Efficacy of Extracorporeal Shock Wave Therapy Versus Mobilization with Movement on Pain, Disability and Range of Motion In Patients With knee Osteoarthritis

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ABSTRACT

Purpose: *To compare between the efficacy of shockwave therapy versus mobilization with movement on patients with knee osteoarthritis.* ***Patients:*** *Forty five patients with knee osteoarthiritis for more than three months participated in this study. They were randomly assigned into 3 equal groups. Each group consists of 15 patients.* ***Methods:*** *Patients were evaluated pre and post treatment for knee pain severity by the visual analogue scale and functional disability using WOMAC scale and ROM of the knee joint using Myrin OB goniometer. Group (A) received shock wave therapy, 10000 shock, 2000/session, 5 sessions, 1 weak apart, 0.18 mj /mm^2 plus an exercise program. Group (B) received mobilization with movement plus the same exercise program, Group (C) received the exercise program alone. The three groups received treatment 3 times per week for 4 weeks.* ***Results:*** *There were no significant differences between shock wave therapy and mobilization with movement. Both were effective than the control group in relieving knee pain and functional disability. Shock wave therapy was the most effective in increasing range of motion of the knee joint with P<0.0001.* ***Conclusions:*** *Both shockwave therapy and mobilization with movement are effective in relieving knee pain and functional disability and should be added to the treatment program.*
Key words: *Osteoarthritis, Shockwave therapy, mobilization with movement, Exercises.*

INTRODUCTION

Osteoarthritis (OA) is recognized as an important source of disability and handicap, which leads to considerable socioeconomic costs due to medical, surgical intervention and frequent absence from work[53]. It results from the normal wear and tear that evolves over the time. The clinical syndrome of joint pain, stiffness, and loss of joint function in OA is generally caused by progressive loss of articular cartilage, sclerosis of subchondral bone, formation of subchondral bone cysts, and osteophytes[27].

Relieving pain, preserving joint physiology and maintaining or recovering normal activity are major goals in treating patients with osteoarthritis. Manual techniques and exercise are basic physiotherapy techniques for these patients. Physical agents can supplement and reinforce these techniques such as electro-stimulation, heat and cold application and ultrasound. Recently, Shock wave has been used to treat OA[44].

Shock waves are sound waves that are generated by a source that creates vibration which are then transported through tissue via fluid and solid particles interaction[39]. The treatment eases inflammation in afflicted area and relieves chronic pain[48].

Extracorporeal shock wave therapy (ESWT) emerges as a new non-invasive, feasible, safe and cost-effective method. It may decrease the need of surgery and therefore, the morbidity of the patient. Extracorporeal shock wave therapy (ESWT) promotes angiogenesis, increase perfusion in ischemic tissue, decreases inflammation, enhances cell differentiation and accelerates wound healing. ESWT showed efficacy in treating nonunion fractures, tendinopathies, and osteonecrosis[3].

The rational for the use of ESWT for osteoarthritis is based on stimulation of soft tissue healing by local hyperemia, neovascularization, inhibition of pain receptors and/or denervation to achieve pain relief and persistent healing of chronic inflammatory processes[28]. It was also found to have a positive effect on the concentration of transforming growth factor beta-1, which have a chemotactic and mitogenic effect on osteoblast cells. There is also some evidence that shock waves may have an effect on nitric oxide syntheses systems implicated in bone healing and remodeling[9]. Extracorporeal shock wave therapy was positively used in altered bone turn over, thus inducing a "protective" effect on the progression of many bone and cartilage degenerative disease. From this point of view, ESWT seems not only to be a powerful non pharmacological and non-invasive tool for normalizing bone metabolism, but also to have a potential value of preventive and therapeutic intervention[2].

Several studies were conducted to find out the effect of application of ESWT on animals with knee osteoarthritis preceded by arthrotomy of the animal joint in order to isolate some component of the joint and show the effect of ESWT specifically on chondrocytes and also evaluate the articular cartilage histologically and macroscopically. They found that ESWT is chondroprotective agent, decrease Calcitonin gene related peptide (CGRP). Consequently, this leads to decrease pain, improving subchondral bone remodeling, and there is no side effect in clinical setting[15,35,37,42,51,52]. Cinar et al.,[11] found that ESWT didn’t affect the healing of chondral defect.

On the other hand, Mobilization with movement (MWM) is a manual therapy treatment technique in which a manual force, usually in the form of a joint glide, is applied to a motion segment and sustained while a previously impaired action such as painful reduced movement or painful muscle contraction is performed[34].

Abdel-Razek[1] found that MWM with exercises were effective than the exercises alone in decreasing pain severity, functional disability and increasing knee joint range of motion in patients with osteoarthritis of the knee joint.

Reports of clinical cases and case series have described the success of MWM in the management of various musculoskeletal conditions[12,13,25,32,36,45,50]. The clinical efficacy of MWM techniques have been established for improving joint function. Mulligan's concept is related to minor positional faults that occur secondary to injury and that lead to maltracking of the joint, resulting in symptoms such as pain, stiffness, or weakness. The cause of positional faults has been suggested as changes in the shape of articular surfaces, thickness of cartilage, orientation of fibers of ligaments and capsules, or the direction and pull of muscles and tendons. MWMs correct this by repositioning the joint, causing it to track normally[55]. Thus, altering mechanical malaligment is a successful treatment to reduce symptoms of knee osteoarthritis.

The studies that compared the shock wave therapy with mobilization with movements are lacking. Thus, this study aimed to investigate which of the two treatment therapies are effective in comparison with exercises in relieving pain severity, reducing functional disability and increasing knee joint range of motion in patients with knee osteoarthritis.

MATERIAL AND METHODS

Forty five male and female patients with unilateral or bilateral knee OA due to degenerative cause, their age were between 40 to 65 years, participated in this study. All patients were referred from an orthopedic surgeon who was responsible for diagnosis of cases based on clinical and radiological examinations. They were randomly distributed into three equal groups. Patients in group (A) received shock wave therapy, plus exercises in the form of strengthening for quadriceps, hamstring, hip abductors and extensors and stretching of the hamstrings, and cuff muscles. Patients in group (B) received mobilization with movement plus the same exercise program and group (C) who received the exercise program alone.

Patients were included in the study if they are diagnosed clinically and radiologically as unilateral or bilateral moderate to severe knee osteoarthritis with grade 3, and 4 on Kellgren & Lawrence scale, able to ambulate independently and have sufficient understanding to perform the tests. Patients were excluded if they had a history of traumatic knee injury including knee ligament or cartilage injury, previous knee surgery, associated comorbidities such as neurological disease, malnutrition, and other inflammatory or infectious disease.

Instrumentations:

The "Shock Master" was used for producing shock waves. Its radial shock wave delivery system is approved for distribution and use in the United States by the Food and Drug Administration (FDA).[30]

Evaluation procedures:

Each patient was assessed just before and after the treatment period. Pain intensity was assessed using the visual analogue scale[40]. Western Ontario and McMaster universities osteoarthritis index (WOMAC) is used to evaluate pain, functional capacity and stiffness. The WOMAC is a validated disease specific self-report questionnaire[6]. Myrin OB Goniometer was used to assess the range of motion of the knee joint[5].

Treatment procedures

Shock wave therapy

All patients received SWT in long sitting position, with the affected knee is exposed, the knee is slightly flexed and the hip is abducted and externally rotated and the shock wave applicator was directed in the most tender point over the medial aspect of the knee joint[23].

Before application of SWT the treatment area was prepared with a coupling gel to minimize the loss of shock waves at the interface between applicator tip and skin. The treatment was performed with the Shock Master. The applicator (hand piece) was pressed upon treatment area up to the first ring with application pressure categorized as "medium". As the patient adjusted to the shockwave-induced pain, the applied energy was increased during the treatment from 2 to 2 bars. Analgesia of the treatment zone was not necessary. Each patient received (10000 shocks, 2000 shock/session, 5 sessions 1 week apart (the study last for one month), energy flux density 0.18mJ/mm^2, energy level 2-4, pulse rate 160/min., 6Hz)[51].

Mobilization with movement

According to the work of Mulligan's[34] and Abdel-razek[1], MWM was conducted as follows.

a- Medial glide Mobilization with movement

The patient lied prone and to apply medial glide the therapist stood on the contra-lateral side, placed a belt around his waist and the patient's lower leg so that the proximal edge was at the tibial joint margin. The therapist stabilized the thigh above the knee with one hand and supported the lower leg with the other. The therapist glided the knee medially with the belt and asked the patient to flex his knee.

b- Lateral glide Mobilization with movement

The patient lied prone and to apply lateral glide the therapist stood on the same side, placed a belt around his waist and the patient's lower leg so that the proximal edge was at the tibial joint margin. The therapist stabilized the thigh above the knee with one hand and supported the lower leg with the other. The therapist glided the knee laterally with the belt and asked the patient to flex his knee.

c-Rotation mobilization with movement

A patient can do his own rotation MWMS with the painful leg on a chair. He placed his hands proximally around the lower leg and rotated his tibia medially. After sustaining this rotation he bent forward to flex his knee (weight-bearing) provided there was no pain. The hands on the fibular side carried it forward at the same time

d- MWM. Dorsal glide with active knee flexion

The patient lied supine and the therapist stood beside the knee to be treated. With his fingers interlaced placed his hands over the flexed knee so that the heel of one hand lied over the tibial plateau, and the heel of the other was over the lower end of the femur. He glided the upper end of the tibia posteriorly when he was trying to proximate the heels of his hands.

The exercise program

The exercise program consisted of stretching of the hamstring muscles and calf muscles and straight leg raising exercises, three sets of 10 repetitions[12] and Isometric strengthening of the quadriceps muscle in the form of 3 sub maximal isometric contractions of increasing intensity[1,16].

RESULTS

Graph pad prism version (6) was used for data analysis. One way ANOVA was used to find out differences among groups. At baseline measurement there was no significant differences among groups in the means of age, weight and chronicity with P<0.05 as shown in table (1).

Table (1): Baseline measurements among groups.

Variable	Group (A) SWT Mean ±SD	Group (B) MWM Mean ±SD	Group (C) Control Mean ±SD	F-value	P value	Sig
Age	52.20(±5.44)	51.93(±6.51)	50.07(±5.73)	0.577	0.56	NS
Weight	92.63(±7.72)	94.5(± 6.36)	92.45(±6.23)	0.418	0.66	NS
Chronicity	7.33(±2.77)	8.40(±2.47)	7.73(±2.81)	0.607	0.55	NS

SWT: shock wave therapy MWM: mobilization with movement Sig.: significance NS: none significant

Within group comparison

Paired t-test was used to find out if there were significant differences between pretreatment and posttreatment means within each group for all variables. For group (A) who received shockwave therapy, there were significant differences between the pretreatment and posttreatment means in pain, functional disability and range of motion of the knee joint with P<0.0001. For group (B) who received mobilization with movement, there were significant differences between the pretreatment and posttreatment means in pain, functional disability and range of motion of the knee joint with P<0.0001. For group (C), the control group, there were significant differences between the pretreatment and posttreatment means in pain, functional disability and range of motion of the knee joint with P<0.0001 as shown in table (2).

Table (2): Comparisons between the pretreatment and posttreatment means for all variables within each group.

Group	Variable	Pre treatment Mean ± SD	Post treatment Mean ±SD	t-value	p-value	S
Group (A) Shock wave therapy	Pain intensity	6.10 (±1.96)	1.83(±0.794)	11.30	0.0001	S
	Functional disability	50.40(±18.94)	17.93(±11.51)	10.66	0.0001	S
	Range of motion	80.33(±7.43)	104.67(±9.15)	20.58	0.0001	S
Group (B) Mobilization with movement	Pain intensity	5.33 (±1.29)	1.27(±1.22)	15.25	0.0001	S
	Functional disability	58.60 (±17.97)	30.47(±23.62)	7.09	0.0001	S
	Range of motion	87.20 (±10.14)	95.67(±7.31)	6.61	0.0001	S
Group (C) Control group	Pain intensity	6.56(±1.51)	4.83(±1.80)	9.21	0.0001	S
	Functional disability	49.33(±14.08)	36.73(±12.80)	10.24	0.0001	S
	Range of motion	81.93(±6.58)	88.07(±4.96)	5.99	0.0001	S

S: significant

Between group comparison

Mean difference was used in the comparison between groups for all variables to detect which group was more effective. ANOVA test was used to compare between the mean differences of the variables among the three groups.

The results revealed that there were significant differences among the three groups for pain, functional disability and range of motion of the knee joint with P<0.0001 as shown in table (3).

Table (3): Comparison between the mean differences of the three groups in pain, functional disability and range of motion variables.

Variable	Group (A) SWT	Group (B) MWM	Group (c) Control group	F- value	P value	S
Pain intensity	4.26 (±1.46)	4.07 (±1.03)	1.733 (±0.73)	23.97	0.0001	S
Functional disability	31.67 (±11.49)	27.00 (±15.45)	12.87 (±5.34)	10.80	0.0001	S
Range of motion	25.00 (±5.00)	8.47 (±5.28)	6.13 (±3.96)	69.44	0.0001	S

SWT: shock wave therapy MWM: mobilization with movement Sig.: significance NS: none significant

Post hoc analysis was conducted to show which group is more effective. The results revealed that for pain intensity, there was no significant difference between SWT and MWM with t=0.484 at P<0.5 while there were significant differences between SWT and the control group with t=6.224 at P<0.05 and between MWM and the control group with t= 7.467 at P<0.05 as shown in fig (1).

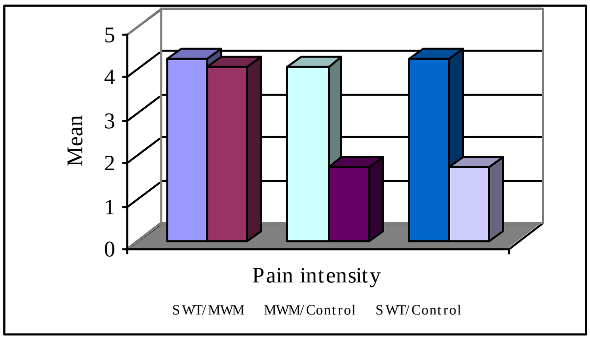

Fig. (1): Pain intensity between groups comparison.

For functional disability, there was no significant difference between SWT and MWM with t=1.109 at P<0.5 while there were significant differences between SWT and the control group with t=4.463 at P<0.05 and between MWM and the control group with t= 3.354 at P<0.05 as shown in fig (2).

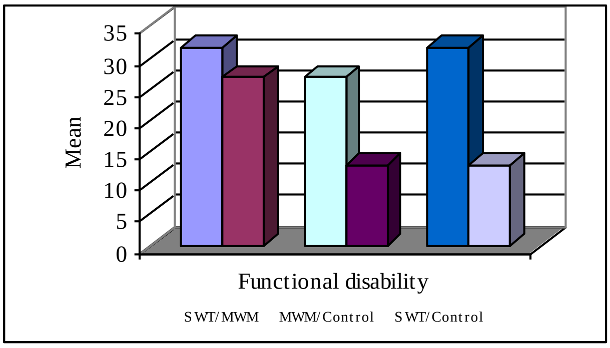

Fig. (2): Functional disability between groups comparison.

For the range of motion of the knee joint, there were significant differences between SWT group and MWM group with t=9.470 at P<0.05 and between SWT group and control group with t= 10.810 at P<0.05, while there was no significant difference between the MWM group and the control group with t= 1.341 at P<0.05 as shown in fig (3).

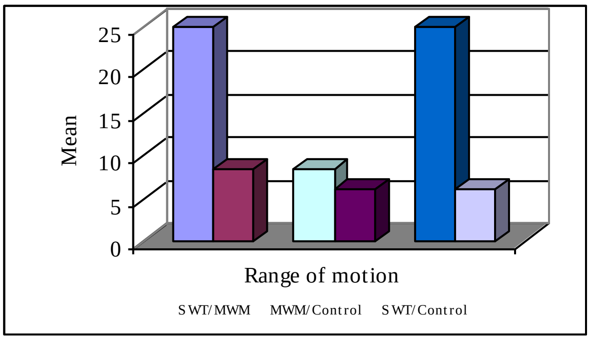

Fig. (3): Range of motion between groups comparison.

DISCUSSION

The results of this study showed that shock wave therapy plus exercise, mobilization with movement plus exercises as well as exercises alone were effective in relieving knee pain, improving functional disability and increasing range of motion of the knee joint. There was no difference between the effects of shockwave and mobilization with movement in relieving knee pain and improving functional disability as both were more effective than the control group. Shockwave in addition to exercises had the advantage of increasing the knee joint range of motion than the mobilization with movement plus exercises or the exercises alone.

Shock wave therapy was effective in relieving knee pain. This result comes in agreement with Imamura et al.,[23] who reported that RESWT is an effective method for treating knee osteoarthritis pain in patients scheduled for a total knee replacement and Takahashi et al.,[47] who stated that Japan

Orthopedics association OA score and visual analogue scale score (VAS score) improved after ESWT treatment of knee osteoarthritis And also is supported by Pritsch et al.,[41] who reported that the beneficial effect was based on the known analgesic effect of ESCT, the theory of cartilage cell growth stimulation and matrix formation.

The analgesic effect of shock wave therapy could be attributed the induced analgesic effect by over stimulating the axons (gate-control theory) thereby increasing a person pain threshold[43]. Other hypothesized mechanism of action include the physical alteration of small axons, this inhibit pain impulse conduction, and chemical alteration of pain receptors neurotransmitters, thereby preventing pain perception[29]. Endorphins that are released locally after a certain number of shocks might help in pain reduction[48]. Besides, ESWT cause reduction of substance P in the target tissue in conjugation with reduced synthesis of these molecules in dorsal root ganglia cells as well as by selective destruction of unmyelinated nerve fibers within the focal zone of ESWT[46].

Our study found that shockwave therapy plus exercises improved the range of motion of the knee joint. This result comes in agreement with Arno et al.,[3] who reported that (SWT) increases perfusion in ischemic tissues, stimulates growth factors, decreases inflammation and accelerate healing which could help in improving function. Pritisch et al.,[41] conducted a follow-up on the "knee injury and osteoarthritis outcome score" (KOOS) found out that ESCT produced a significant improvement in pain and function.

About the knee range of motion, SWT was effective in increasing knee joint range of motion. The improvement of knee range of motion in osteoarthritis patients in this study could be attributed to the positive analgesic effect, anti inflammatory effect and tissue regeneration after using SWT[10,43].

The current study revealed that mobilization with movement plus exercises were effective in decreasing pain, reducing functional disability and improving range of motion. In comparison with the exercise group, mobilization with movement added an advantage in reducing pain and disability, but there were no difference between both groups in improving range of motion. This result came in agreement with Abdel-razek[1] who found that the group who received both mobilization of movement and exercises was more effective in relieving pain and improving range of motion than exercises alone while there was no significant difference between both in reducing functional disability. May be the only difference between both studies regarding the improvement in knee joint range of motion is that we chose patients with grade3,4 on Kellgren & Lawrence scale, while in abdelrazek study they treated more milder cases with grades 1 and two on the same scale, so they could achieved more improvement in range of motion.

The improvement in functional disability for Chronic KOA patients in this group could be attributed to analgesic effect of MWM technique which leaded to decrease pain and improve knee functions. It may also attributed to Mulligan's concept of the ability of MWM to correct minor positional faults that occur secondary to knee osteoarthritis and that lead to maltracking of the joint, resulting in symptoms such as pain, stiffness, or weakness[34].

Our results showed that exercises alone were effective in relieving knee pain and disability besides improving the range of motion. These results came in agreement with several authors who found almost the same results[30-33]. Muscles are important for shock absorption and help in stabilizing the joint. Periarticular muscle weakness may result in the progression of structural damage to the joint in OA. Furthermore, insufficient loading of a joint will lead to atrophy of both articular cartilage and the sub-chondral bone. Exercise regimes that strengthen the quadriceps muscle may, in addition to decreasing joint pain, slow the progression of joint damage in patients with knee OA[14]. Muscle spasm was believed to impede blood flow to the muscle, causing ischaemic pain and further spasm. Stretching the muscle was thought to restore blood flow to the muscle and interrupt the pain -spasm-pain cycle[8].

The functional activities in KOA patients are greatly influenced due to painful limited mobility of the knee joint and lack of strength and motor control which guarding the patient during performance of the functional activities like sitting, standing and walking. The patient's functional activities improved as the pain decreased and knee ROM increased. In addition, the exercise program aimed to increase individuals' confidence in the use of their knee and overcome the fear of physical activity[38].

The exercise program was effective in increasing knee joint range of motion in agreement with Mikesky et al.,[31], Gur et al.,[17], Wyatt et al.,[56] and Hopman-Rock[19]. This finding related to stretching exercises which increased flexibility and also strengthening exercises[14]. Also, in agreement with Huang et al.,[21] Who stated that Six treatment sessions of stretching with infrared or ultrasound were more effective than stretching without heat at increasing the ROM and decreasing joint contracture.

Conclusion

Adding the shockwave therapy or MWM to the exercise program will be helpful in decreasing pain and functional disability but the shock wave have an extra advantage of increasing the range of motion more effectively than the MWM.

Acknowledgement

I would like to thank Reda Kotb Abdelrazek and Shaimaa Naguib for their help.

Funding resources: none

Conflict of interest: none.

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الملخص العربي

فاعلية العلاج الموجات التصادمية مقابل التحريك المفصلي مع الحركة على الألم ، العجز الوظيفي ومدى الحركة في مرضى خشونة الركبة

الغرض : للمقارنة بين فاعلية العلاج الموجات التصادمية مقابل التحريك المفصلي مع الحركة في مرضى خشونة الركبة. **المرضى :** خمسة وأربعون مريضا بخشونة الركبة لأكثر من ثلاثة أشهر اشتركوا في الدراسة . تم توزيعهم عشوائيا على ثلاث مجموعات متساوية . تكونت كل مجموعة من 15 مريض . **الطرق :** تم تقييم المرضى قبل وبعد العلاج لشدة الألم بإستخدام المقياس البصري والعجز الوظيفي باستخدام مقياس وماك ومدى الحركة بإستخدام منقلة ميرين . تلقت المجموعة (أ) العلاج بالموجات التصادمية بالإضافة إلى التمرينات والمجموعة (ب) تلقت التحريك المفصلي مع الحركة بالإضافة إلى التمرينات والمجوعة (ج) تلقت التمرينات فقط ثلاث مرات أسبوعيا لمدة أربعة أسابيع . **النتيجة :** لم يكن هناك فرق بين العلاج الموجات التصادمية مقابل التحريك المفصلي مع الحركة . كلاهما كان فعالا أكثر من مجموعة التمرينات في تقليل الألم والعجز الوظيفي . كان العلاج الموجات التصادمية أكثر فاعلية في زيادة مدى الحركة بمفصل الركبة . **الاستنتاج :** كلا من العلاج الموجات التصادمية والتحريك المفصلي مع الحركة فعال في تقليل الألم والعجز الوظيفي ويفضل إضافته لبرنامج العلاج .

الكلمات الدالة : خشونة المفاصل ، العلاج الموجات التصادمية ، التحريك المفصلي مع الحركة ، التمرينات .