Original Article

Osteopathic manipulative treatment improves function and relieves pain in knee osteoarthritis: A single-blind, randomized-controlled trial

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ABSTRACT

Objectives: In this study, we aimed to compare the efficacy of osteopathic manipulative treatment (OMT) to exercise treatment in the knee osteoarthritis (OA).

Patients and methods: A total of 100 patients (9 males, 76 females; mean age 54.8±8.5 years; range, 40 to 70 years) with Stage II-III bilateral knee OA enrolled to the study and randomized into two groups between January 2015 and June 2015. Group 1 performed exercise and received OMT and Group 2 performed exercise alone. We assessed the clinical parameters with Western Ontario MacMaster Questionnaire (WOMAC) pain score, WOMAC joint stiffness score, WOMAC physical function score, Visual Analog Scale (VAS) and 50-m walking time. All patients were assessed at the beginning of the study, just after the treatment, and four weeks after the treatment.

Results: There was no significant difference between groups in terms of physical examination and clinical assessment parameters before treatment. Functional improvement (p<0.05) and pain relief (p<0.05) were significantly higher in the exercise + OMT group.

Conclusion: Based on our study results, OMT is a particular treatment used by osteopathic physicians to complement conventional treatment of OA of the knee. In addition to the conservative treatment, OMT can be used.

Keywords: Exercise; function; gonarthrosis; manipulation; osteoarthritis; pain.

Osteoarthritis (OA) of the knee is a chronic, progressive and debilitating disease with noticeable pain and stiffness and causes physical disability. This condition also affects the patient's functionality.[1] The management of the OA aims reducing pain, increasing physical function, preventing disability, and increasing quality of life.[2] Depending on the stage of the disease, there are different treatment options. For patients who have signs and symptoms of early knee OA with generalized knee pain, conservative treatment methods should be chosen as first-line treatment.[3]

Osteopathic manipulative treatment (OMT) is a component of conservative care. Pathophysiology of the knee OA is partly related to changes in the autonomic nervous system, blood and lymph flow, fascial tension, range of motion limitations, and relationships of the length and tension of the muscles around the knee.[4,5] Understanding of the somatic, sympathetic, and lymphatic systems and their integrated parts is necessary for understanding the etiology and management of knee pain. Therefore, evaluation of the surrounding muscle strength, flexibility, tone, skin topography, range of motion, and soft tissues is essential to effectively manage knee OA. Although lack of evidence, OMT has been advised as a complementary alternative therapy for patients with early stages of knee OA.[6,7] Due to the insufficiency of larger clinical studies and strong evidence for the effectiveness of OMT for OA of the knee, we decided to design a study. In the present study, we aimed to assess the efficacy of OMT with exercise treatment in relieving the pain caused by OA of the knee.

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PATIENTS AND METHODS

A total of 100 patients (9 males, 76 females; mean age 54.8±8.5 years; range, 40 to 70 years) who presented to the Physical Medicine and Rehabilitation outpatient clinics of İstanbul Medeniyet University, Göztepe Training and Research Hospital with knee pain lasting for more than six months were included in the study between January 2015 and June 2015. Six patients in the exercise + OMT group and nine patients in the exercise group were left the study by their own will. The study was completed with 85 patients. Patients diagnosed as bilateral primary knee OA according to the American College of Rheumatology (ACR) criteria. The anteroposterior (AP) and lateral knee radiographs taken to stage OA according to the Kellgren and Lawrence radiological staging scale and Stages II-III were included in the study. A written informed consent was obtained from each participant. The study protocol was approved by İstanbul Medeniyet University, Göztepe Training and Research Hospital Ethics Committee (Date: 30/12/2014; No: 0179). The study was conducted in accordance with the principles of the Declaration of Helsinki. Exclusion criteria were follows: inflammatory arthritis, soft tissue rheumatism an inflammation in the knee joint, higher erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), history of knee surgery, trauma (meniscopathy or instability), intraarticular intervention or physical therapy within the last six months. Also, patients using anti-inflammatory drugs other than simple analgesics, those using knee braces, patients with vascular and cardiovascular disease, paresis or neuropathy, intraarticular neoplasm, osteonecrosis and mental mood disorder and those with knee contracture were excluded from the study.

We evaluated the patients with a detailed medical history, and systemic and locomotor system examinations. All patients were questioned for age, sex, educational level, employment status, Body Mass Index, habits, complaint duration, use of analgesics, previous treatments, accompanying chronic disease, drugs used and previous surgical interventions.

Complete blood count, full urinalysis, ESR, CRP, fasting blood sugar, uric acid, kidney and liver function tests were analyzed in all patients. Radiological evaluation was performed with the AP and lateral radiographs according to the Kellgren and Lawrence radiological staging.[8] On physical examination, the patients were evaluated in terms of pain, heat increase, effusion, crepitation, patellar grind test, valgus stress, varus stress, McMurray, anterior and posterior drawer test and Apley compression and distraction tests. Knee circumference and range of motion of all patients were actively measured using a standard goniometer. Clinical parameters were evaluated with the Western Ontario MacMaster Questionnaire (WOMAC),[9] pain score (0-25), WOMAC stiffness of the joints score (0-10), WOMAC physical functioning of the joints score (0-85), Visual Analog Scale (VAS) and 50-m walking time.

The patients were prevented from taking nonsteroidal anti-inflammatory drugs one week before beginning of the study and during the study period. They were allowed to take paracetamol up to 3 g daily for pain control. The drugs they used due to systemic diseases were continued. The patients who met the criteria specified in the study protocol were randomized on www.randomizer.org[10] website and divided into two groups. Each group consisted of 50 patients. Exercise + OMT were administered to the Group 1, while exercises alone were given to the Group 2.

An exercise program including quadriceps isometric strengthening straight leg lifting, iliotibial band, hamstring stretching, strengthening abductor and adductor muscle of the hip and stretching exercises was applied as 10-repetitive 3 set, two days a week, totally four sessions, in the clinic, and the program was taught to the patients for applying two times a day at home.

Adherence of the patients to the house exercise program was followed-up by weekly phone visits. Patients in the Group 1 were administered OMT as 3 min mobilization and 3 min compression for bilateral patellofemoral and tibiofemoral joint respectively with one minute intervals in addition to the exercise program. Following these applications, two min bilateral lower extremity pumping technique was performed. All these applications were taught to the patient for applying twice a day at home. Adherence of the patients to the more program was followed by weekly phone visits.

To provide standardization, all evaluations were made before treatment, after treatment and four weeks after treatment by a physiatrist who was blind to the treatment method. The exercises were applied and taught to the patients by another physiatrist. The OMT was performed by a third physiatrist who has been completed osteopathy training.

Statistical analysis

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for

Table 1. Demographic characteristics of the osteopathic manipulative treatment and exercise groups and baseline measurements

Characteristic	Osteopathic manipulative treatment group					Exercise group					p
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	
Number of patients	44					41					
Age (year)			53.9±8.2					55.6±8.8			0.364*
Sex											0.999†
Female	39	88.6				37	90.2				
Male	5	11.4				4	9.8				
Marital status											0.423†
Single	2	4.5				4	9.8				
Married	42	95.5				37	90.2				
Education											0.059†
Illiterate	7	15.9				12	29.3				
Elementary school	21	47.7				24	58.5				
Middle school	13	29.5				4	9.8				
University	3	6.8				1	2.4				
Occupation											0.456†
House wife	31	70.5				34	82.9				
Retired	7	15.9				5	12.2				
Worker	1	2.3				0	0				
Other	5	11.4				2	4.9				
Body Mass Index (kg/m^2)			32.3±5.2					30.9±5.9			0.243*
Smoking											0.740†
Yes	6	13.6				4	9.8				
No	38	86.4				37	90.2				
Analgesic use											0.185‡
None	6	13.6				10	24.4				
Sometimes	33	75.0				23	56.1				
Always	5	11.4				8	19.5				
Complaint duration (year)				2	0.25-15				2	0.25-15	0.465§
Any treatment before											0.787†
None	29	65.9				26	63.4				
Medical	6	13.6				7	17.1				
Physical therapy	6	13.6				4	9.8				
Medical + physical therapy	2	4.5				4	9.8				
Medical + physical therapy + other	1	2.3				0	0				
Kellgren 2	33	75				33	80.5				0.544‡
Kellgren 3	11	25				8	19.5				0.544‡
Surgical history (other than musculoskeletal system)											0.097‡
Yes	20	45.5				26	63.4				
No	24	54.5				15	36.6				
Chronic disease											0.183‡
Yes	25	56.8				29	70.7				
No	19	43.2				12	29.3				
Medication due to chronic disease											0.152‡
Yes	20	45.5				25	61				
No	24	54.5				16	39				

SD: Standard deviation; Min: Minimum; Max: Maximum; * Independent samples t-test; † Fisher's exact test; ‡ Pearson's chi-square test; § Mann-Whitney U test.

Table 2. Examination findings of the groups before (baseline), after (posttreatment) and four weeks after the treatment (follow-up)

Measure / Group	Baseline Right n	%	n	%	Baseline Left n	%	n	%	Posttreatment Right n	%	n	%	Posttreatment Left n	%	n	%	Follow-up Right n	%	n	%	Follow-up Left n	%	n	%	Right Baseline to posttreatment p§	Right Posttreatment to follow-up p§	Left Baseline to posttreatment p§	Left Posttreatment to follow-up p§
Warmth																												
Exercise + OMT	1	2.3	43	97.7	3	6.8	41	93.2	0	0	44	100	0	0	44	100	1	2.3	43	97.7	0	0	44	100	0.999	0.999	0.500	0.999
Exercise	5	12.2	36	87.8	1	2.4	40	97.6	2	4.9	39	95.1	0	0	41	100	2	4.9	39	95.1	2	4.9	39	95.1	0.999	0.999	0.999	0.062
p	0.102†				0.617†				0.230†				-				0.607†				0.230†							
Effusion																												
Exercise + OMT	1	2.3	43	97.7	3	6.8	41	93.2	0	0	44	100	0	0	44	100	1	2.3	43	97.7	0	0	44	100	0.250	0.062	0.125	0.004**
Exercise	4	9.8	37	90.2	1	2.4	40	97.6	2	4.9	39	95.1	2	4.9	39	95.1	1	2.4	40	97.6	3	7.3	38	92.7	0.062	0.999	0.250	0.006**
p	0.192†				0.617†				0.230†				0.230†				0.999†				0.108†							
Crepitation																												
Exercise + OMT	36	81.8	8	18.2	40	90.9	4	9.1	34	77.3	10	22.7	36	81.8	8	18.2	29	65.9	15	34.1	30	68.2	14	31.8	0.001**	0.140	0.006*	-
Exercise	38	92.7	3	7.3	37	90.2	4	9.8	32	78	9	22	31	75.6	10	24.4	28	68.3	13	31.7	31	75.6	10	24.4	0.360	0.032*	0.042*	0.999
p	0.136				0.999†				0.932‡				0.484‡				0.815‡				0.447‡							
Patellar grind																												
Exercise + OMT	32	72.7	12	27.3	37	84.1	7	15.9	20	45.5	24	54.5	26	59.1	18	40.9	12	27.3	32	72.7	20	45.5	24	54.5	0.004**	0.016*	0.001**	0.140
Exercise	38	92.7	3	7.3	32	78	9	22	27	65.9	14	34.1	27	65.9	14	34.1	19	46.3	22	53.7	20	48.8	21	51.2	0.006**	0.042*	0.360	0.032*
p	0.016*‡				0.476†				0.059‡				0.520‡				0.068‡				0.759‡							
Valgus stress																												
Exercise + OMT	8	18.2	36	81.8	8	18.2	36	81.8	2	4.5	42	95.5	1	2.3	43	97.7	2	4.5	42	95.5	2	4.5	42	95.5	0.062	0.999	0.032*	0.999
Exercise	14	34.1	27	65.9	5	12.2	36	87.8	9	22	32	78	3	7.3	38	92.7	5	12.2	36	87.8	3	7.3	38	92.7	0.125	0.250	0.999	0.999
p	0.093‡				0.444‡				0.017*‡				0.349†				0.255†				0.669†							
Varus stress																												
Exercise + OMT	7	15.9	37	84.1	7	15.9	37	84.1	1	2.3	43	97.7	2	4.5	42	95.5	1	2.3	43	97.7	1	2.3	43	97.7	0.062	0.999	0.125	0.999
Exercise	13	31.7	28	68.3	2	4.9	39	95.1	5	12.2	36	87.8	2	4.9	39	95.1	2	4.9	39	95.1	2	4.9	39	95.1	0.016*	0.500	0.999	0.999
p	0.086‡				0.158†				0.102‡				0.999†				0.607†				0.607†							
McMurrey																												
Exercise + OMT	2	4.5	42	95.5	5	11.4	39	88.6	0	0	44	100	0	0	44	100	1	2.3	43	97.7	1	2.3	43	97.7	0.999	0.999	0.125	0.999
Exercise	4	9.8	37	90.2	1	2.4	40	97.6	1	2.4	40	97.6	1	2.4	40	97.6	1	2.4	40	97.6	1	2.4	40	97.6	0.500	0.999	0.999	0.999
p	0.423†				0.204†				0.482†				0.482†				0.999†				0.999†							
Anterior drawer																												
Exercise + OMT	1	2.3	43	97.7	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0.999	0.999	-	-
Exercise	0	0	41	100	0	0	41	100	0	0	41	100	0	0	41	100	0	0	41	100	1	2.4	40	97.6	-	-	-	0.999
p	0.999†				-				-				-				-				0.482†							
Posterior drawer																												
Exercise + OMT	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	-	-	-	-
Exercise	0	0	41	100	0	0	41	100	0	0	41	100	0	0	41	100	0	0	41	100	1	2.4	40	97.6	-	-	-	0.999
p	-				-				-				-				-				0.482†							
Apley compression																												
Exercise + OMT	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	-	0.999	-	-
Exercise	2	4.9	39	95.1	0	0	41	100	1	2.4	40	97.6	0	0	41	100	1	2.4	40	97.6	1	2.4	40	97.6	0.999	-	-	0.999
p	0.230†				-				0.482†				-				0.482†				0.482†							
Apley distraction																												
Exercise + OMT	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	0	0	44	100	-	-	-	-
Exercise	2	4.9	39	95.1	0	0	41	100	0	0	41	100	0	0	41	100	0	0	41	100	0	0	41	100	0.999	-	-	-
p	0.230†				-				-				-				-				-							

OMT: Osteopathic manipulative treatment; † Fisher's exact test; ‡ Pearson chi-square test; § McNemar test (Bonferroni corrected p values were reported); * p<0.05; ** p<0.01; - No relevant assessment was able to be performed due to small sample size.

Table 3. Clinical parameters before and after the treatment

	Baseline			Posttreatment			Follow-up			Baseline to Posttreatment				Posttreatment to follow-up			
	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	p	Mean±SD	Median	Min-Max	p
VAS active																	
OMT	6.8±1.8			3.8±1.9			2.6±2.2			-3.0±1.6			<0.001**§	-1.3±1.7			<0.001**§
Exercise	6.5±1.8			4.5±2.7			4.3±2.8			-2.0±2.0			<0.001**§	-0.2±2.3			0.999§
p†		0.434			0.192			0.003**			0.016*				0.023*		
VAS passive,																	
OMT		3	0-8		0	0-5		0	0-5		-2	-8-3	<0.001**¶		0	-2 - 3	0.066¶
Exercise		3	0-7		0	0-7		0	0-10		-1	-6-2	<0.001**¶		0	-2 - 10	0.649¶
p‡		0.482			0.630			0.223			0.082				0.190		
50 m walking time																	
OMT	58.1±8.6			53.1±6.0			48.8±5.5			-5.0±5.5			<0.001**§	-4.3±3.2			<0.001**§
Exercise	60.3±9.6			56.8±7.1			54.8±8.1			-3.5±5.4			<0.001**§	-2.0±6.8			0.131§
p‡		0.266			0.011*			<0.001**			0.212				0.044*		
Knee circumference right																	
OMT	39.5±3.2			39.3±3.2			39.0±3.1			-0.2±0.8			0.123§	-0.3±0.8			0.014*§
Exercise	40.2±4.1			40.0±4.0			39.8±3.8			-0.2±0.9			0.163§	-0.2±0.8			0.283§
p‡		0.394			0.395			0.282			0.977				0.386		
Knee circumference left																	
OMT	39.4±3.1			39.2±3.1			38.9±3.1			-0.2±0.8			0.125§	-0.2±0.9			0.149§
Exercise	40.0±3.9			39.8±3.8			39.8±4.0			-0.2±0.9			0.333§	0.1±0.8			0.999§
p‡		0.464			0.443			0.269			0.916				0.124		
Knee flexion right																	
OMT	123.9±6.0			126.3±5.4			127.5±5.2			2.4±4.2			0.001**§	1.3±3.6			0.052§
Exercise	121.2±10.2			124.4±7.5			126.0±5.0			3.2±6.2			0.004*§	1.6±5.1			0.103§
p‡		0.153			0.192			0.175			0.495				0.724		
Knee flexion left																	
OMT	123.9±6.9			126.0±5.8			127.5±5.3			2.2±4.0			0.002*§	1.5±3.7			0.021*§
Exercise	122.6±9.0			125.1±6.9			125.7±7.3			2.6±5.5			0.010*§	0.6±5.5			0.964§
p‡		0.453			0.516			0.204			0.698				0.392		
Knee extension right																	
OMT		0	0-10		0	0-10		0	0-10		0	-10 - 0	0.063¶		0	-10 - 0	0.317¶
Exercise		0	0-15		0	0-10		0	0-10		0	-15 - 0	0.006**¶		0	-10 - 10	0.340¶
p‡		0.049*			0.460			0.839			0.089				0.361		
Knee extension left																	
OMT		0	0-10		0	0-10		0	0-10		0	-10 - 0	0.102¶		0	-5 - 0	0.317¶
Exercise		0	0-15		0	0-10		0	0-10		0	-15 - 0	0.016*¶		0	-10 - 10	0.453¶
p‡		0.112			0.574			0.839			0.144				0.493		
Womac pain																	
OMT	13.7±3.4			9.7±3.2			7.8±2.8			-4.0±2.8			<0.001**§	-1.9±3.1			<0.001**§
Exercise	14.3±4.2			11.7±4.5			12.3±4.5			-2.7±4.0			<0.001**§	0.6±4.9			0.826§
p‡		0.459			0.027*			<0.001**			0.078				0.005**		
Womac stiffness																	
OMT	4.4±1.7			3.5±1.7			2.8±1.4			-0.9±1.4			<0.001**§	-0.7±1.4			0.004**§
Exercise	4.6±1.8			3.8±1.8			3.7±1.8			-0.8±1.5			0.001**§	-0.1±1.8			0.999§
p‡		0.557			0.457			0.012*			0.856				0.076		
Womac physical																	
OMT	46.9±10.3			36.5±10.8			29.3±10.3			-10.4±8.7			<0.001**§	-7.2±5.8			<0.001**§
Exercise	47.6±12.9			42.0±12.9			43.2±15.2			-5.6±11.1			0.005**§	1.2±14.0			0.999§
p‡		0.768			0.035*			<0.001**			0.030*				0.001**		

VAS: Visual Analog Scale; SD: Standard deviation; Min: Minimum; Max: Maximum; OMT: Osteopathic manipulative treatment; † Independent samples t-test; ‡ Mann-Whitney U test; § Paired t test (Bonferroni corrected p values were reported); ¶ Wilcoxon signed-ranks test (Bonferroni corrected p values were reported); * p<0.05; ** p<0.01.

statistical analysis. Definitive were expressed in mean and standard deviation (SD), median (min-max), frequency, and ratio were used for defining the data. The convenience of quantitative variables to normal distribution was evaluated by Shapiro-Wilk test and graphical evaluations. Independent samples t-test was used for intergroup comparison of the normally distributed variables, and Mann-Whitney U test was used for intergroup comparison of the non-normally distributed qualitative variables. We used paired t-test for evaluation of intra-group normally distributed variables, and Wilcoxon signed-ranks test for evaluation of intra-group non-normally distributed qualitative variables. Comparison of qualitative data was evaluated by Pearson chi-square test, Fisher's exact test, and McNemar test. An alpha level of =0.05 and a *p* value of <0.05 were considered statistically significant.

RESULTS

Demographics of the patients included in the study are shown in Table 1. No statistically significant difference was found between the groups in terms of demographic characteristics (p>0.05).

In inter-group distribution, patients were homogeneous in laboratory tests and knee radiographs according to the radiological staging scale by Kellgren and Lawrence, and no statistically significant difference was observed between the groups (p>0.05).

Physical examination findings (warmth, effusion, crepitation, patellar grind test, valgus stress, varus stress, McMurrey, anterior drawer, posterior drawer, Apley compression, Apley distraction, knee circumference measurement and range of motion) of the groups before, after and four weeks after the treatment are presented in Table 2. While there were no significant differences between the groups before the treatment (p>0.05), findings after the treatment showed statistically significant differences (p<0.05).

Clinical evaluation parameters (VAS, WOMAC, and 50-m walking time) of the groups before, after and four weeks after the treatment are given in Table 3. While there were no significant differences between the groups before the treatment (p>0.05), clinical parameters at the follow-up after the treatment showed statistically significant differences (p<0.05).

DISCUSSION

Osteoarthritis of the knee causes pain and functional limitation and, as it progresses, patients often enter a cycle of pain, inactivity, and weakness. Osteopathic manipulative treatment aims to stretch the soft tissues, detach tissue adhesions, increase blood flow and lymphatic drainage, decrease edema, improve range of motion, and lower the pain. Our findings revealed that OMT and exercise treatment together improves function and reliefs pain more than exercise treatment alone.

Muscle strengthening and aerobic exercises are found to be effective in reducing pain and improving physical function in patients with mild to moderate knee OA.[11,12] As we review the literature, we found that the combination of OMT and exercise was shown to reduce the need for total knee replacement and steroid injections.[13,14] Moss et al.[15] reported greater improvements in pain or stiffness in the OMT group, compared to the control group. Deyle et al.[13] suggested that a combination of manual physical therapy and supervised exercise provided functional benefits in knee OA patients and it might delay or prevent the need for surgical intervention. Abbott et al.[16] demonstrated that in OA patients with knee pain, manual physiotherapy prevailed standard care. The benefits were kept up to one year. Similarly, we demonstrated the functional benefits as well as pain relief and improvements in physical findings with exercise + OMT in this study.

On the other hand, Wang et al.[17] reported equal results between manipulation and exercise versus manipulation alone in their clinical study. This study supports our results in a way, as they showed the clinical effect of manipulation on knee OA. We compared exercise and manipulation with exercise alone in our study. We also found a study[18] in the literature review, which investigated the use of OMT in post-arthroplasty patients that reported OMT was not effective than a sham therapy in the post-surgical cases. However, the authors reported that the therapists in this study were studying osteopathy and they did not complete their education yet. Postoperative effects of OMT can be studied in the future, although currently we do not have sufficient reports and knowledge. Furthermore, Ebert et al.[19] showed that manual lymphatic drainage techniques aid in the early postoperative stages after total knee arthroplasty and improve active knee flexion for up to six weeks postoperatively.

Manipulation is known with the high velocity, low amplitude manual thrusting procedures aiming to increase the motion of the joints. The results of manipulation-induced joint mobility consists decreased pain, decreased muscle hyperactivity, increased

reflexes in the autonomic system, improvement in joint proprioception and, collectively, an increase in joint mobility.[20-22] These effects compose the purpose of manipulation/manual therapy to the peripheral joints in clinical circumstances of acute or chronic (i.e., repetitive) strain and sprain of these joints as well as of chronic arthritic degeneration.[23]

In conclusion, OMT is a particular treatment used by osteopathic physicians to complement conventional treatment of musculoskeletal disorders. There are many studies showing the value of manual therapy in treating knee pain and osteoarthritis. Besides, expert opinions support that osteopathic manipulative treatment of the knee is useful in relieving knee pain. Therefore, it is assumed that OMT would provide similar benefits to those derived from studies reviewing other manual therapies.

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