Combined effect of using static traction in some therapeutic methods to reduce knee arthritis symptoms

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Introduction

Osteoarthritis is a common musculoskeletal disease and leads to functional drop and loss in quality of life. Clinically, the condition is described by joint pain, tenderness, crepitus, stiffness and limitation of movement with occasional effusion and variable degrees of local inflammation (Pereir *et al.*, 2015).

The pain in knee osteoarthritis is frequently activity associated; constant pain frequently becomes a feature later in the disease (Syed and Wani 2014). Pain in knee osteoarthritis is not simply attributable to the structural modifications in the affected joint, but the consequence of interaction between structural modification, peripheral and central pain processing mechanisms (Eitner *et al.*, 2017).

However, pain is not the only consequence of knee osteoarthritis experienced by patients. Pain is associated with function, with physical movements triggering pain, while pain, in turn, causes limitations in physical function (Castrogiovanni and Musumeci 2017).

There are many risk factors linked with knee osteoarthritis, commonly - joint dysplasia, intra articular fractures, meniscal injuries etc. osteoarthritis has often been found to be linked with occupation involving repetitive stress to the joint in the form of bending activities, operation of heavy vibrating tools, long term farming (Bardoloi *et al.*, 2017).

Sports that subject joints to repetitive high levels of impact and torsional loading raise the risk of articular cartilage degeneration and the subsequent clinical syndrome of knee osteoarthritis. These people and those with early osteoarthritis can benefit from regular physical activity, but they should have a careful evaluation of their joint structure and function before participation. They should consider measures that decline the intensity and frequency of impact and torsional loading of joints, including use of sports equipment that declines joint impact loading, improving muscle strength, tone, and general conditioning so that muscle contractions support protect joints from injury and high impact, and reducing body weight (Buckwalter and lane 1997; Wheaton and Jensen 2010).

To maximize the functional capacity of patients with knee osteoarthritis, therapeutic exercise programs that emphasize stretching, strengthening and conditioning and education and that are personalized to disease severity and patients' individual musculoskeletal abnormalities are recommended (Kunduracilar *et al.*, 2018). Many people with knee osteoarthritis are capable of performing independent exercise programs with an objective of improving physical fitness, and some need personalized exercise instruction and support to be able to participate in rehabilitation programs and to maintain health, improve function, and decrease their risk of inactivity-related illness (Sisto and Malanga 2006).

Transcutaneous electrical nerve stimulation (TENS) is usually used to treat the pain of knee osteoarthritis, stimulation was effective in decreasing knee pain and statistically significant results favoring for relief of knee stiffness and increase in long-term pain relief (Brosseaul *et al.*, 2004).

The effects of electrical muscles stimulation (EMS) have been studied in a variety of patient populations which involved patients recovering from total knee replacement, anterior cruciate reconstruction, knee osteoarthritis and stroke patients, and there is no consensus regarding the therapeutic effectiveness of EMS in a extensive variety of patient populations (Hasegawa *et al.*, 2011).

Ultrasound (US) is one of the commonly used nonpharmacological treatment methods for knee osteoarthritis. Many studies were recognized that, significant improvements in terms of pain, function, and quality of life scales were noted in osteoarthritis ultrasound treated group in comparison with the other groups (Yildiz *et al.*, 2015).

Studies have shown that cooling can be an efficient in decreasing the pain for knee osteoarthritis and improving of the knee function (Alberca *et al.*, 2017).

Studies proved that, mechanical joint traction of the knee using an external fixing device on patients with knee osteoarthritis showed hopeful results. It enlarged the joint space and cartilage thickness, reduced the area of lost brain areas, and improved the total function (Intema *et al.*, 2011; Alpayci *et al.*, 2013).

The present study aimed at assessing the combined effect of using static traction in some therapeutic methods to reduce knee arthritis symptoms for reducing the pain and improving the quality of patients' life.

2. Materials and methods

2.1. Study sample

The study sample comprised twenty four players (30-45 years–old) diagnosed with knee osteoarthritis, had no issues of blood pressure, pulse, and breathing, they also had no consciousness or sensory disorders. The sample was selected from team sports player (basketball, handball, volleyball and five-a-side football) whose participant in the periodic of Egyptian companies, the study was applied from March 2017 to May 2018.

2.2. Study domains

2.2.1. Study time

Period: From March 2017- May 2018.

2.2.2. Study place

Study was performed at health and sport scientific center Port Said.

2.3. Study approach

Study was performed using experimental approach.

2.4. Experimental setup and working

The study sample was divided randomly to three subsample, the first was treated with the traditional treatment method (therapeutic exercise programs, TENS / EMS, ultrasound (US) and cooling), the second was treated same as the first with addition static knee joint traction treatment, done separately, and the last one combined all treatment methods with exception that the static traction and TENS / EMS were done at the same time.

2.4.1. Therapeutic exercise programs

Therapeutic exercise program should include periods of warm-up, aerobic exercise, and cool-down that include exercises to improve or maintain flexibility, range of motion (ROM), muscle strength and endurance, and cardiovascular fitness and health (Sisto and Malanga 2006).

Warm-up strategy may improve subsequent performance but only if the duration of the warm-up strategy is ≤ 16 min (McGowan *et al.,* 2015).

Table 2.1: Warm up exercise name, volume and mode

Exercises	Volume		Mode
Lunges with unilateral trunk rotation (2 sides)	4 sets	10 s	Static
Lunges with unilateral trunk rotation	4 sets	8 reps	Dynamic

Elbow extension (sprawl)	4 sets	20 s	Isometric
Superman	4 sets	20 s	Isometric
Static crunches with hip abduction	4 sets	20 s	Static
Static crunches with hip flexed and trunk rotations (2 sides)	3 sets	10 s	Static
Static crunches with trunk rotations lying down (2 sides)	3 sets	10 s	Static
Static crunches with trunk rotations standing-up (2 sides)	3 sets	10 s	Static
Static elbow extension with unilateral knee flexion (2 sides)	3 sets	10 reps	Dynamic
Standing from the guard (2 sides)	3 sets	10 reps	Dynamic

reps = repetitions.

(Bidonde *et al.*, 2015) recommends that, for aerobic exercise, most adults should involve moderate-intensity cardiorespiratory exercise training using large muscle groups and rhythmical activities for 30 minutes per day on three sessions per week for a total of 90 minutes.

Table 2.2: Aerobic exercise name and volume

(static stretching)			
Exercises	**Volume**		
Adductors	3 reps	10 s	
Hamstrings	3 reps	10 s	
Abductors	3 reps	10 s	
Shoulders	3 reps	10 s	
(dynamic stretching)			
Backward roll	2 sets	30 s	10 reps
Base changes for the abductors	2 sets	30 s	10 reps
Scorpion for shoulders and trunk	2 sets	30 s	10 reps
Hip abduction	2 sets	30 s	10 reps

After training, a low-intensity cool-down session should be implemented to facilitate a gradual transition from an exercise level to a resting state. A cool-down period is essential after a training session and should last approximately 5–10 minutes (Costa *et al.*, 2015).

Table 2.3: Cool-down exercise name, volume and mode

Exercises	**Volume**		**Mode**
Frontal scorpion	2 sets	30 s	Static
Spinal extension for the abdomen and hip flexors	2 sets	30 s	Static
Backward roll for the cervical and lumbar spine	2 sets	30 s	Static
Lateral base for the gluteus and lumbar spine	2 sets	30 s	Static

2.4.2. Transcutaneous electrical nerve stimulation (TENS)

Brief-intense TENS (BITENS), pulses of long duration (0.9ms) are set at high frequency (150Hz) and sensory, motor, and nociceptor fibers are stimulated. This treatment was applied for 20min/day (Rongsawad and Ratanapinunchai 2018) participant received 18 sessions as 3sessions/week.

2.4.3. Electrical muscles stimulation (EMS) training:

The electrical stimulator delivered a constant current symmetrical biphasic waveform with pulse duration of 100μs and a frequency of 50Hz. Each EMS session consisted of 10 muscle contractions. Each contraction lasted 10 seconds and a rest interval was detected between each contraction. The EMS intensity (mA) was set according to each participant's tolerance level (Karthikeyan and Moorthy 2016). Each EMS session was applied for 20-min/day, EG participant received 18 sessions as 3sessions/week.

2.4.4. Ultrasound (US)

In US therapy (frequency: 1MHz, intensity: 1.5W/cm2, duration: 8min) was applied to the anterior, medial, and lateral areas of the knees bilaterally (Yildiz *et al.*, 2015). The treatment was applied for three days a week for six weeks.

2.4.5. Cold therapy

Cooling with cold gel pack with fabric covered applied directly to the skin of the injured knee for 20–30 minutes at least once per day (Shehata and Fareed 2013).

2.4.6. The static traction

In the static traction, participants were asked to turn their hip and knee joints at 60 degrees in the supine position. The tibia was protected with a strap, and continuous knee joint traction treatment was applied to pull the tibia in the cephalocaudal direction. The force applied by the traction was around 6% of the participant's weight, and traction continued for 20 minutes at a stretch. This treatment was run for 20 minutes continuously, once a day, and three times a week for six weeks (Lee *et al.*, 2018).

2.4.7. Tools:

In order to achieve the aim of the study, two tools were utilized to collect the data. These tools are as follows:

Tool I: Measuring test: As the knee movement range using the goniometer (Hancock *et al.*, 2018), knee circumference using measuring tape (Silva *et al.*, 2014), and knee anterior and posterior thigh muscles strength using dynamometer (Mentiplay *et al.*, 2015).

Tool II: Knee injury and osteoarthritis outcome score (KOOS): It was to assess patients' opinion about their knee and associated problems. The English version was used. It consists of five main parts as follow: Part one (pain), part two (symptoms), part three (activities of daily living) (ADL), part four (sport and recreation) (Sport/Rec) and part five (quality of life) (QOl) (Roos and Lohmander 2003; Shehata and Fareed 2013).

3. Results and discussion

No study participant left the research project for any reason. No side effects or complications were observed during the treatment.

Data collected using different measuring tools, revealed that there were improvements in knee measurements in pre compared to the post measuring tests for the three experimental groups with different three treating programs. The maximum improvement was detected with the third experimental groups, compared with the second and the first groups, after six weeks of treating using different treating programs. Results were presented in **Tables 3.4-3.6** and **Figure 3.1.**

Treatment of OA aims to decrease joint pain and stiffness, preserve and increase joint mobility, decrease physical limitations, increase the quality of life, prevent further joint damage, and educate patients about the course and results of the disease. The use of physical treatment modalities is vital due to the considerable gastrointestinal and cardiac side effects of pharmacological agents commonly used in the treatment of OA, which is an important issue especially for the geriatric patients (Bhatia *et al.*, 2013).

TENS study results is in line with Samuel and Maiya (2015) who reported that, TENS preferentially depolarizes sensory nerve fibers, and modulates pain through both opiate and non-opiate mechanisms, with quick start but short duration of analgesia; patients perceive this mode as the most comfortable form of TENS which improving subjective outcomes in patients with pain due to knee osteoarthritis.

EMS increases muscle oxidative capacity and enhances glucose disposal (Buuren *et al.,* 2015). Many studies has provided strong evidence representing that electrical muscular stimulation has been suggested as a method for increasing strength of the quadriceps femoris and decreasing pain in knee osteoarthritis (Giggins *et al.,* 2012).

US, which is among the most usually used physical treatment methods, is a deep heating modality with analgesic and antispasmodic effects on muscles. Analgesic efficacy of therapeutic US outcome may be because of thermal and non-thermal effects. Thermal effects lead to a decrease in pain sensation by affecting tissue metabolism, capillary permeability, pain threshold, and an increase in tissue elasticity. Non-thermal effects reduce pain sensation by stimulating tissue regeneration, altering cell membrane permeability, and increasing the intracellular calcium entrance to the neural system (BAPMR 2013; Yildiz *et al.*, 2015).

Cooling study results are in line with Brosseau *et al.* (2003); Kuyucu *et al.* (2015); who reported that the application of ice packs for three weeks is followed by some enhancement in pain. Using cold treatment can decrease the pain and stiffness and reduce inflammation and swelling.

The result of current study shows that traction had enhancing effect in management of osteoarthritis knee joint. The enhancement in functional result from the application of traction may be because of relief of abnormal pressure on nociceptive receptor systems. Effects of traction involved increased vascular and lymphatic flow (suction aspiration effect) which tends to decrease stasis, edema and coagulates in chronic congestions. Traction stimulates proprioceptive reflexes and helps to tone muscles, which tend to decrease fatigue and restore elasticity and resiliency (Teichtahl *et al.*, 2003).

Table 3.4: Mean, standard deviation, difference, difference (%) and t-test between pre and post measurements for first group.

Knee measurements		Pre		Post		Difference	Difference (%)	t-value
		Mean	± SD	Mean	± SD			
Movement range	Extension	159.75	4.71	174.75	2.82	15	9.39	-9.92*
	Flexion	48.75	5.34	32.50	3.34	-16.52	-33.33	-6.52
circumference	Mid patella	47.50	2.45	45.25	2.12	-2.25	-4.74	-9.00*
	Above 7 cm.	51.00	2.62	49.25	2.60	-1.75	-3.43	-10.69*
	Below 7 cm.	43.88	2.59	42.50	3.25	-1.38	-3.13	-1.02*
Thigh mus	Anterior	16.88	3.14	22.25	3.15	5.38	31.85	-20.43*

	Posterior	9.62	1.41	13.50	1.20	3.88	40.26	-9.64*
Koss	**Pain**	27.56	2.96	38.53	3.63	10.96	39.77	-5.50*
	Symptom	21.86	3.03	38.43	3.58	16.57	75.79	-9.10*
	ADL	23.33	2.46	35.74	3.07	12.42	53.23	-7.61*
	Sport/Rec	16.26	1.82	29.37	3.44	13.11	80.61	-10.55*
	QOL	18.80	3.22	33.61	2.99	14.81	78.80	-9.72*

T critical at alpha 0.05= 1.89*

Table 3.5: Mean, standard deviation, difference, difference (%) and t-test between pre and post measurements for second group.

Knee measurements		**Pre**		**Post**		**Difference**	**Difference (%)**	**t-value**
		Mean	**± SD**	**Mean**	**± SD**			
Movement range	**Extension**	161.00	5.24	178.00	2.14	17.00	10.56	-8.21*
	Flexion	48.00	3.85	28.25	2.92	-19.75	-41.15	-10.57
circumference	**Mid patella**	48.13	2.30	45.00	2.39	-3.13	-6.50	-25.00*
	Above 7 cm.	50.75	1.91	48.25	1.67	-2.50	-4.93	-13.23*
	Below 7 cm.	44.25	2.49	40.88	2.23	-3.38	-7.63	-18.44*
Thigh muscles	**Anterior**	16.38	3.58	23.00	3.51	6.63	40.46	-25.19*
	Posterior	8.63	1.77	14.13	1.96	5.50	63.77	-16.80*
Koss	**Pain**	24.33	3.38	53.82	3.15	29.49	121.22	-28.58*
	Symptom	20.52	1.97	55.84	3.21	35.32	172.10	-26.98*
	ADL	24.46	2.13	50.72	3.35	26.26	107.35	-27.57*

	Sport/Rec	21.26	2.54	45.00	3.78	23.75	111.71	-12.61*
	QOL	22.66	2.65	49.23	2.14	26.56	117.20	-25.14*

Table 3.6: Mean, standard deviation, difference, difference (%) and t-test between pre and post measurements for third group.

Knee measurements		**Pre**		**Post**		**Difference**	**Difference (%)**	**t-value**
		Mean	**± SD**	**Mean**	**± SD**			
Movement range	**Extension**	157.50	4.50	179.50	3.66	22.00	13.97	-29.10*
	Flexion	50.00	5.45	26.25	2.71	-23.75	-47.50	-11.39
circumference	**Mid patella**	47.00	3.07	43.38	2.97	-3.53	-7.71	-9.67*
	Above 7 cm.	50.13	2.30	47.00	2.73	-3.13	-6.23	-8.92*
	Below 7 cm.	43.13	2.75	39.38	2.13	-3.75	-8.70	-9.10*
Thigh muscles	**Anterior**	16.25	3.06	24.13	3.04	7.88	48.47	-15.28*
	Posterior	10.00	2.27	17.13	2.47	7.13	71.25	-31.45*
Koss	**Pain**	24.64	2.32	61.10	3.38	36.46	184.00	-29.66*
	Symptom	20.99	2.46	67.85	2.01	46.86	223.26	-75.28*
	ADL	23.54	2.44	61.40	3.15	37.86	160.81	-27.80*
	Sport/Rec	18.11	1.77	58.76	3.45	40.65	224.48	-31.18*
	QOL	18.74	2.76	64.84	2.88	46.10	245.97	-30.02*

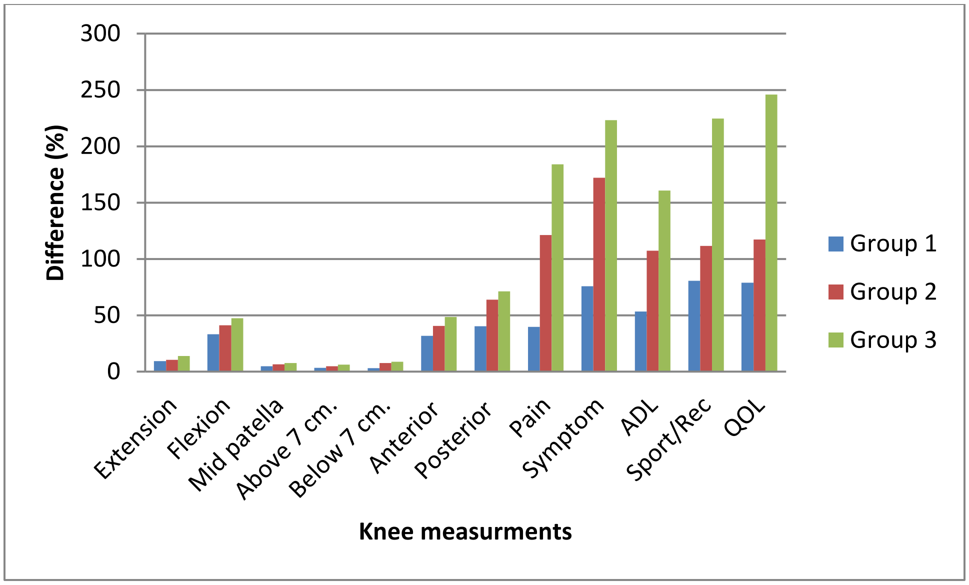

Figure3.1. Difference (%) of knee measurements of the three experimental groups, using three different treating programs.

Data analysis indicated significant variations (P<0.01) in knee measurements among three different experimental groups, using three different treating programs **(Table 3.7, 3.8)**.

The maximum improvement was detected with the third experimental groups, compared with the second and the first groups, these results are in line with Jagtap and Shanmugam (2014); who reported that various traditional approaches are used in treating osteoarthritis of knee joint but their study shows that ultrasound and exercises alone shows minimal effect in reduction of pain than compared to traction along with ultrasound and exercises. Traction was more effective in decreasing pain and improving quality of life than using conventional therapy alone.

Table 3.7: ANOVA test for variation in knee measurements among the three different experimental groups

Knee measurements		**Source of variation**	**SS**	**df**	**MS**	**F**
Movement range	**Extension**	Between groups	94.33	2.00	47.17	5.46
		Within groups	181.50	21.00	8.64	
		Total	275.83	23.00		
	Flexion	Between groups	163.00	2.00	81.50	9.06
		Within groups	189.00	21.00	9.00	
		Total	352.00	23.00		
[illegible]	**Mid patella**	Between groups	16.58	2.00	8.29	1.31

		Within groups	133.38	21.00	6.35	
		Total	149.96	23.00		
	Above 7 cm.	Between groups	20.33	2.00	10.17	1.79
		Within group s	119.00	21.00	5.67	
		Total	139.33	23.00		
	Below 7 cm.	Between groups	39.08	2.00	19.54	2.92
		Within groups	140.75	21.00	6.70	
		Total	179.83	23.00		
Thigh muscles	**Anterior**	Between groups	14.25	2.00	7.13	0.68
		Within groups	220.38	21.00	10.49	
		Total	234.63	23.00		
	Posterior	Between groups	60.08	2.00	30.04	7.91
		Within groups	79.75	21.00	3.80	
		Total	139.83	23.00		
Koss	**Pain**	Between groups	2123.96	2.00	1061.98	92.28
		Within groups	241.67	21.00	11.51	
		Total	2365.63	23.00		
	Symptom	Between groups	3500.71	2.00	1750.36	193.66
		Within groups	189.81	21.00	9.04	
		Total	3690.52	23.00		
	ADL	Between groups	2658.61	2.00	1329.30	130.49
		Within groups	213.93	21.00	10.19	
		Total	2872.54	23.00		
	Sport/Rec	Between groups	3459.15	2.00	1729.58	136.39
		Within groups	266.30	21.00	12.68	
		Total	3725.45	23.00		
	QOL	Between groups	3900.00	2.00	1950.00	267.84
		Within groups	152.89	21.00	7.28	
		Total	4052.89	23.00		

F critical at alpha 0.05=
Sum of squares (SS), degree of freedom (df), mean sum of squares (MS) and F stat (F).

Table 3.8: Difference meaning level among mean of knee measurements for the three different experimental groups using L.S.D test

Knee measurements		**Experimental groups**	**Mean**	**Mean differences**			**L.S.D**
				Group 1	**Group 2**	**Group 3**	
Movement range	**Extension**	**Group** 1	174.75	-	3.25*	4.75*	3.06
		Group 2	178.00		-	1.50	
		Group 3	179.50			-	
	Flexion	**Group** 1	32.50	-	-4.25*	-6.25*	3.12
		Group 2	28.25		-	-2.00	
		Group 3	26.25			-	

circumference	Mid patella	**Group** 1	45.25	-	-0.25	-1.88	2.62
		Group 2	45.00		-	-1.63	
		Group 3	43.38			-	
	Above 7 cm.	**Group** 1	49.25	-	-1.00	-2.25	2.48
		Group 2	48.25		-	-1.25	
		Group 3	47.00			-	
	Below 7 cm.	**Group** 1	45.25	-	-0.25	-1.88	2.69
		Group 2	45.00		-	-1.63	
		Group 3	43.38			-	
Thigh muscles	Anterior	**Group** 1	22.25	-	0.75	1.88	3.73
		Group 2	23.00		-	1.13	
		Group 3	24.13			-	
	Posterior	**Group** 1	13.50	-	0.63	3.63*	2.03
		Group 2	14.13		-	3.00*	
		Group 3	17.13			-	
Koss	Pain	**Group** 1	38.53	-	15.29*	22.58*	3.53
		Group 2	53.82		-	7.29*	
		Group 3	61.10			-	
	Symptom	**Group** 1	38.43	-	17.41*	29.42*	3.13
		Group 2	55.84		-	12.01*	
		Group 3	67.85			-	
	ADL	**Group** 1	35.74	-	14.98*	25.66*	3.32
		Group 2	50.72		-	10.68*	
		Group 3	61.40			-	
	Sport/Rec	**Group** 1	29.37	-	15.63*	29.39*	3.70
		Group 2	45.00		-	13.76*	
		Group 3	58.76			-	
	QOL	**Group** 1	33.61	-	15.62*	31.23*	2.81
		Group 2	49.23		-	15.61*	
		Group 3	64.84			-	

* Level of significance at 0.05

Conclusion

Maximum improvement in knee measurements was detected with the third experimental groups, compared with the second and the first groups, after six weeks of treating using different treating programs. The combined effect of using static traction in some therapeutic methods to reduce knee arthritis symptoms was the most effective method for reducing the pain and improving the quality of patients' life.

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