 1st Week	105.4 $\pm$ 13.08		106.7 $\pm$ 10.92	
End of 2nd Week	106.6 $\pm$ 13.06		110 $\pm$ 10.25	
End of 3rd Week	108.2 $\pm$ 13.18		114.1 $\pm$ 9.85	

**Table No. 3.3 ROM SCORE (Range of motion) for both the groups**

#group A- TENS with Retro-walking, group B- UST with retro-walking

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Above table shows there is a significant increase ROM scores each week in both the groups (F=31.6 and F=15.78 are both significant).

	<b>Mean (Group A)</b>	<b>Mean (Group B)</b>	<b>Mean Difference</b>	<b>t-value</b>	<b>p-value</b>
Day 1st	7.53	7.67	0.13	0.673	0.504
End of 1st Week	7.06	6.57	1.5	2.485*	0.016
End of 2nd Week	6.23	5.43	0.8	4.124*	0
End of 3rd Week	4.9	3.8	1.1	6.425*	0

**Table No: 4.1 Independent 't' test for comparison of  
Group A and Group B with VAS score Value**

#group A- TENS with Retro-walking, group B- UST with retro-walking

Above table shows Comparison of Group A and Group B with VAS score Value. Group B patients showed more improvement than Group A.

	<b>Mean (Group A)</b>	<b>Mean (Group B)</b>	<b>Mean Difference</b>	<b>t-value</b>	<b>p-value</b>
Day 1st	71.2	75.53	2.33	1.347*	0.183
End of 1st Week	68.57	67.33	1.23	0.697	0.489
End of 2nd Week	65.43	61.9	3.53	2.001*	0.05
End of 3rd Week	62.4	55.4	7	3.926*	0

**Table No 4.2 Independent 't' test for comparison of  
Group A and Group B with WOMAC score Value**

#group A- TENS with Retro-walking, group B- UST with retro-walking

Above table shows comparison of Group A and Group B with WOMAC score Value. Group B patients showed more improvement than Group A.

	<b>Mean (Group A)</b>	<b>Mean (Group B)</b>	<b>Mean Difference</b>	<b>t - Value</b>	<b>p - Value</b>
Day 1st	104.1	104.5	0.4	0.127	0.9
End of 1st Week	105.4	106.7	1.36	0.439	0.662
End of 2nd Week	106.6	110	3.46	11.44*	0.257
End of 3rd Week	108.2	114.1	5.9	19.79*	0.053

**Table No 4.3 Independent 't' test for comparison of  
Group A and Group B with ROM score Value**

#group A- TENS with Retro-walking, group B- UST with retro-walking

Above table shows comparison of Group A and Group B with ROM score Value Group B patients showed more improvement than Group A.

As a conclusion we may say that the effectiveness of ultrasound therapy with retro walking in chronic Osteoarthritis of knee is better than transcutaneous electrical nerve stimulation (TENS) with Retro walking.

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**Null Hypothesis:** There will be no significant difference in WOMAC (Knee disability index) and the V.A.S (Measure of pain.) in subjects with chronic knee Osteoarthritis treated with transcutaneous electrical nerve stimulation (TENS) with retro walking versus Ultrasound therapy with retro walking.

**Alternative Hypothesis:** There will be significant difference in WOMAC (Knee disability index) and the V.A.S (Measure of pain.) in subjects with chronic knee Osteoarthritis treated with transcutaneous electrical nerve stimulation (TENS) with retro walking versus Ultrasound therapy with retro walking.

By statistical analysis there is a significant difference in WOMAC (Knee disability index) and the V.A.S (Measure of pain.) in subjects with chronic knee Osteoarthritis treated with transcutaneous electrical nerve stimulation (TENS) with retro walking versus Ultrasound therapy with retro walking.

Hence null hypothesis is rejected and Alternative Hypothesis Accepted.

**DISCUSSION:** In this study 60 patients of chronic OA knee were divided in to group A and group B respectively, each group consisting of 30 patients. There are 9 patients (30%) in group A and 11 patients (36.67%) in group B with their age group ranges between 45 to 50 years. The age group between 51-55 years has 9(30%) patients in group A and 6(20%) patients in group B. The age group between 56-60 years has 6(20%) patients in group A and 6(20%) patients in group B. The age group between 61-65 years has 6(20%) patients in group A and 7(23.33%) patient in group B. S Kuzgunat et al<sup>17</sup> (2010) also opted the samples with their age group lesser than 65 years.

The present study comprised of 12 male patients (40%) and 18 female patients (33.33%) in group A. In group B 10 male patients (60%) and 20 female patients (66.67%) were participated. Studies by R K Arya, Vijay jain<sup>18</sup> (2013) states that 60% of American with arthritis are women.

Using VAS scale for pain assessment, we found that there is significant improvement in group B patients (pre-test value was 7.6 and decreased to 3.8 with mean difference of 3.8 by the end of 3rd weeks) than the group A patients who had pre-test value 7.5 which decreased to 4.9 with mean difference of 2.6 by end of 3rd weeks. As per the study by Mirsad Muftic et al<sup>19</sup> (2013) the application of continuous ultrasound in patient with chronic pain caused by degenerative changes in musculoskeletal system led to significant reduction in pain.

WOMAC (Assessment of physical function) scale was used as 2<sup>nd</sup> outcome measures for both the Groups, and the researchers found that there is significant improvement in group B Patients (with pre-test value 75.33 that decreased to 55.4 with mean difference of 19.93 by the end of 3rd week) than the group A patients (with pre-test value 71.2 decreasing to 62.4 with mean difference of 8.8 by end of 3rd weeks). The study by F Tascioglu et al<sup>17</sup> (2010) found that there was significant improvement in total WOMAC score and walking speed inpatient those who received both continuous and pulsed ultrasound therapy.

The researchers have used universal goniometer to assess (The range of motion of knee flexion) as 3<sup>rd</sup> outcome measures for both the groups and found that there is significant improvement in group B patients (With pre-test value of 104.5 Degree increasing to 114.1 degree with mean difference of 9.6 degree by the end of 3rd weeks) compared with group A patients (With pre-test score of 104.1 degree, increasing to 108.2 degree with mean difference of 4.1 degree by end of 3rd weeks). Chia-ling lee et al<sup>20</sup> (2005) concluded and confirmed that patient receiving pulse ultrasound therapy with intraarticular hyaluronan therapy improved range of motion of knee joint.

### Limitations of the Study:

- The study was limited to age group of 45-65 years.
- The study was limited to assess only the pain intensity by using VAS and functional outcome by WOMAC score and range of motion by goniometer.
- The study had a short duration follow up by 3rd week post treatment.
- Drop out.

### Suggestions and Further Recommendation:

- As this study was done only with chronic knee osteoarthritis, further studies are also suggested to detect the progress in patients with other knee complains.
- In this study, subjects were tested for pain and functional outcome, similar studies could also be done to detect the strength of quadriceps muscles.
- Further studies should be conducted in larger sample size and with wider age group as this study only considered age group from 45-65 years.
- As this study was done only for a 3 weeks, a short term study should be conducted with long term follow up sessions to know the effectiveness of the treatment.
- To improve knee range of motion intra articular hyaluronan therapy was suggested instead of plain ultrasound and TENS treatment along with retro walking

**CONCLUSION:** Group B patients who had ultrasound therapy with retro walking showed better improvement in pain reduction (VAS) compared with group A patients, who had TENS with retro walking.

Group B patients who had ultrasound therapy with retro walking showed better improvement in WOMAC score (knee disability index) compared with group A patients, who had TENS with retro walking.

Group B patients who had ultrasound therapy with retro walking showed better improvement in knee ROM compared with group A patients, who had TENS with retro walking.

### BIBLIOGRAPHY:

1. Mônica de Oliveira Melo a,d,\*, Fernando Amâncio Aragão a,b, Marco Aurélio Vaz a,c. Neuromuscular electrical stimulation for muscle strengthening in elderly with knee osteoarthritis, A systematic review. *Complementary Therapies in Clinical Practice* 19 (2013) 27-31
2. Omer Ke Ocaman, Halil Koyuncu, Ahmet Dinc, Halime Toros, Safak S. Karamehmetoglu. The Comparison of the Effects of Electrical Stimulation and Exercise in the Treatment of Knee Osteoarthritis. *Turk J Phys Rehab* 2008; 54: 54-8
3. M. C. Hochberg. Osteoarthritis New Approaches. *MEDICOGRPHIA*, 2013; Vol. 35, No. 2: 139-144.
4. Gladys LY Cheing, Christina WY Hui-Chan, KM Chan. Does four weeks of TENS and/or isometric exercise produce cumulative reduction of Osteoarthritic knee pain? *Clinical Rehabilitation* 2002; 16: 749-60.
5. John Low and Ann Read. Electrical stimulation of nerve and muscle; 3rd edition: page no.94Rutjes AW, Nüesch E, Sterchi R, et al:



6. Dilek Durmus, Gamze Alayh, Ferhan Canturk. Effects of quadriceps electrical stimulation program on clinical parameters in the patients with knee Osteoarthritis. *Clin Rheumatol* (2007); 26: 674-78
7. Therapeutic ultrasound for osteoarthritis of the knee or hip. *Cochrane Database Syst Rev* 2010; 1: CD003132.
8. Bates, B.T., Morrison, E., Hamill, J. (1984) A comparison between forward and backward running. In: Adrian, M., Deutsch, H. (Eds.), *The 1984 Olympic Scientific Congress Proceedings*, Microform Publications, Eugene, OR, 127 -135.
9. Buford, J. A. and Smith, J. L. (1990) Adaptive control for backward quadrupedal walking II. Hindlimb muscle synergies, *J Neurophysiol*, 64, 756-766.
10. Chaloupka, E.C., Kang, J., Mastrangelo, M.A. and Donnelly, M.S. (1997) Cardiorespiratory and metabolic responses during forward and backward walking, *Journal of Orthopaedic & Sports Physical Therapy*, 25, 302-306.
11. Susan B O'Sullivan. Chapter 26, Arthritis. *Physical rehabilitation*, New Delhi, Jaypee, 2008; 1067.
12. Brand K. D. the role of analgesic and exercise therapy in the management of knee OA. *Pain Am. J. ther*, 2003; 200; 7(2): 75-90.
13. Fitzgerald G K, Otis c. Role of physiotherapy in the management of knee OA. *curr opin rheumatol* 2004; 16; 143-147.
14. Ptizker k. pathology of Osteoarthritis of the knee joint. *Oxford university press oxford*: 1999.pg. 50-56.
15. McAlindon TE, Cooper C, Kirwan JR, Dieppe PA. Determinants of disability in osteoarthritis of the knee. *Ann Rheum Dis* 1993; 52: 258-62.
16. Kugler LM, Amstrong CW, Moleski B. Comparative analysis of the kinematics and kinetics of forward and backward human locomotion. *ISBS*. 1988; 6: 451-64.
17. Tascioglu F, Kuzgun S, Armagan O, Ogutler G. (2010). Short-term effectiveness of ultrasound therapy in knee osteoarthritis. *Journal of International Medical Research* 38(4): 1233-42.
18. RK Arya, Vijay Jain April- June 2013, osteoarthritis of knee joint. *Journal of Indian academy of clinical medicine*.
19. Mirsad Muftic et al, 11/22/2013, therapeutic ultrasound and pain in degenerative disease of musculoskeletal system.
20. Mao- hsiung Huang et al, 1/12/2005, journal of preliminary result of intergrated therapy for patients with knee osteoarthritis.

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### **AUTHORS:**

1. Somashekar
2. R. Raja
3. J. N. Sridharamurthy
4. Shrijan Timsina
5. Vivek Jha

### **PARTICULARS OF CONTRIBUTORS:**

1. Professor, Department of Orthopaedics, KIMS, Bangalore.
2. Associate Professor, Department of Physiotherapy, KIPS, Bangalore.
3. Professor, Department of Orthopaedics, KIMS, Bangalore.

### **FINANCIAL OR OTHER**

**COMPETING INTERESTS:** None

4. Resident, Department of Physiotherapy, KIPS, Bangalore.
5. Resident, Department of Orthopaedics, KIMS, Bangalore.

### **NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:**

Dr. Vivek Jha,  
Room-318,  
KIMS Resident Quarters,  
KIMS Hospital, K. R. Road,  
V. V. Puram, Bangalore-560004.  
E-mail: vj.1104@gmail.com

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