

The effect of Dexamethasone 0.4% Iontophoresis in treatment of knee Osteoarthritis

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Abstract: Introduction: Osteoarthritis of the knee is reported to be a major health problem worldwide. It is the most common articular rheumatic disease. It principally affects the elderly and has variable clinical presentations. It often carries a significant morbidity as compared to any other joint. **Purpose:** to investigate the effect of Dexamethasone 0.4% iontophoresis in the treatment of knee osteoarthritis. **Study Design:** A pre test post test control group design. **Materials and Methods:** 40 patients of both sexes aged between 45 to 65 years were involved. They were divided into two equal groups with 20 patients each. Patients in group (B) received Dexamethasone 0.4% iontophoresis in addition to the traditional treatment method. The traditional treatment included 10 min of stretching exercises (for hamstring and gastrocnemius muscles) and 10 min of strengthening exercises (for quadriceps muscles) in the form of Isometric multiple angles at 0, 45 and 90 degrees of knee flexion. Patients in the second group (A) received the traditional treatment only. Treatment was done three times a week for four weeks. Knee Range of motion, and functional performance were measured before and after the treatment. **Results:** differences in knee ROM and functional performance of the 2 groups were noted. The experimental Group (B) showed better improvement as compared to the control group (A). **Conclusion:** Dexamethasone 0.4% iontophoresis proved to be beneficial in improving knee Range of motion, and functional performance in patients with knee primary osteoarthritis.

[Abdelhamid Akram Fathy and Soheir M. Abd El Rahman. **The effect of Dexamethasone 0.4% Iontophoresis in treatment of knee Osteoarthritis.** *Life Sci J* 2016;13(1):28-34]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). <http://www.lifesciencesite.com>. 5. doi:[10.7537/marslsj13011605](https://doi.org/10.7537/marslsj13011605).

Keywords: Iontophoresis, Dexamethasone, Osteoarthritis, Exercises.

1. Introduction:

Osteoarthritis (OA) is a disease chiefly involving the deterioration of articular cartilage. This is reflected clinically by the gradual development of pain, stiffness and loss of motion in weight-bearing joints⁽¹⁾. Osteoarthritis of the knee is reported to be a major health problem worldwide. The etiology of knee (OA) is not entirely clear, but its incidence increases with age and among women. Obesity is a risk factor for the development and progression of (OA) and it eventually leads to the need for total knee replacement.^(3,4)

Osteoarthritis is associated with a substantial socioeconomic burden. The job related cost is huge, making its incidence exceed that of asthma, pulmonary, renal and neurological diseases combined.^(5,8)

Early degenerative changes predict the progression of the disease. The disability and pain associated with knee (OA) are correlated to the loss of quadriceps femoris muscle strength (loss of force-generating capacity of the muscle).⁽⁷⁾

Some degree of mobility limitation is experienced by 80% of patients with knee (OA); 25% of adults with knee (OA) cannot perform major activities of daily living (ADL); 11% need help with

personal care and 14% require help with their routine needs.^(5,6)

The therapeutic approach is mainly directed towards symptoms. Many treatment options including pharmacological and non-pharmacological measures are recommended in the management of OA. Non steroidal anti-inflammatory drugs (NSAIDs) are frequently prescribed, but they have significant side effects.⁽¹¹⁾

Physiotherapy is one of the recommended management options in patients with OA. Physical agents are devices used with physical modalities to produce beneficial therapeutic effects. Heat, cold, pressure, light, and even electricity have been used for thousands of years to accelerate healing and decrease pain. Heat therapy is applied to obtain analgesia, decrease muscle spasm, increase collagen extensibility and accelerate metabolic processes.⁽¹⁸⁾

Evidence driven from scientific research supports exercise as a primary conservative therapeutic approach. Participation in regular physical activities provides significant benefits in the treatment of Knee (OA). Unfortunately, some patients with Knee (OA) still feel hesitant to participate in physical activities due to the fear of worsening their OA symptoms.^(14,18)

Failure to remain active and disuse of the affected limb may accelerate impaired joint mechanics. This potentially results in articular cartilage softening and matrix dysfunction, leading to more rapid cartilage degeneration. Immobility and disuse also result in a loss of flexibility of the underlying soft tissues around the knee joint. This can lead to impaired gait mechanics, unequal distribution of force across the joints (proximal and distal), and the clinical findings of pain and dysfunction.^(3,18)

Inflammatory disorders of the musculoskeletal system and acute soft tissue injuries are often treated topically. However, poor permeability of the skin (with the stratum corneum as the main barrier), allows only small quantities of drugs to enter the body. Several techniques, such as Iontophoresis, have been developed to increase the permeability of the stratum corneum. This enhances penetration in deeper tissues such as muscles, tendons, and joints.^(2,9,10)

Iontophoresis has drawn significant attention in the last 25-30 years and it has been applied to common musculoskeletal conditions such as Knee (OA). However, there were controversies about its effect in controlling the symptoms associated with patients suffering from knee osteoarthritis.^(2,13)

Iontophoresis is a therapeutic technique that involves the introduction of ions into body tissues by means of a direct electrical current.⁽¹⁷⁾

It was found that iontophoresis drug delivery for Knee (OA) provided an alternative to hypodermic corticosteroid injections. Iontophoresis allows a short

administration of the drug with minimal systemic side effects. Moreover, the discomfort associated with needle injection at an already tender area can be avoided.⁽¹⁵⁾

Avoiding the use of hypodermic needles also prevents further tissue trauma and eliminates the risk of infection at the injection site.⁽¹²⁾

Dexamethasone sodium phosphate Iontophoresis solution is a preservative-free aqueous solution. It produces better outcomes as compared to the preservative solution which may contain positively charged ions that compete with the negatively charged Dexamethasone ions.^(16,17)

Recent studies support the idea that, iontophoresis offers an opportunity to deliver medication without injections or invasive penetration of the medications. It is considered as a transdermal drug delivery method that uses a small electrical current to drive the ionically charged steroid medication through the skin. Evidence suggested that Dexamethasone administration via iontophoresis is an effective, noninvasive means of decreasing the pain associated with Knee (OA).^(16,17)

2. Material and Methods:

Subjects:

Forty subjects (20 Males and 20 Females) with a confirmed diagnosis of primary knee (OA) participated in this study. The mean age, weight, and height is shown in table (1). The subjects were recruited from different governmental hospitals.

Table (1) Demographic characteristics of all participants

Range	Men (n=20)		Women (n=20)	
	Mean	±SD	Mean	±SD
Age (y)	54.2	8.2	50.1	9.8
Weight (kg)	80.6	15.2	90.1	10.1
Height (cm)	168.2	11.5	158.3	8.6

The patients included in this study suffered from unilateral primary knee (OA) and were not treated by Physical Therapy previously.

Patients were excluded if they had any bone deformities in the femur or tibia, had a history of knee surgery, bony changes on the articular surfaces of the knee joint (osteophytes), meniscal or ligamentous injury of the affected knee, systematic diseases affecting the knee joint (such as rheumatoid arthritis) and/or any neurological disorder affecting the motor ability of the affected limb.

Instrumentation:

All the patients selected in this study were evaluated for knee active range of motion using a Universal Goniometer. For treatment, Ultrasonic therapy was applied using the COMBI-500 electrotherapy unit (Combi 500 produced by Gymna

Uniphy-Belgium). The same machine was used in the application of Iontophoresis with Dexamethasone.

The outcomes of the treatment were measured at the end of the last session. A universal goniometer was used to measure the changes in active range of motion of the knee joint. Patient satisfaction was measured objectively by asking the patients to answer the questions on the WOMAC Osteoarthritis Index 3.1, which represents patient's functional performance.

Procedure:

For Evaluation:

All the patients in this study were referred with the diagnosis of knee Osteoarthritis. Patients were screened to make sure that they met the inclusion criteria. In the first session, the patients were asked to sign a consent form. They were asked to localize area of pain and determine the level of pain using (VAS).

To determine the ROM of the affected knee a universal Goniometer was used. The patient was placed in supine position or reclined with the hip and knee in neutral rotation. The Goniometer was placed on the affected knee with the lateral epicondyle of the femur as the axis. The proximal arm was placed parallel to the long axis of the femur and pointing to the greater trochanter. The distal arm was placed parallel to the long axis of the fibula and Tibia, pointing towards the lateral malleolus. In this position, the degree of knee extension was measured. After that, the patient was asked to flex the hip and knee to the maximum range. This was done with the sole of the foot planted on the bed and the heel moving towards the buttocks.

The patients determined the functional ability of their knees using the WOMAC (Western Ontario and McMaster universities) index of osteoarthritis. WOMAC index is used to assess patients with osteoarthritis of the knee using 24 parameters. It can be used to monitor the course of the disease or to determine the effectiveness of the treatment. It consists of 3 subscales; Pain (5 items), Stiffness (2 items) and Physical Function (17 items). It uses the following grades for all items: None, Mild-Moderate, Severe and Extreme. These grades correspond to an ordinal scale (0-4). The scores are summed for items in each subscale, with possible ranges as follows: pain 0-20, stiffness 0-8, and physical function 0-68. The total score of the scale 0-96 and the highest score on the WOMAC scale indicates the worst pain, stiffness, and functional limitation.

For Treatment:

The patients in this study were randomly distributed to 2 equal groups (Group A and Group B) with 20 patients in each group.

All the patients were treated by performing stretching exercises for the hamstring and Gastrocnemius muscles (with 20 seconds hold at the maximum range of stretching, according to the patient's tolerance of pain). This was followed by 10 min of strengthening exercises for the quadriceps, in the form of Isometric multiple angles at 0, 45, 90 degrees of knee flexion (with 10 seconds hold in each repetition). The patients were treated for 12 sessions (Three sessions per Week for four weeks).⁽³⁾

Patients in group (A) were considered as the control group. Patients in group (B) represented the

experimental group. The results obtained from both the groups were compared. Patients in group (B) were treated following the treatment protocol mentioned earlier. In addition, they received Dexamethasone 0.4% Iontophoresis (for 12 sessions over 4 weeks) using Gymna 500 iontophoresis current, placed on the affected knee for 20 min.

On the negative electrode (Active electrode), the negative ionized 0.4% Dexamethasone solution was added. The electrode was placed on the medial aspect of the knee joint just below the medial femoral condyle. The positive electrode (reference electrode) was placed on the lateral aspect of the knee joint just above the head of fibula. During application, the knee was positioned at 20 degrees of knee flexion.⁽²⁾

3. Results:

The aim of this study was to determine the effect of Dexamethasone 0.4% iontophoresis in the treatment of knee osteoarthritis. The hypothesis was that there is no significant effect of Dexamethasone 0.4% iontophoresis in the treatment of patients with knee osteoarthritis. Changes in knee range of motion and the functional performance of the patients was measured before and after the treatment. The treatment for group A (control group) was the traditional treatment method. Dexamethasone 0.4% iontophoresis was added along with the traditional treatment for patients in group B (experimental group). The treatment continued for 12 sessions (three sessions per week for one month). Paired t-test was used to analyse whether there was a significant difference before and after the treatment in group (A), before and after the treatment in Group (B), and to compare the difference between the two groups.

Range of Motion:

On average, the pre-treatment ROM of knee flexion was 95±10 degrees. After treatment, the average of the ROM of knee flexion in group (A) and group (B) was 108±8 degrees and 110±10 degrees respectively ($p<0.001$) table (2) Figure (1).

WOMAC Index:

The functional activities of patients were measured using WOMAC (Western Ontario and McMaster universities). On average, It was found that the pretreatment score was 65±15. After treatment, the average score in group (A) and group (B) was 40±10 and 32±7 respectively. ($p<0.001$) table (3) Figure (2).

Table 2. Average ROM of knee flexion before and after treatment in both groups

		Range	±SD	Mean	P^b
Pre treatment		85-105	10.2	93	<0.001
After Treatment	(A)	100-116	9.8	105	
	(B)	100-120	7.9	114	

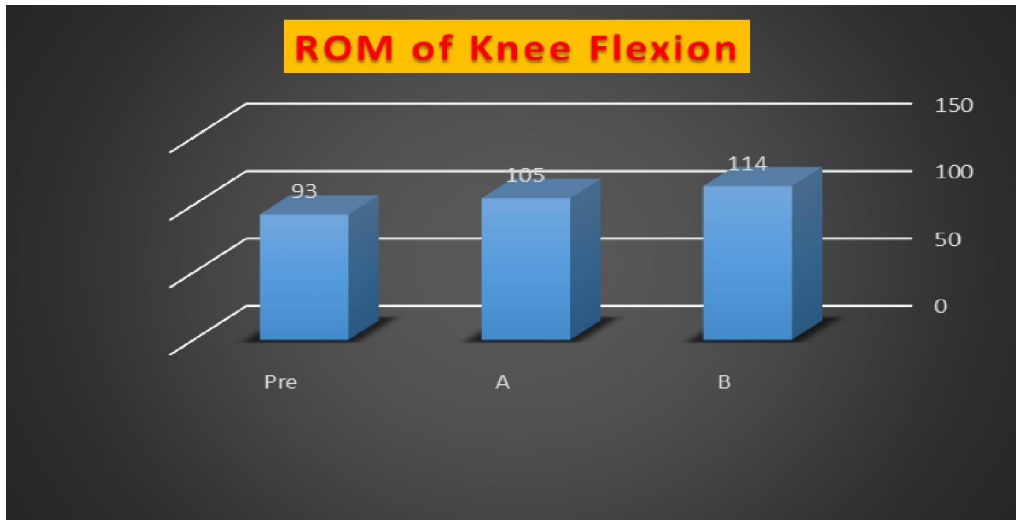


Fig (1) Average ROM of knee flexion before and after treatment in both groups.

Table 3. Average of WOMAC index score before and after treatment in both groups

		Range	±SD	Mean	<i>P</i> ^b
Pre treatment		50-80	8.1	63	<0.001
After Treatment	(A)	30-50	6.3	46	
	(B)	25-39	5.7	34	

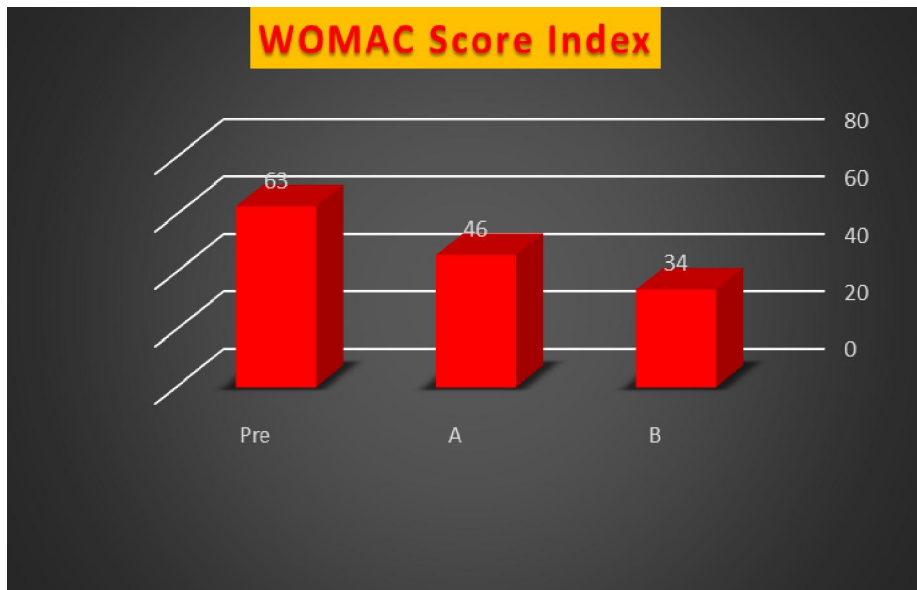


Fig (2) Average of WOMAC index score before and after treatment in both groups.

The effect of Dexamethasone 0.4% Iontophoresis:

Paired t-test was used to analyze the significance of dexamethasone 0.4% iontophoresis in the treatment of knee osteoarthritis. Differences in the outcomes of ROM of knee flexion and the WOMAC score index were compared in both the groups.

Range of Motion between the groups:

A significant difference in ROM was found between the control and experimental groups. After treatment, the average ROM of knee flexion was 108±8 degrees for group (A) and 110±10 degrees for group (B). (*p*<0.001) table (4) Figure (3).

Table 4. Average ROM of knee flexion in both groups

	Range	±SD	Mean	<i>P</i> ^b
Group (A)	100-116	9.8	105	<0.001
Group (B)	100-120	7.9	114	

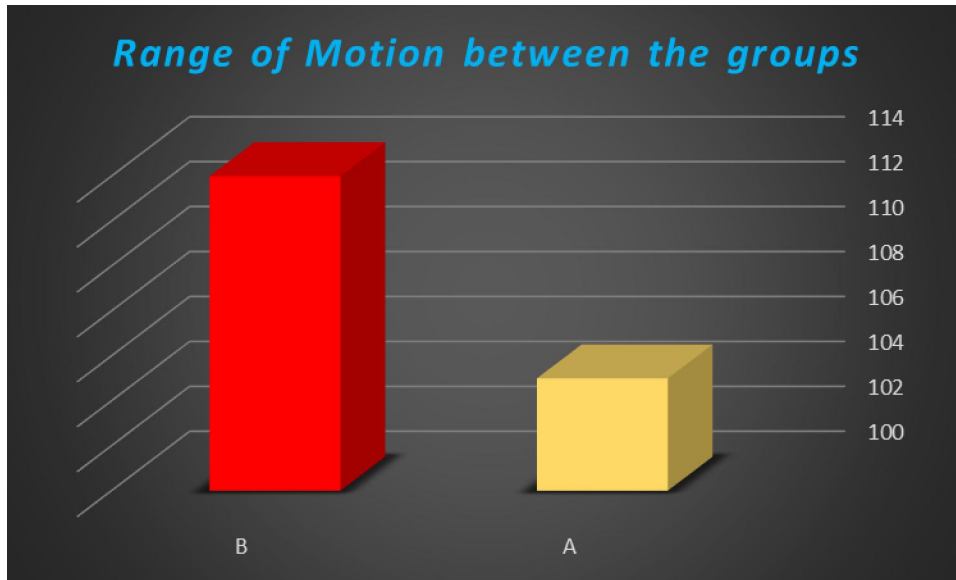


Fig (3) Average ROM of knee flexion in both groups

WOMAC Index between the groups:

A significant difference was found between the two groups in the WOMAC index score. On average,

the WOMAC index scores of group (A) and group (B) after treatment were 40±10 and 30±10 respectively. (p<0.001) table (5) Figure (4).

Table 5. WOMAC index score

	Range	±SD	Mean	<i>P</i> ^b
Group (A)	30-50	6.3	46	<0.001
Group (B)	25-39	5.7	34	

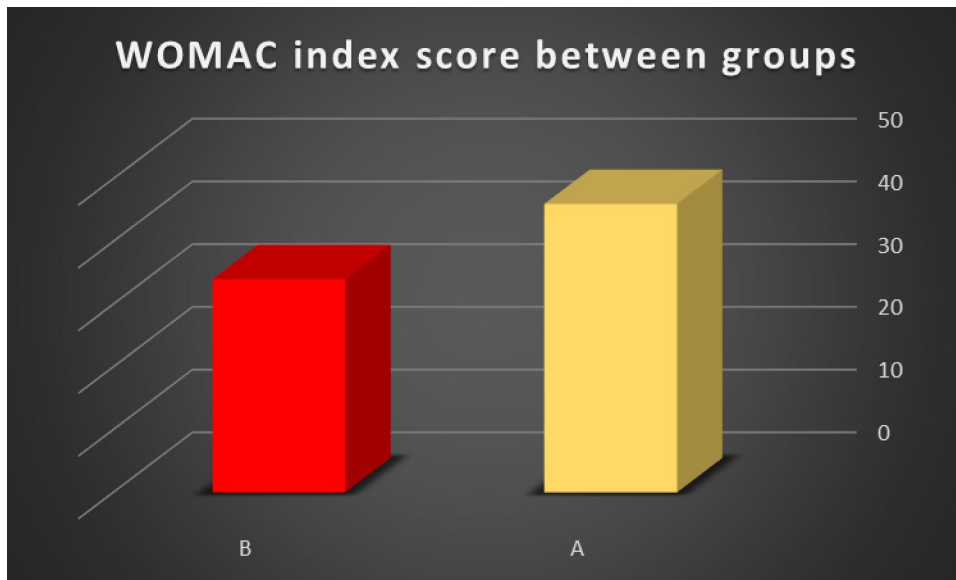


Fig (4) Average WOMAC index score in both groups

4. Discussion:

The main purpose of this study was to determine the effect of dexamethasone 4% Iontophoresis on patients with knee osteoarthritis. Physical Therapy modalities and exercises have played a role in the treatment of patients with this condition. Recent research has shown that modalities alone are not sufficient to relieve symptoms. The use of exercise in addition to modalities has proven to be more effective. Research has shown that the application of pulsed ultrasound along with strengthening exercises (for quadriceps) and stretching exercises (for hamstrings), can alleviate pain and improve the function of patients with knee OA. ⁽⁷⁾ Dexamethasone 4% Iontophoresis is a noninvasive Physical therapy modality which allows direct control of inflammation in the underlying tissue. It was found that adults with rheumatoid arthritis experienced a reduction in knee pain after the application of Dexamethasone 4% Iontophoresis. ⁽¹²⁾ It was found that dexamethasone 4% had a significant effect in reducing pain in patients diagnosed with medial collateral ligament (knee) sprain. This study compared the effect of dexamethasone with a placebo treatment. ⁽¹⁶⁾ A recent study has also shown that the best application of Iontophoresis for knee osteoarthritis is with Methylprednisolone Sodium succinate (SoluMedrol). However, this study compared the effect of this method with a placebo group. ⁽¹⁹⁾ A comparison between the use of dexamethasone sodium phosphate and Methylprednisolone Sodium succinate found that dexamethasone 4% Sodium phosphate is more stable as compared to Methylprednisolone sodium succinate. Evidently, Dexamethasone 4% sodium phosphate can be stored at room temperature for one month without undergoing any changes. On the contrary, Methylprednisolone sodium succinate must be used within 48 hours of mixing, as the solution eventually loses its stability. ⁽¹²⁾ Another study showed that there are no statistical differences in the pressure-pain threshold and active ROM in arthritic joints, following the application of dexamethasone 4% iontophoresis. ⁽²⁾ The small sample size might have been responsible for these findings as this was a case study and dexamethasone 4% iontophoresis was applied on one case only. Recent studies revealed that the use of dexamethasone Iontophoresis was more effective in reducing pain at rest, as compared to other corticosteroids drugs.

Conclusion:

The study provided evidence to support the use of iontophoresis of 4% dexamethasone in controlling the pain and improving the functional activities of patients with knee osteoarthritis.

Acknowledgements:

The author thanks Cairo University for supporting this study.

Conflict of interest:

There is no conflict of interest to be declared.

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1/12/2016