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Whole body vibration versus kinesio-taping technique in patellofemoral pain syndrome

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***Abstract*---**Background: Patellofemoral Pain Syndrome (PFPS) is a common musculoskeletal problem especially in adolescents and patellar tracking or malposition and lower limb muscle strength have been implicated a contributing factor. Objective: The purpose of this study was to compare between the effect of Whole Body Vibration technique versus Kinesio-Taping technique on pain threshold, pain intensity and functional level "mobility" in patients with Patello-Femoral Pain Syndrome. Methods: Forty five patients of both genders with age ranged from eighteen to forty years old participated in this study. They were assigned randomly into three groups (Group A, Group B and Group C). Group A consisted of 15 patients received Whole Body Vibration technique (3 sessions per week for 4 weeks) in addition to conventional physical therapy exercises, Group B consisted of 15 patients received Kinesio-Taping technique (2 sessions per week for 4 weeks) in addition to conventional physical therapy exercises, Group C consisted of 15 patients received conventional physical therapy exercises only (3 sessions per week for 4 weeks). Pain threshold was measured by pressure algometry, pain intensity was measured by visual analogue scale and functional level was measured by kujala patellofemoral questionnaire. Results: The results revealed that there were significant improvement on pain threshold, pain intensity and functional level "mobility" in the three groups but there

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was more significant improvement of all values in the Group B that received the Kinesio-taping technique. Conclusion: Patients showed significant improvement regarding pain threshold, pain intensity and functional level in case of treatment by whole body vibration and kinesio-taping, but kinesio-taping was better than whole body vibration regarding to these variables.

***Keywords*---**patellofemoral pain syndrome, whole body vibration, Kinesio-Taping.

Introduction

Patellofemoral pain syndrome (PFPS) is one of the most common orthopedic knee afflictions among both adults and adolescents. This syndrome, constitutes 5% of all injuries and 25% of knee injuries [1]. It is characterized by pain in the back of the knee cap that comes in contact with the femur and it is usually aggravated by walking stairs, deep squatting, kneeling, prolonged sitting, and standing up from sitting [2]. Because PFPS has multifactorial causes, many rehabilitation strategies have been implemented for patients with PFPS and the goals of patellofemoral rehabilitation are to maximize quadriceps strength while minimizing the patellofemoral joint reaction forces and stresses [3]. Treatment of PFPS varies from medication, taping, bracing and up to different rehabilitation approaches, including strength exercises, balance and proprioceptive exercises to regain normal activities of daily level and optimizing function [4].

The effectiveness of whole-body vibration (WBV) has been shown in previous studies to be an alternative and safe method for stimulating neuromuscular overload and may be incorporated into current neuromuscular rehabilitation programs in order to speed up a return to full activity [5]. Recently, Whole Body Vibration (WBV) training has been suggested due to its strong favorable effects on improving muscle strength and power, balance, function, or reducing pain. It has been shown that in the previous studies that WBV training improves knee pain, knee function and muscular performance in individuals with PFPS [6].

Many authors have proposed that the primary cause of PFPS is lateral tracking of the patella. Based largely upon the theory of patellar mal-tracking, The Kinesio Taping (KT) is a relatively new application of a more compliant adhesive taping used a system of treatment for PFPS by taping the patella in a medial direction [7]. Application of KT to the skin over affected muscle and joint structures is purported to alleviate pain and facilitate microcirculation by providing proper positional stimuli through the skin, influencing interstitial tissue to normalize skin tension [8].

Although the previous studies demonstrated that both of WBV and KT had been approved their abilities in improving the functional activity and decreasing the pain in PFPS subjects but up till now the most appropriate treatment for PFPS has not been determined. So this study was conducted to compare between the effect of WBV and KT in treatment of patients with PFPS on pain threshold, pain intensity and functional level "mobility".

Materials and Methods

Study design

Randomized control trial (pre and posttest experimental study).

Participants

Sample size of this study was calculated by G-power analysis (with estimated number of Forty five patients of both genders with age ranged from 18-40 years). All patients were selected from the orthopedic outpatient clinic and physical therapy departments at Faquos Hospital. Patients were divided into three groups, each group consisted of fifteen subjects.

Group A: (n=fifteen patients) Experimental group received Whole Body Vibration technique (3 sessions per week for 4 weeks) in addition to conventional physical therapy exercises.
Group B: (n=fifteen patients) Experimental group received Kinesio-Taping technique (2 sessions per week for 4 weeks) in addition to conventional physical therapy exercises.
Group C: (n=fifteen patients) Control group received conventional physical therapy exercises only (3 sessions per week for 4 weeks) in the form of (Straight leg raise "SLR" exercise, Quadriceps setting exercise, Side Lying Hip Abduction, Side lying hip adduction, self-stretching exercises for Calf, Hamstring, Quadriceps muscles) [9].

Inclusion criteria

- Patients diagnosed with unilateral Patello-Femoral Pain with at least three months [10].
- Age of patients ranged from 18 to 40 years [11].
- BMI less than 30 kg/ m^2 [12].
- Patient complained from increasing pain severity after at least two of the following provocative activities as (Stair ascent and descent, Squatting, Kneeling, running, or Prolonged sitting).
- Patients included in the study recorded a positive grind test.

Exclusion criteria

Patients were excluded from the study if they are suffering from any of the following:

- History of steroid injection of the knee.
- Ankle arthritis, gouty arthritis.
- Skin rashes or history of allergy to kinesio tapes.
- History of any surgical intervention of the back, hip, knee or foot.
- Lower limb deformity such as pes-planus, knee valgus or varus deformities.
- Previous lower limb disease such as hip and tibiofemoral osteoarthritis.
- Diabetes or peripheral neuropathy.

Instrumentation for assessment

Pressure Algometry

Pressure algometry can be incorporated for clinical assessment to objectively assess pain and monitor progress. It is the minimal pressure when the patient feels a painful sensation (Fig.1) [13].

Fig. (1): Pressure Algometry.

Visual Analogue Scale (VAS)

An evaluation tool used to evaluate pain sensation [14]. The visual analog scale (VAS) is a validated, subjective measure for acute and chronic pain. Scores are based on self-reported measures of symptoms that are recorded with a single handwritten mark placed at one point along the length of a 10-cm line that represents a continuum between the two ends of the scale “no pain” on the left end (0 cm) of the scale and the “worst pain” on the right end of the scale (10 cm) (Fig.2) [15].

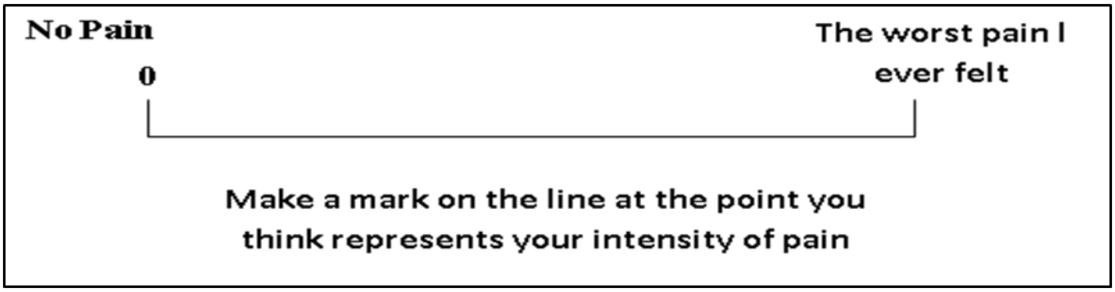

Fig. (2): Visual Analogue Scale.

The Kujala patellofemoral questionnaire

The Arabic version of Kujala patellofemoral score questionnaire is a valid and responsive outcome for measuring the disabilities in functioning and activities in PFPS patients. This questionnaire is a functional evaluation instrument to evaluate knee problems related to the patellofemoral system. Which is a 13-item questionnaire including different items on pain related to functioning and activities. The categories within each item are weighted and item scores summed to provide an overall index scored from 0 to 100, where the maximum score of 100 represents no disability [16].

Instrumentation for treatment

-Whole Body Vibration

Max Fit whole body massage machine with a vibrating platform. WBV therapy may be applied while standing or exercising on the platform. The vibrations are characterized by parameters such as direction, amplitude, velocity, and frequency, which can be combined to generate different treatment protocols and intensities. Vibration platforms deliver vibration over a range of frequencies (5-90 Hz) and amplitudes (also known as dis-placements), even up to 10 mm (Fig. 3) [17].

Fig. (3): Whole body vibration Machine.

Kinesiology Taping

The Premium World-Wide Brand 5cm*5m Amazon Ares Kinesiology Tape (Fig.4) was used in the study. KT is manufactured pre-stretched by 15-25% as it was applied to the backing paper. It is characterized by the ability to stretch to 120-140% of its original length and, following application, recoil back towards its unstretched length. Kinesiology Tape purportedly mimics the physical qualities of the skin as it is believed to be the same weight and thickness of the epidermis along with its inherent elastic properties. It is comprised of polymer elastic wrapped in 100% cotton fibers, which allows for evaporation of moisture. Kinesiology Tape is both waterproof and breathable and it can be worn during exercise, showering and even swimming. It dries quickly and seldom causes skin irritation [18].

Fig. (4): Amazon Ares KT.

Procedures

Assessment Instrumentation

All patients got full explanation of the objective of the study, demonstration on equipment, and procedures. All patients were evaluated before any intervention (pre-treatment test) and after treatment (post-treatment test).

Assessment of Pain threshold

The assessment was done causing an increasing pressure by a previously calibrated electronic algometer with a 1 cm^2 probe that will be held perpendicular to the skin in the center of the anterior aspect of patella without quadriceps contraction, increasing the pressure 20 kPa/s until the patients said "stop," meaning that the pressure sensation in their knees was beginning to become painful. Measurements were done with the patients were resting in a reclining position and the knee flexed to approximately 20°, with a small pillow beneath the knee. The Pain Threshold was assessed three times in the affected knee with 1 min apart every assessment from the previous one and the final PPT value of the knee was considered as the average of the three measurements [19].

Assessment of pain intensity

The patient was asked to mark any point on the continuum that expresses his/her pain intensity at the time of evaluation.

-Functional level of patients

The Arabic version of Kujala patellofemoral questionnaire was used for functional evaluation of knee problems related to the patellofemoral system. Each patient was asked to read the scoring system carefully then he/she chosed the suitable description for him/her. The summation of scores of the thirteen point was represented the total score.

Treatment procedure

Group A (Experimental group): Patients in this group received WBV technique in addition to conventional physical therapy exercises. Whole body vibration training was performed on an axial (vertical) vibration platform. The frequency of the vibration platform (amount of vibrations per second) was fixed at 35 Hz and the amplitude of the vibration platform (peak-to-peak displacement) was set at 2 mm. A total of 4 different types of WBV exercises in 3 sets was applied for 30 or 45 or 60 s/set with a 30 s rest period between sets and a 60 s rest period between exercises. The patients of were asked to take off their shoes, to stand on the vibration platform with their socks on, and the correct position on the vibration platform was adjusted before each exercise (Figs. 5, 6, 7, 8) [20],[21].

Lunge-step position: The foot of the affected side was placed on the vibration platform with the knee angle at 90° in line with the second digit of the foot in the sagittal plane. Patients were asked to stabilize their hips in a vertical position and the knee is not to be positioned anterior to the toes. The foot of the non-affected side was placed on the ground and patients could hold onto the handlebars to support their balance. This exercise was performed bilaterally. As shown in (Fig.5).

Fig. (5): Whole body vibration " Lunge-step position".

Semi-squat position: The patients stood on the vibration platform with feet 20 cm apart while the knees are bending 45 degrees in line with the second digit of the foot in the sagittal plane and were not to be positioned anterior to the toes, and the hips were bending 45 degrees. The patients were asked to keep their backs neutral and they could hold onto the handlebars to support their balance. As shown in (Fig.6).

Fig. (6): Whole body vibration "Semi-squat position".

Ball squeeze squat position: Similar instructions were given for knee and hip positions as in the semi-squat position, while squeezing the inner thighs to keep the ball steady. As shown in (Fig.7).

Fig. (7): Whole body vibration "Ball squeeze squat position".

Dynamic squat position: The patients stood on the vibration platform as in the semi-squat position, then both knees and hips were bent from 45 degrees to 60 degrees and extended from 60 degrees to 45 degrees. As shown in (Fig. 8).

Fig. (8): Whole body vibration "Dynamic squat position".

Group B (Experimental group): Patients in this group received KT technique in addition to conventional physical therapy exercises. The KT was applied by a certified physical therapist. An I-strip was applied on the rectus femoris from its origin to its insertion with 10% stretch applied (muscular facilitation mode) ending in a Y-shape on either side of patella with 50–75% tension, while maintaining a slight knee flexion at 30 degrees. Finally, the ends of the bandage were applied with no tension. (Fig.9) [22],[23].

Fig. (9): I-strip application of KT.

Group C (Control group): The patients in this group received conventional physical therapy exercises only in the form of (Straight leg raise "SLR" exercise, Quadriceps setting exercise, Side Lying Hip Abduction, Side lying hip adduction, Self-stretching exercises for Calf, Hamstring, and Quadriceps muscles) [9].

Straight leg raising (SLR) exercise

The patient lied on his/her back with his/her affected leg straight out in front of him/her. Bend the knee of the sound side and place the foot flat on the floor. Tighten the thigh muscle of the affected leg and lift it about 8 inches off the floor, keeping the thigh muscle tight throughout. Hold this position 10 seconds. Slowly lower the leg back down to the floor. Do 3 sets of 10. (Fig.10).

Fig. (10): Straight leg raising (SLR) exercise.

Quadriceps setting exercise

The patient lied on his/her back with his/her injured leg straight and the other leg bent, press the back of the knee of the injured leg against the floor by tightening the muscles on the top of your thigh. Hold this position 10 seconds. Relax. Do 3 sets of 10. (Fig. 11).

Fig. (11): Isometric contraction of quadriceps.

Side Lying Hip Abduction

The patient Lied on his/her side with the affected limb is the top one, then tighten the front thigh muscles and lift that leg 8 to 10 inches away from the other leg. Hold this position 10 seconds Keep the leg straight and lower slowly. Do 3 sets of 10. (Fig. 12).

Fig. (12): Side Lying Hip Abduction

Side lying hip adduction

The patient lied on his/her side on the affected limb, and place the top leg and foot flat on the floor in front of him/her. Lift the affected leg upwards towards the ceiling to feel a pull on the inside and outside of the thigh. Hold this position 10 seconds, and repeat the movement up and down 10 times for 3 sets. (Fig. 13).

Fig. (13): Side lying hip adduction

Self-stretching exercises for Hamstring muscle

The patient placed the heel of his/her injured leg on a stool about 15 inches high. Keep his/her knee straight. Lean forward, bending at the hips until he/she feels a mild stretch in the back of his/her thigh. Make sure he/she does not roll his/her shoulders and bend at the waist when doing this or he/she will stretch his/her lower back instead of his/her leg. Hold the stretch for 15 to 30 seconds. Repeat 3 times. (Fig. 14).

Fig. (14): Stretching exercises for Hamstring.

Self-stretching exercises for Quadriceps muscle

The patient stood an arm's length away from the wall with his/her injured leg farthest from the wall. Facing straight ahead, brace himself/herself by keeping one hand against the wall. With his/her other hand, grasp the ankle of his/her injured leg and pull his/her heel toward his/her buttocks. Don't arch or twist the back. Keep the knees together. Hold this stretch for 15 to 30 seconds. (Fig. 15).

Fig. (15): Stretching exercises for Quadriceps.

Self-stretching exercises for Calf muscle

The patient faced a wall, putting his/her hands against the wall at about eye level. Keep one leg back with the heel on the floor, and the other leg forward. Turn your back foot slightly inward (as if you were pigeon-toed) as you slowly lean into the wall until he/she feels a stretch in the back of your calf. Hold for 15 to 30 seconds. Repeat 3 times and then switch the position of your legs and repeat the exercise 3 times. (Fig. 16).

Fig. (16): Stretching exercises for Calf

Statistical analysis

The statistical analysis was carried out via the SPSS Package for Windows version 25. (SPSS, Inc., Chicago, IL). For demographic data, the mean and standard deviation were used (weight, age, BMI, and height). The independent t-test was performed to compare demographic data variables between the two groups. One-way ANOVA is a statistical technique which is utilized to compare the investigated major variables of interest across different test groups. Bonferroni correction test was utilized to compare between pairwise between and within groups of the tested variables, that F was significant from the ANOVA test. All statistical analyses were significant at the probability level less than an equal 0.05 ($P \leq 0.05$).

Results

The main purpose of this study was to investigate the effect of whole-body vibration technique versus kinesio-taping technique in treating patients with PFPS. This study was conducted on forty-five patients with PFPS. They were randomly assigned into three groups equal in numbers. Group A (WBV group): was received WBV technique in addition to conventional physical therapy exercises for 4 successive weeks. Group B (KT group): was received KT technique in addition to conventional physical therapy exercises for 4 successive weeks. Group C (Control group): received conventional physical therapy exercises only for 4 successive weeks. Data obtained from all groups before and after 4 successive weeks of intervention was statistically treated to analyse the scores of pressure algometer (kPa/s), Visual analogue scale VAS (score) and The Arabic version of Kujala patellofemoral score questionnaire (score).

General characteristics of participants
Demographic data
Group A (WBV group)

Fifteen patients (6 males and 9 females) were included in this group. The mean values of their age, height, weight and BMI were 25.73 ± 3.71 years, 165.26 ± 6.47 cm, 73.6 ± 8.84 kg and 26.88 ± 1.85 Kg/m2 respectively.

Group B (KT group)

Fifteen patients (7 males and 8 females) were included in this group. The mean values of their age, height, weight and BMI were 26.6 ± 4.27 years, 168.46 ± 6.15 cm, 72.0 ± 7.76 kg and 26.12 ± 1.13 Kg/m2 respectively.

Group C (Control group)

Fifteen patients (5 males and 10 females) were included in this group. The mean values of their age, height, weight and BMI were 25.73 ± 3.82 years, 166.33 ± 4.8 cm, 73.46 ± 6.78 kg and 26.52 ± 1.72 Kg/m^2 respectively. Comparing the general characteristics of the patients of all groups by one-way ANOVA test revealed that there were no significant differences found between groups in the demographic characteristics, including age, weight, height and BMI ($p>0.05$) as shown in Table (1) and (Figures. 17, 18, 19 and 20).

Table (1): Demographic characteristics of patients in all groups

	Group A $\bar{x}$ ± SD	Group B $\bar{x}$ ± SD	Group C $\bar{x}$ ± SD	f-value	p-value	Sig.
Age (years)	25.73 ± 3.71	26.6 ± 4.27	25.73 ± 3.82	0.241	0.787	NS
Height (cm)	165.26 ± 6.47	168.46 ± 6.15	166.33 ± 4.8	1.16	0.826	NS
Weight (kg)	73.6 ± 8.84	72.0 ± 7.76	73.46 ± 6.78	0.192	0.323	NS
BMI (Kg/m^2)	26.88 ± 1.85	26.12 ± 1.13	26.52 ± 1.72	0.852	0.434	NS

$\bar{x}$: Mean value MD: Mean Difference P-Value: Probability
SD: Standard Deviation f-value: one-way ANOVA test NS : Non-significant

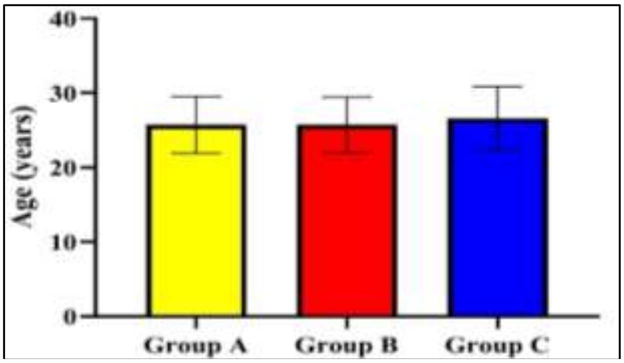

Fig. (17): Mean values of age between groups.

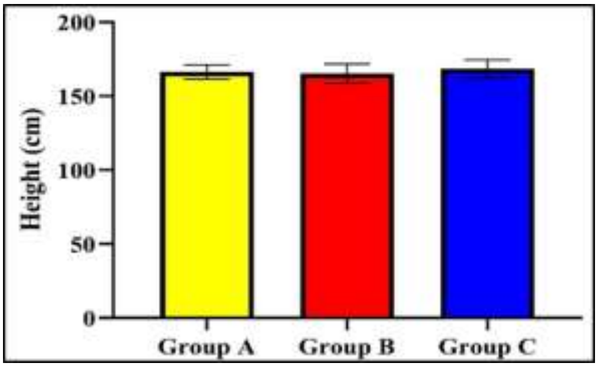

Fig. (18): Mean values of height between groups.

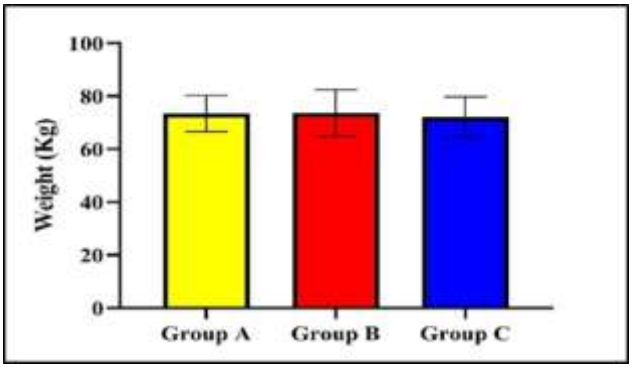

Fig. (19): Mean values of weight between groups.

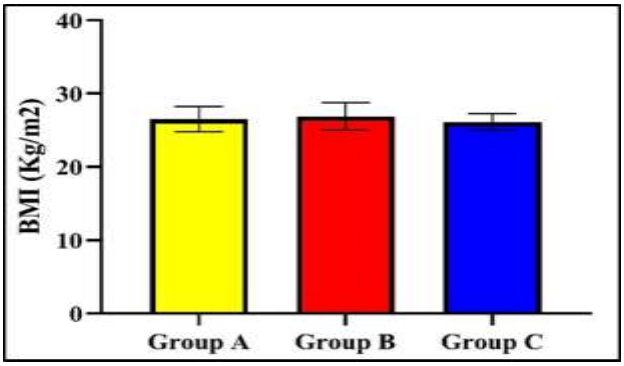

Fig. (20): Mean values of BMI between groups.

Gender distribution

As shown in Table (2) and (Fig. 21), the frequency distribution of gender between groups revealed that group A included 6 males with percentage of 40 % and 9 females with percentage of 60 %. While group B included 7 males with percentage of 46.66 % and 8 females with percentage of 53.33 %. However, group C included 5 males with percentage of (33.33 %) and 10 females with percentage (66.66 %). Chi-squared test revealed that there was no significant difference between groups regarding gender distribution as (p-value > 0.05).

Table (2): The frequency distribution of gender in both groups

Group	Gender					
	Male No (%)	Female No (%)	Total	χ^2	P- value	Sig.
Group A	6 (40 %)	9 (60 %)	15 (100 %)	0.556	0.757	NS
Group B	7 (46.66 %)	8 (53.33 %)	15 (100 %)			
Group C	5 (33.33 %)	10 (66.66 %)	15 (100 %)			
Total	18 (40 %)	27 (60 %)	45 (100 %)			

$\chi 2$ = Chi square test NS= non-significant

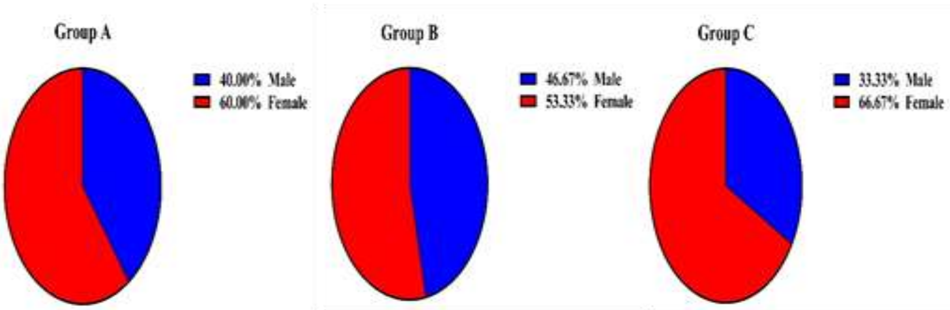

Fig. (21): The frequency distribution of gender in all groups

Pressure algometer (kPa/s)

Table (3) and **(Fig. 22)** represents the mean values of the pressure algometer pre- and post-treatment for all groups, as well as multiple pairwise comparison tests among all groups (Group A, Group B & Group C) pre- and post-treatment.

Within groups

In the group A, the pre and post treatment mean scores of pressure algometer were 16.93 ± 3.95 & 42.53 ± 4.06 respectively, there was a highly significant difference with percentage of improvement 151.21%. While in the group B, the pre and post treatment mean scores of pressure algometer were 15.86 ± 3.6 & 57.06 ± 5.2 respectively, there was a highly significant difference with percentage of improvement 259.77 %. However, in the group C, the pre and post treatment mean scores of pressure algometer were 14.26 ± 3.23 & 29.53 ± 5.47 respectively, there was a highly significant difference with percentage of improvement 107%.

Between groups

One-way ANOVA test revealed no significant difference between groups as regard pressure algometer pre-treatment as p value = 0.139. Also, post hoc (Bonferroni) test revealed a highly significant difference in the pressure algometer between groups post treatment as P value = 0.0001. Pairwise comparison test revealed a highly significant difference between WBV group & Control group in favor to WBV group. Also, there was a highly significant difference between KT group & Control group in favor to KT group. However, when comparing WBV group & KT group there was a highly significant difference between groups post-treatment in favor to KT group.

Table 3: Mean values of pressure algometer for all groups pre-and post- treatment

	Pressure algometer (kPa/s)					
	Pre-treatment	Post-treatment	t- value	p-value	Sig.	% of change
Group A	16.93 ± 3.95	42.53 ± 4.06	-21.80	0.0001	S	↑ 151.21%
Group B	15.86 ± 3.6	57.06 ± 5.2	-26.37	0.0001	S	↑ 259.77%
Group C	14.26 ± 3.23	29.53 ± 5.47	-21.8	0.0001	S	↑ 107%
f-value	2.073	115.99				
P- value	0.139	0.00001				
Sig.	NS	S				

Multiple pairwise comparisons between both groups (group effect)				
Group effect		MD	P-value	Significance
Post-treatment	Group A vs. Group B	-14.53	0.0001*	S
	Group A vs. Group C	13.0	0.0001*	NS
	Group B vs. Group C	27.53	0.0001*	S

P-Value: Probability value MD: mean difference NS: Non-significant
F-Value: one-way ANOVA test S: Significant

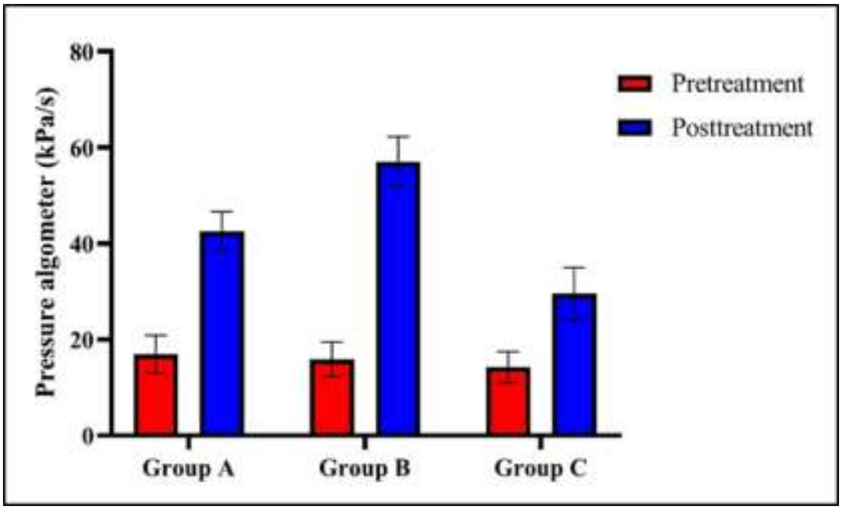

Fig. (22): Mean values of Pressure algometer between groups pre- and post-treatment

Visual Analogue Scale (VAS)

Table (4) and (Fig. 23) represents the mean values of the VAS pre- and post-treatment for all groups, as well as multiple pairwise comparison tests among all groups (Group A, Group B & Group C) pre- and post-treatment.

Within groups

In the group A, the pre and post treatment mean scores of VAS were 6.86 ± 1.45 & 3.53 ± 1.18 respectively, there was a highly significant difference with percentage of improvement 48.54 %. While in the group B, the pre and post treatment mean scores of VAS were 7.33 ± 1.29 & 1.46 ± 0.51 respectively, there was a highly significant difference with percentage of improvement 80.08 %. However, in the group C, the pre and post treatment mean scores of VAS were 6.93 ± 1.38 & 4.86 ± 1.3 respectively, there was a highly significant difference with percentage of improvement 29.87 %.

Between groups

One-way ANOVA test revealed no significant difference between groups as regard VAS pre-treatment as p value = 0.609. Also, post hoc (Bonferroni) test revealed a highly significant difference in the VAS between groups post treatment as P value = 0.0001. Pairwise comparison test revealed a highly significant difference between WBV group & Control group in favor to WBV group. Also, there was a highly significant difference between KT group & Control group in favor to KT group. However, when comparing WBV group & KT group there was a highly significant difference between groups post-treatment in favor to KT group.

Table 4: Mean values of VAS for all groups pre-and post- treatment

	Visual analogue scale (score)					
	Pre-treatment	Post-treatment	t- value	p-value	Sig.	% of change
Group A	6.86 ± 1.45	3.53 ± 1.18	17.83	0.0001	S	↓ 48.54 %
Group B	7.33 ± 1.29	1.46 ± 0.51	21.43	0.0001	S	↓ 80.08 %
Group C	6.93 ± 1.38	4.86 ± 1.3	11.37	0.0001	S	↓ 29.87 %
f-value	0.502	39.17				
P- value	0.609	0.00001				
Sig.	NS	S				

Multiple pairwise comparisons between both groups (group effect)				
Group effect		MD	P-value	Significance
Post-treatment	Group A vs. Group B	2.06	0.0001*	S
	Group A vs. Group C	-1.33	0.004*	S
	Group B vs. Group C	-3.4	0.0001*	S

P-Value: Probability value MD: mean difference NS: Non-significant
F-Value: one-way ANOVA test S: Significant

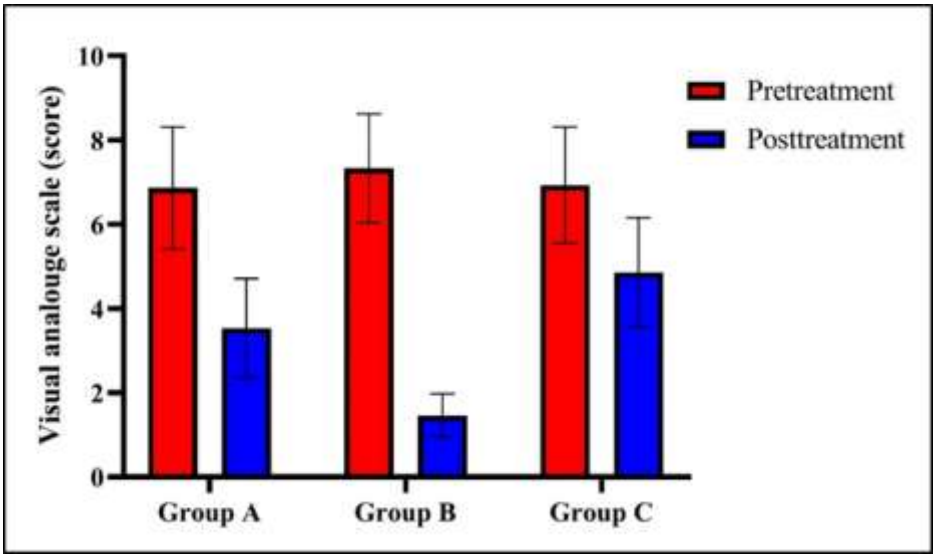

Fig. (23): Mean values of VAS between groups pre- and post-treatment.

Kujala patellofemoral score questionnaire (score)

Table (5) and (Fig. 24) represent the mean values of the Kujala patellofemoral score questionnaire pre- and post-treatment for all groups, as well as multiple pairwise comparison tests among all groups (Group A, Group B & Group C) pre- and post-treatment.

Within groups

In the group A, the pre and post treatment mean scores of Kujala patellofemoral score questionnaire were 55.93 ± 20.71 & 71.6 ± 11.05 respectively, there was a highly significant difference with percentage of improvement 28.01 %. While in the group B, the pre and post treatment mean scores of Kujala patellofemoral score questionnaire were 53.86 ± 22.21 & 87.4 ± 7.32 respectively, there was a highly significant difference with percentage of improvement 56.7 %. However, in the group C, the pre and post treatment mean scores of Kujala patellofemoral score questionnaire were 60.8 ± 17.73 & 69.86 ± 14.82 respectively, there was a highly significant difference with percentage of improvement 14.9 %.

Between groups

One-way ANOVA test revealed no significant difference between groups as regard Kujala patellofemoral score questionnaire pre-treatment as p value = 0.634. Also, post hoc (Bonferroni) test revealed a highly significant difference in the Kujala patellofemoral score questionnaire between groups post treatment as P value = 0.0001. Pairwise comparison test revealed no significant difference between WBV group & Control group post-treatment. However, there was a highly significant difference between KT group & Control group in favor to KT group. Also, when comparing WBV group & KT group there was a highly significant difference between groups post-treatment in favor to KT group.

Table 5: Mean values of Kujala patellofemoral score questionnaire for all groups pre-and post- treatment

	Kujala patellofemoral score questionnaire (score)					
	Pre-treatment	Post-treatment	t- value	p-value	Sig.	% of change
Group A	55.93 ± 20.71	71.6 ± 11.05	-5.32	0.0001	S	↑ 28.01 %
Group B	53.86 ± 22.21	87.4 ± 7.32	-7.35	0.0001	S	↑ 56.7 %
Group C	60.8 ± 17.73	69.86 ± 14.82	-9.26	0.0001	S	↑ 14.9 %
f-value	0.461	10.61				
P- value	0.634	0.00001				
Sig.	NS	S				

Multiple pairwise comparisons between both groups (group effect)				
Group effect		MD	P-value	Sig.
Post-treatment	Group A vs. Group B	-15.8	0.0001*	S
	Group A vs. Group C	1.73	1.00	NS
	Group B vs. Group C	17.53	0.0001*	S

P-Value: Probability value MD: mean difference NS: Non-significant
F-Value: one-way ANOVA test S: Significant

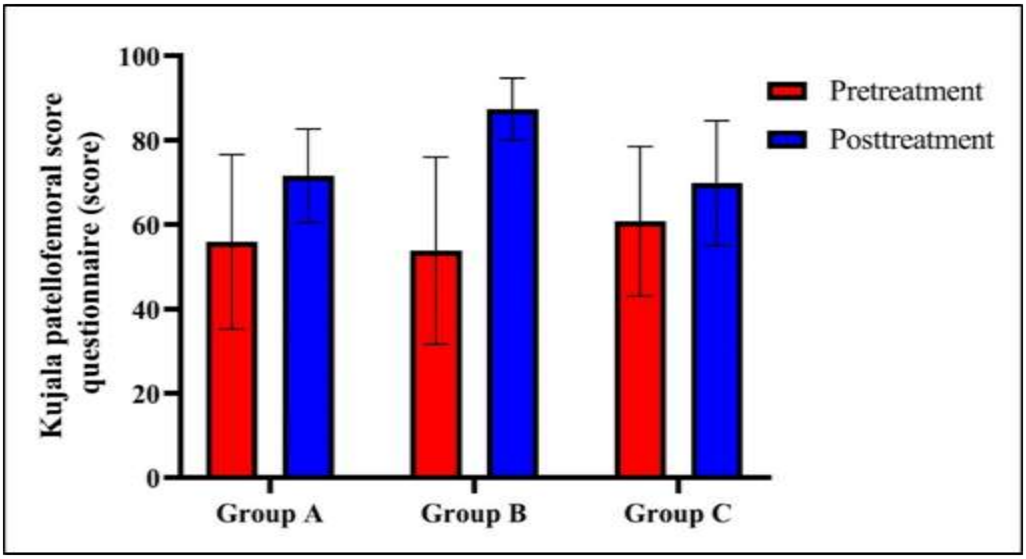

Fig. (24): Mean values of Kujala patellofemoral score questionnaire between groups pre- and post-treatment

Discussion

Whole body vibration (WBV) training has demonstrated improvements in muscle strength, power, balance, flexibility, proprioception or human gait in healthy adults and in many musculoskeletal disorders [24]. Blackburn et al. [25] reported that the pain reduction after WBV training may be that the increase in sensory inputs from the mechano-receptors of the skin, joint and muscle responses caused by vibration could also a favor reduction in pain level caused by physical activity in subjects with PFPS or even improve the quadriceps atherogenic muscle inhibition. Mustafa et al. [26] concluded that Whole Body Vibration training was more effective in reducing knee pain intensity and increasing knee extensor muscular performance. The findings also indicate that Whole Body Vibration training plus home exercise was not found to be more effective than home exercise alone for efficient functional enhancement and quality of life improvement. Also in this study, although no difference was observed on muscle strength between groups, they found an additional enhancement on muscular endurance of the knee extensors in the Whole Body Vibration group compared to the control group.

Angel Yañez-Álvarez et al. [27] were in line with our study in that their findings indicate that performing exercises on the vibrating platform achieves better immediate results in terms of pain relief and functional knee self-reported outcomes in comparison with exercises on their own (without a vibratory stimulus). Therefore, the combination of exercise and vibration may be considered to have a high short-term value in clinical practice for pain relief and improve lower limb functionality. Kinesio-Taping, introduced by Kenzo Kase in 1990, has recently become increasingly popular among athletes. Because of its flexibility, it can be applied to manage patellar tracking and muscle imbalance in patients with PFPS [28].

Wen Dien Chang et al. [29] determined that Kinesio-Taping significantly improve muscle activity, motor function and quality of life, benefits which are possibly facilitated by pain relief. Kuru et al. [23] showed that significant improvements in pain reduction were obtained as well as improvements in knee extension strength in the Kinesio-Taping group were significant which is effective for knee extension strength and quadriceps muscle strength, which are considered important for patients with Patello-Femoral Pain Syndrome. Also this study showed improvements of the Kujala patellofemoral questionnaire from pre- to post-treatment results.

Also, the results were in line with Chang et al. [30] who reported that Kinesio-Taping of the muscles can help joint mechanoreceptors improve joint position sense and might help cutaneous mechanoreceptors stimulate the muscle spindle or Golgi tendon organ. Kinesio-taping is effective in controlling patellar tracking through increased muscle force-sense and that might the mechanism of pain relief in Patello-Femoral Pain Syndrome patients. So from the results of this study, there was significant improvement of group (A) which received whole body vibration technique and also on group (B) which received kinesiology taping technique more than the group (C) which received exercises only, but on the other hand, group (B) showed improvement on pain intensity, pain threshold and functional activity more than the other groups.

Conclusion

It can be concluded that, four weeks of intervention either through whole body vibration, kinesio-taping or even conventional physical therapy only were effective in improving pain threshold, pain intensity and functional level in patients with patello-femoral pain syndrome. However adding kinesio-taping to conventional physical therapy improve pain threshold, pain intensity and functional level more efficiently.

Recommendations

The results of the present study offered the need for considering the following recommendations:

- Further study with longer follow-up is necessary.
- Future similar comparisons including a larger number of patients and possibly longer treatment period.
- Future studies needed to determine the effect of whole body vibration and kinesio-taping on both sex.

Conflict of Interest

The author declared no conflicts of interest with respect to the authorship and/or publication of this article.

Financial Disclosure

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this article.

Ethical Approval

Cairo University, Non-Interventional Clinical Research Ethics Board approved the study (Approval Date: 8.2.2021).

Informed Consent:

A written informed consent form was obtained from the participants. All the participants signed a declaration of informed consent.

Author's contributions

MIM was responsible for formulating the idea, conducting the research, collecting and organizing the data and clinical evaluations. GAA was responsible for the statistical analysis, reviewing the literature and assisting in writing the original draft. NAA was responsible for critical reviewing and approving the final draft. The final draft has been critically reviewed and approved by all authors and the content and similarity index of the manuscript is the responsibility of all of them.

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