

# Effects of Magnesium in Physiotherapy Treatment for Patients with Knee Osteoarthritis

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## ABSTRACT

**Background:** Osteoarthritis (OA) is a complex joint degenerative disorder. Pain is a dominant characteristic, becoming persistent and more limiting as the disease progresses, resulting in reduced physical function, quality-of-life. Magnesium deficiency is considered to be a major risk factor for osteoarthritis development and progression. Oral magnesium presents unique challenges for many individuals to effectively restore intracellular magnesium levels. Transdermal magnesium absorption could be more effective than oral absorption due to its greater absorption rate and presents fewer negative effects due to its gastrointestinal tract-bypassing nature.

**Method:** Total 40 subjects with knee osteoarthritis were selected as per the inclusion and exclusion criteria and randomly assigned to either Group A (intervention) or Group B (conventional), each having 20 patients. Assessment of the outcome measures was done pre and post 8 sessions. Outcome measures used were Visual Analogue Scale (VAS), Western Ontario and McMaster Universities Arthritis Index (WOMAC), Timed up and go test (TUG), 9 Step stair climb test, Knee ROM, Quadriceps strength using pressure biofeedback. Group A was given conventional therapy along with Epsom salt foot soak and Magnesium oil application. Group B was given conventional therapy alone.

**Result:** There was statistically significant improvement seen in all the outcome measures in intragroup analysis with  $p < 0.05$ . Intergroup analysis showed statistically significant difference in VAS on activity, WOMAC, Knee ROM, Quadriceps strength with  $p < 0.05$  indicating Group A performed better than Group B.

**Conclusion:** The study found that Magnesium when used as an adjunct to conventional therapy shows significant difference in pain levels, knee mobility, quadriceps strength and better functionality in activities of daily living.

**KEYWORDS:** Knee osteoarthritis, Epsom salt, Magnesium, Physiotherapy.

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## INTRODUCTION

Osteoarthritis is the second most common rheumatologic condition and the most

common joint illness in India, with a prevalence of 22% to 39% [1]. It is characterized by several distinct structural changes,

including the progressive loss of articular cartilage, thickening of the subchondral plate, formation of osteophytes at joint margins, and the emergence of subchondral cysts. Patients with osteoarthritis frequently report experiencing pain upon movement, particularly when initiating movement or walking, often described as a dull ache. Persistent pain at rest or during the night can indicate advanced osteoarthritis. Pain associated with morning stiffness which may alter as the day passes by. Swelling around the knee, can manifest as either hard swelling due to bony spurs known as osteophytes or soft swelling caused by joint inflammation and excess fluid accumulation. Magnesium deficiency is considered to be a major risk factor for osteoarthritis development and progression [2].

Magnesium deficiency is active in several pathways that have been implicated in OA, including increased inflammatory mediators, cartilage damage, defective chondrocyte biosynthesis, aberrant calcification and a weakened effect of analgesics [3].

Magnesium is the second most abundant intracellular cation and is an important micronutrient essential for various physiological processes [4].

It serves as a critical cofactor for reactions powered by ATP (adenosine triphosphate). Transport of potassium and calcium across the plasma membrane may also require the presence of Mg. Magnesium has been therefore termed as nature's physiologic calcium channel blocker [5].

For adults, the recommended daily amount (RDA) for magnesium is 400–420 milligrams (mg) for men and 310–360 mg for women [6]. Oral magnesium presents unique challenges for many individuals to effectively restore intracellular magnesium levels. Most oral magnesium supplements commonly cause a laxative effect in the bowels, irrespective of their form, which complicates their usage. Hence transdermal delivery could allow for the liver and stomach to be bypassed, which could translate into a much greater percentage of the active ingredient reaching the bloodstream, and more specifically to the site of application [6].

Multiple therapeutic interventions are available for the treatment of osteoarthritis but it is important that the interventions used need to be feasible and convenient so as to achieve better compliance. Magnesium sulphate is a component in Epsom Salt. Epsom salt has been a safe complementary home alternative to medication to relieve pain and stress, it is frequently added to foot soaks and hot baths. Transdermal application of magnesium could offer as a simple, cost effective, easy, efficient methodology, with negligible side effects to increase cellular magnesium levels. Hence this study was conducted to provide further data on the effect of Magnesium (through topical application of magnesium oil and immersion in Epsom salt foot soak) on patients with knee osteoarthritis.

#### **AIM**

· To determine the therapeutic effects of Magnesium in physiotherapy treatment for patients with knee osteoarthritis.

#### **OBJECTIVES**

1. To assess the effects of conventional therapy in osteoarthritis on pain, knee range of motion, quadriceps strength and functional mobility.
2. To assess the effects of Magnesium as an adjunct to conventional therapy in osteoarthritis.
3. Comparison of the above two groups.

#### **METHODOLOGY**

- **STUDY DESIGN:** Interventional study
- **STUDY TYPE:** Comparative study
- **SAMPLING METHOD:** Simple random sampling
- **PLACE OF STUDY:** Nanavati Hospital OPD
- **SAMPLING CALCULATION:** 40 (20 in each group)
- **STUDY POPULATION:** Subjects with knee osteoarthritis
- a. INCLUSION CRITERIA:**
  - Subjects diagnosed with knee osteoarthritis by orthopaedics
  - Subjects with Kellgren-Lawrence (KL) grading I to III
  - Age group 40-70 years

**b. EXCLUSION CRITERIA:**

- Subjects with other known musculoskeletal conditions of knee
- Subjects with Kellgren-Lawrence (KL) grading IV
- Having other joint pathologies (for example, rheumatoid arthritis, severe osteoporosis, or fracture)
- Uncontrolled blood pressure, diabetes mellitus or suspected diseases that may restrict exercise

**2. Functional Mobility assessment**

- a) Western Ontario and McMaster Universities Arthritis Index (WOMAC)
- b) Timed up and go test (TUG)
- c) 9 Step Stair Climb Test
- 3 Knee Range of Motion
- 4. Quadriceps strength using Pressure Biofeedback

**OUTCOME MEASURES**

**1. Pain assessment**

**a) Visual Analog Scale (VAS)**

On Rest

On Activity

**PROCEDURE**

**Table 1:** Conventional Therapy.

SESSION	EXERCISES	FREQUENCY
1-2	Cryotherapy for knee	10 minutes
3-8	Paraffin wax bath for knee	10 minutes
1-2	➤ Isometric exercises- Static quadriceps, hamstring, gluteus, adductors, abductor	10 reps * 1 set* 5 seconds hold
	➤ Active Range of motion and Strengthening exercises-	
	• In supine lying- Ankle toe movements, Ankle toe rotations (clockwise and anticlockwise), Heel slides, Straight leg raise, Vastus medialis obliques strengthening, Bridging	
	• In side lying- Straight leg abduction, Clamshells	
	• In prone lying- Hip extension with knee bent, Hip extension with straight leg, Prone knee bending	
3-4	• In sitting- Dynamic quads	10 reps * 1 set* 10 seconds hold
	➤ All the exercises of Session 1 and 2	
	➤ In addition-	
5-6	• In standing- Hip- Flexion, extension, abduction, adduction; Hamstring curl, Heel raises, Toe raises	10 reps * 1 set* 5 seconds hold
	• Closed chain exercise- Mini squats- against the wall	
	• All the exercises of Session 3 and 4 with half kg weight cuff, theraloop (colour- red, resistance- medium).	
	• In addition-	
	• Strengthening exercise progression- Bridging with isometric adduction and abduction; Prone knee bending with reciprocal contraction of knee flexors and extensors at acute angle, 90 degrees, obtuse angle	
7-8	• Closed chain exercise (without theraloop)- Lunges- front, back, lateral	10 reps * 1 set* 10 seconds hold
	• Balance training- Spot marching, Step up and down, Tandem standing- eyes open, eyes close, Mat walking	
	• All the exercises of Session 5 and 6 with half kg weight cuff, theraloop (colour- red, resistance- medium)	
	➤ In addition-	
All 8 sessions	• Strengthening exercise progression- Bridging + isometric adduction and abduction + knee extension	3 reps* 30 seconds
	• Closed chain exercise (with theraloop)	
	➤ Stretches- tendoachilles, quadriceps, hamstring, iliotibial band, gluteus, piriformis, iliopsoas, adductors	

Ethical committee approval, CTRI registration and informed consent of the subjects was taken. Subjects were randomly divided and assigned to Group A (Intervention) and Group B (Conventional). Intervention of 8 sessions was given, outcome measures were assessed pre and post completion of intervention period and data analysis was done.

**Group A: Conventional Therapy + Epsom Salt Foot Soak + Magnesium oil application:** To make an Epsom salt foot soak the subjects were asked to fill the bathtub or a bucket with warm water until it is deep enough to cover your feet or till your mid-calf level. Add 50 grams of Epsom salt (Epsom salt sachets were given to the subjects) to the warm water. Soak your feet for 20 minutes twice a day and pour the water over the knees with a mug to obtain localized effect. Dry thoroughly after the soak and then moisturize the feet.

4-5 Sprays of Magnesium oil were sprayed over the knee \* once a day. Dab oil with the hand so that the entire region around the knee is covered well. 4 sprays provide 50 mg of pure elemental magnesium.

(Dosage of Magnesium was decided with biomedical and pharmaceutical guidance depending on the RDA and transdermal absorption of Magnesium sulphate- 20-40%.)

**Group B: Conventional Therapy + Warm water foot soak:** Along with the conventional therapy, subjects were asked to dip their feet in warm water for 20 minutes \* twice a day.

**RESULTS**

The data analysis was done using the Statistical Package for Social Science version 29 (SPSS-29). The intragroup data was analysed using a ‘Paired t-test’ for changes in post-intervention value from pre-intervention. The difference between the two groups, the intergroup data was analysed using an independent t-test.

The following table shows the baseline data of the subjects analysed for the study:

**Table 2:** Demographic data.

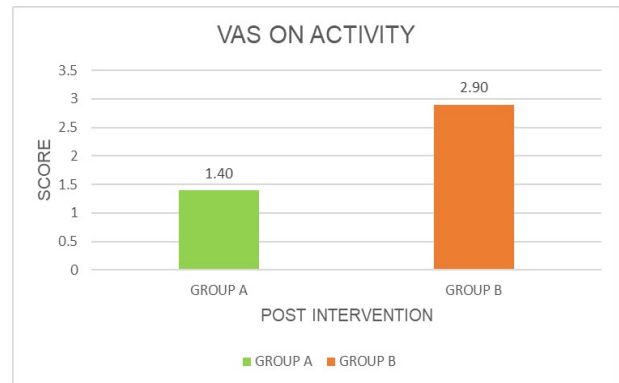
	Group A	Group B
Age	58.45 ± 7.56	56.60 ± 7.50
Gender	F: M: 14:6	F: M: 12:8
Weight (kgs)	76.25 ± 9.37	71.30 ± 10.23

**Intragroup analysis:** There was statistically significant difference in all the outcome measures with p<0.05 indicating both the treatments were effective.

**Intergroup analysis:**

**Table 3:** VAS on activity- post intervention analysis between group A and group B.

Post	Group A	Group B	p value
VAS activity	1.40 ± 1.78	2.90 ± 1.88	0.01

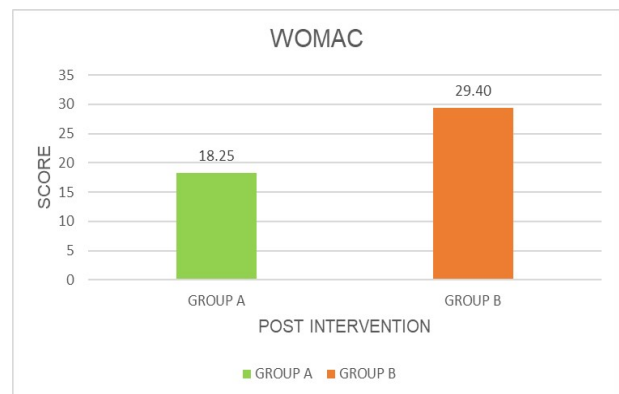


**Graph 1:** VAS on activity- post intervention analysis between group A and group B.

Interpretation: There is statistically significant improvement in VAS on activity of both groups with p <0.05

**Table 4:** WOMAC- post intervention analysis between group A and group B.

Post	Group A	Group B	p value
WOMAC	18.25 ± 9.52	29.40 ± 8.21	<0.001

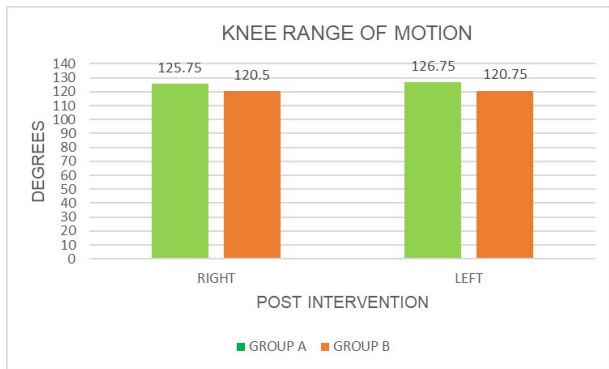


**Graph 2:** WOMAC- post intervention analysis between group A and group B.

Interpretation: There is statistically significant improvement in WOMAC of both groups with p<0.05

**Table 5:** Knee ROM- post intervention analysis between group A and group B.

Post	Group A	Group B	p value
Knee ROM right	125.75 ± 5.20	120.50 ± 7.05	0.01
Knee ROM left	126.75 ± 5.91	120.75 ± 7.12	0.006



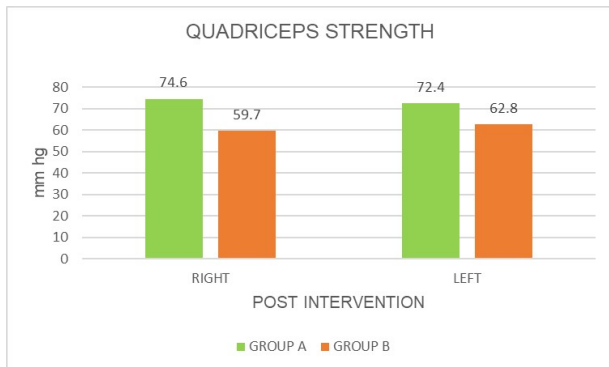
**Graph 3:** Knee ROM- post intervention analysis between group A and group B

Interpretation: There is statistically significant improvement in Knee ROM of both groups with  $p < 0.05$

**Table 6:** Quadriceps strength- post intervention analysis between group A and group B.

Post	Group A	Group B	p value
Quadriceps strength right	74.60 ± 8.92	59.70 ± 7.05	<0.001
Quadriceps strength left	72.40 ± 8.69	62.80 ± 5.85	<0.001

**Graph 4:** Quadriceps strength- post intervention analysis between group A and group B.



Interpretation: There is statistically significant improvement in Quadriceps strength of both groups with  $p < 0.05$

There is no statistically significant difference seen in VAS on rest, TUG, 9 step stair climb test between both the groups with  $p > 0.05$ . Thus, both the treatments are equally effective.

## DISCUSSION

Both the groups, individually showed decrease in the pain intensity levels post intervention. The treatment strategies included cryotherapy which was given in the initial two sessions helped in alleviating pain by Lewis Hunting reaction by alternate phase of vasoconstriction and vasodilatation limiting swelling and extent of tissue damage. Reduced nerve transmission velocity in pain fibers is

another theory for how cryotherapy works and may be a means of producing analgesia and pain reduction [7].

Paraffin wax bath for knees given for session 3-8. Paraffin wax bath helps in increasing the local circulation, improving both arterial and soft tissue blood flow to the afflicted areas, thereby reducing joint stiffness along with easing the pain.

Other treatment strategies included strengthening exercises which helped in reducing the pain levels. In a study done by Noel M. et al. on proprioceptive impairments in OA knee patients, it was seen that resisted exercise may repair joint mechanics and muscle strength while enhancing physical performance. Moreover, it may correct joint biomechanics and muscle firing patterns, reducing joint discomfort and cartilage deterioration, thereby reducing pain, and improving physical functions [8].

Group A showed better result in pain reduction than Group B. Group A received Magnesium oil application and Epsom salt foot soak in addition after each session. Magnesium plays an important role in the prevention of central sensitization and in the attenuation of established pain hypersensitivity, and its main mode of action appears to involve its voltage-gated antagonist action at N-methyl-D-aspartate (NMDA) receptors. Magnesium inhibits calcium ions entering cells by blocking NMDA receptors, which causes an antinociceptive effect [9].

Hence, transdermal application of Mg offered an effective mean of absorption and alleviating the pain levels.

Mg acts as a cofactor in various enzymatic reactions crucial for energy metabolism, cell growth, glycolysis, and protein synthesis. When bound to ATP it forms the Mg-ATP complex, serving as the primary energy source vital for physiological functions like nerve conduction, muscle contraction, and blood pressure regulation. It reduces, delays the lactate accumulation in the muscle. Hence better recruitment of muscle fibre and increased exercise performance [10].

Also, magnesium is found to be active in

several pathways that have been implicated in OA, helping to reduce inflammatory mediators, cartilage damage, defective chondrocyte biosynthesis, aberrant calcification and greater effect of analgesics [3].

Since the pain levels subsided, along with improving the knee mobility Group A which received Mg as an adjunct has a better quadriceps muscle strength than Group B. The above summative effects helped the subjects to perform their routine activities with ease and comfort seen in the other outcome measures.

## CONCLUSION

The study found that Magnesium when used as an adjunct to conventional therapy shows statistically significant difference in pain levels, knee mobility, quadriceps strength and better functionality in activities of daily living.

## LIMITATION

Standard dose of Magnesium was used for everyone.

## FUTURE SCOPE OF STUDY

Investigate the different compounds of magnesium (oxide, glycinate, taurate, chloride etc.). Formulation of magnesium (oil, spray, lotion, gel etc.) can be studied to determine its effect on other musculoskeletal conditions.

## ABBREVIATIONS

**KOA** – Knee osteoarthritis

**Mg** – Magnesium

**ROM** – Range of Motion

**TUG** – Timed Up and Go Test

**9 SSCT** – 9 Step Stair Climb Test

**WOMAC** – Western Ontario and McMaster Universities Arthritis Index

**CTRI** – Clinical Trial Registry of India

**mm hg** – Millimeters of mercury

**PBF** – Pressure Biofeedback

**mg** – milligrams

## Authors Contribution

**Khadija Lokhandwala:** Contributed towards selection of topic, Research Process, Research Design, Data Collection, Manuscript Drafting.

**Poonam Parulekar:** Research Design, Statistical Research Analysis, Discussion and Editing.

**Ali Irani:** Research Design, Statistical Research Analysis, Discussion and Editing.

## Conflicts of interest: None

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