Evaluation of Short-Wave Diathermy and Ultrasound Treatments as Combined Physical Treatments for Knee Osteoarthritis

Diz Osteoartritinde Kombine Fizik Tedavi Uygulamalarında Kısa Dalga ve Ultrason Tedavilerinin Etkinliğinin Değerlendirilmesi

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ABSTRACT Objective: Ultrasound and short-wave diathermy treatments for pain and functional state evaluations of physical treatment combinations are studied for patients who have primary knee osteoarthritis. **Material and Methods:** We studied 110 patients who have bilateral primary knee osteoartritis. All patient socio-demographic data, joint range of motion, radiologic grades, visual analog scale (VAS) values, and paracetamol needs were recorded. Patients were randomly divided into three groups. For Group 1, hot packs transcutaneous electrical nerve stimulation (TENS), ultrasound, and quadriceps strengthening exercises were given. For Group 2, hot packs, TENS, short-wave diathermy, and quadriceps strengthening exercises were given. For Group 3, only quadriceps strengthening exercises were given. Evaluations were taken at the beginning, immediately after, and four weeks after treatment. **Results:** In all treatment groups, statistical progress in range of motion, Lequesne index, time up and go tests, repetitive sit and stand up test times and VAS values were observed after treatment. In Groups 1 and 2, changes in VAS values and reductions in paracetamol requirements compared to the control group were statistically low ($p<0.05$). In Group 1 and Group 2, patient satisfaction scores for treatment, compared to Group 3, were statistically high. There was no difference between Group 1 and 2 in the means for pain and functional parameters. **Conclusion:** Our study found that combined physical treatment and exercises for mid-grade primary bilateral knee osteoartritis treatment yields better improvement than treatment with only exercises. Ultrasound and short-wave diathermy combined physical treatments showed no differences in pain and other functional evaluation parameters.

Keywords: Osteoarthritis; knee; ultrasonic therapy; short-wave therapy; exercise; rehabilitation

ÖZET Amaç: Primer diz osteoartrit tanılı hastalarda, fizik tedavi kombinasyonları içerisinde uygulanan ultrason ve kısa dalga diatermi tedavilerinin ağrı ve fonksiyonel durum üzerine olan etkilerini araştırmaktır. **Gereç ve Yöntemler:** Çalışmaya 110 bilateral primer diz osteoartriti olan hasta alındı. Tüm hastaların sosyodemografik verileri, eklem hareket açıklıkları, radyolojik evreleri, vizüel analog skala (VAS) değerleri, parasetamol alım ihtiyaçları kaydedildi. Hastalar üç gruba randomize edilerek, üç ayrı tedavi grubu oluşturuldu. Grup I'e sıcak paket, transkutanöz elektriksel sinir stimülasyonu (TENS), ultrason ve kuadriseps güçlendirme egzersizleri, Grup II'ye sıcak paket, TENS, kısa dalga diatermi (KDD) ve quadriseps güçlendirme egzersizleri Grup III'e kuadriseps güçlendirme egzersizlerinden oluşan tedavi programı verildi. Fonksiyonel değerlendirmede Lequesne skalası kullanıldı. Time up go testi ve tekrarlı oturup kalkma test süreleri kaydedildi. Ağrı, VAS ile hastanın tedaviden memnuniyeti 4 puanlık likert skala ile değerlendirildi. Değerlendirmeler başlangıç, tedavi sonrası ve tedaviden dört hafta sonrasında yapıldı. **Bulgular:** Her üç tedavi grubunda; tedavi öncesi ve sonrasına göre eklem hareket açıklıkları, Lequesne indeksi, time up go testi, tekrarlı oturup kalkma test süreleri ile VAS değerleri arasında istatsitiksel anlamlı iyileşme gözlenmiştir. Grup I ve Grup II'de, VAS skorlarındaki değişim ve paresetamol alım ihtiyacındaki azalma kontrol grubuna göre istatistiksel olarak anlamlı oranda düşük bulunmuştur ($p<0,05$). Grup I ve Grup II'de hastanın tedavi memnuniyet skoru Grup III'e göre istatistiksel olarak anlamlı yüksek bulundu. Grup I ve II arasında ağrı ve fonksiyonel parametreler arasında istatistiksel anlamlı fark bulunmamıştır. **Sonuç:** Çalışmamız orta derecede primer bilateral diz osteoartritinde kombine fizik tedavi ve egzersiz uygulamalarının, sadece egzersiz tedavisine göre ağrı üzerine bir miktar daha olumlu etkilerinin olabileceğini düşündürmüştür. Kombine fizik tedavi uygulamalarında kullanılan derin ısıtıcının, ultrason ya da kısa dalga diyatermi olması ağrı ve diğer fonksiyonel değerlendirme parametreleri üzerine bir fark yaratmamaktadır.

Anahtar Kelimeler: Osteoartrit; diz; ultrason tedavisi; kısa dalga tedavisi; egzersiz; rehabilitasyon

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Osteoarthritis is a chronic progressive rheumotologic disease characterized by degeneration in articular cartilage. Knee osteoarthritis is the most common type of osteoarthritis and its prevalence in patients who over 60 years old is about 10-15%.[1,2] Clinically, joint pain, swelling, muscle weakness, disability in daily living activities, and degradation in life quality occurs. The WHO says knee osteoarthritis in men is in 8th place and in women is in 4th place in global disability lists.[4]

In osteoarthritis treatment, there is no cure taken into account. The main purpose of treatment is to reduce pain, reduce cartilage deformation, enhance functionality, and reduce disability. Many pharmacologic and non-pharmacologic treatment options are recommended in osteoarthritis treatment.[5-9] As patients age, there are serious co-morbid situations and multiple pill taking is common; because of that, non-pharmacologic approaches and treatments other than surgery are generally attractive for patients with osteoarthritis. Non-pharmacologic treatments of knee osteoarthritis include patient education, lifestyle changes, and physical treatment.[8,10] Physical treatments for knee osteoarthritis include shallow hot applications, therapeutic ultrasound, TENS, short-wave diathermy, and exercise.[11-15] Therapeutic ultrasound and short-wave diathermy are kinds of physical treatments that introduce heat to deep tissues. Therapeutic ultrasound converts electrical energy to sound waves; the sound waves become heat energy as they pass through the tissues.[16] Short-wave is an electromagnetic treatment that occurs through ionic movement that increases heat in deep tissues.[17] Deep heaters are using for enhancing ROM and tissue healing, and for reducing pain and edema.[16] In the literature, these treatments are used separately or in combination.[11-14,18]

In knee OA, discussions still exist about the effectiveness of physical treatment agents.[19,20] Our aim in knee OA is to compare the effectiveness of combined physical treatment agents and exercise treatment on pain and physical function, and to compare the effectiveness of ultrasound and short-wave diathermy as deep heaters for pain and physical function.

MATERIAL AND METHODS

Our study included 110 patients chosen randomly from our clinic. All of the selected patients have primary bilateral knee OA. Patients were between the ages of 40 and 60, had been experiencing knee pain for at least one year and according to radiological evaluation, patients with grade 2 knee OA based on the Kellgren-Lawrence (KL) classification. Patients were informed about the study and all permissions were received from the ethical commitee. Socio-demographic data, body mass index (BMI), duration of knee pain, and duration of morning stiffness were recorded for all patients, and physical treatment was provided. Knee ROM was evaluated using goniometric measurement. For radiologic grade, all front and back knee graphs were evaluated and classified according to KL radiologic classification.

EXCLUSION CRITERIA

The exclusion criteria for the study included knee pathology other than knee OA, hip and waist pathology resulting in knee pain, wounds to the joint and inflammation and scarring, previous knee surgery, systemic illness intercepts requiring physical treatment, non-steroidal anti-inflammatory (NSAIDs) drug use one week before the study start, intra-articular hyaluronic acid injections within six months of the study, intra-articular steroid injection one month prior to the study, and physical treatment for the knee in the previous six months.

TREATMENT GROUPS

Before treatment, all patients were taught about knee OA and knee anatomy via visual materials. All patients took courses about daily living activities to be careful of, ergonomic protection, and the importance of the exercises. Patients were divided randomly into three groups. Group 1 was given quadriceps strengtening exercises, ultrasound, TENS, and hot packs as physical treatment. Group 2 received quadriceps strenghtening exercises, short-

wave diathermy, TENS, and hot pack applications. Group 3 was given only quadriceps strengthening exercises given. All physical treatments were given 5 days a week for a total of 2 weeks. Short-wave diathermy treatment was applied while the patient was in a seated position in a wooden chair. Treatment was given via 12 cm diameter electrodes parallel to the knees in a continuous mode and thermic dose for 15 minutes. Ultrasound treatment was applied to patients sitting in bed with their legs extended. The treatment was applied to both knees via 3 MHz bonnets at a rate of 1.5 w/cm^2 every 5 minutes. Transcutaneous electrical nerve stimulation was applied via two 5 x 7 cm electrodes at a 100 MHz frequency and 100 micsc. current time for 20 minutes. Hot packs were applied to knees for 20 minutes. Quadriceps strengthening exercises were given like home exercises. All exercises were shown and carefully explained. Visual exercise diagrams were also given to patients. All exercises were for 10 repetitions twice a day for a 6-week period.

Only paracetamol was given to patients as medical treatment. If they had pain, they were allowed to take 500 mg up to 6 times a day (3000 mg/day), and the number of pills they took was recorded daily. These numbers were evaluated at the beginning and the 4th week of treatment.

EVALUATION CRITERIA

All patients were evaluated before and after treatment and 4 weeks after treatment for pain, physical function, and treatment strength.

Pain Evaluation

The visual analog scale (VAS) was used and patients were requested to mark their pain intensity on a scale of 0 to 10.

Physical Function Evaluation

For functional evaluation, the Lequesne index was used. This index gives specific evaluation values for pain, maximum walking distance, and daily life activities of patients. The maximum evaluation grade is 24 points. Light to medium pain is graded from 0 to 7, serious pain is graded from 8 to 13, and a grade of 14 or more indicates extreme pain and functional disorder.[22]

Timed Up and Go Test

Patients are requested to stand up from their chair, walk 3 meters, and come back and sit in their chair again. The time it takes is recorded. For the test results, 3 evaluations were taken into account and the average was calculated.

Repetitive Sit and Stand up Tests

Patients are asked to fold their hands over their chest and sit and stand up from their chair 5 times. The time it takes is recorded. An average times of 3 scores was taken.

Patients' Satisfaction Scores for Treatment

Evaluation of treatment satisfaction was requested from the patients at the end of treatment and 4 weeks after treatment. This evaluation was done via a Likert scale (0 ineffective, 1 minimal effect, 2 moderate effect, 3 good effect, 4 very good effect).

STATISTICAL ANALYSIS

Statistical analysis was performed using the NCSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 statistical software (Utah, USA).Kruskal Wallis test Mann Whitney U test and Wilcoxon Signed Ranks was used for evaluate the variables with non-normal distribution. Values of $p<0.01$ and $p<0.05$ were deemed statistically significant.

RESULTS

There were 110 patients in the study. No complications occurred in any group during treatment. One patient with an upper respiratory tract infection could not complete the treatment and another patient withdrew from the study for personal reasons. All treatments were consistent and there was no variation in the treatments. One patient couldn't be reached for the follow up 4 weeks after the treatment.

In the combined treatment, the Group 1 mean age was 59.45±8.64 years. The Group 2 mean age was 58.61±7±6.82 The Group 3 mean age was 58.1±7.74 years. There was no significant difference between these groups regarding age, sex, ed-

ucation level, employment status, smoking habits, BMI, radiological grades, symptom duration, or duration of morning stiffness (Table 1).

Statistically, there was no significant difference between the three groups before treatment based on VAS values, ROM, the Lequesne index, the timed up and go test, or repetitive sit and stand up times (Table 2). Each of the three groups progress between before and after treatment and before and 4 weeks after the treatment ($p<0.05$) (Table 2).

The cases studied showed a lot of improve between before and after treatment and before and 4 weeks after treatment according to VAS values ($p=0.001$; $p<0.01$). Changes were greater in group 1 and 2 than in group 3 according to the before and after treatment VAS scores respective ($p=0.001$, $p=0.002$).There was no difference between group 1 and group 2 VAS values before and after treatment, and before and 4 weeks after treatment ($p>0.05$) (Table 2).

There was little difference in the Lequesne index scores, the timed up and go test, the repetitive sit and stand up test, and ROM test values before and after treatment and before and 4 weeks after treatment ($p>0.05$) for each of the three groups (Table 2).

There was a statistically large difference between paracetamol intake before and 4 weeks after treatment ($p=0.001$. Group 1 and 2 showed a greater difference than group 3 in paracetamol intake scores before and 4 weeks after treatment ($p=0.003$; $p=0.001$; $p<0.01$) There was no difference between group 1 and group 2 paracetamol intake.

Each of the three groups reported a difference in treatment satisfaction between before and 4 weeks after treatment. Satisfaction rates were higher for groups 1 and 2 than for group 3 ($p<0.05$). There was no difference in treatment satisfaction between groups 1 and 2.

DISCUSSION

We studied the effects of ultrasound and short-wave treatments compared with exercise only to determine short-term functional results and pain levels. All three treatment methods are effective. Paracetamol needs in the combined treatment groups were lower and reduction of VAS scores were higher than for the only exercises group.

The effect of ultrasound on knee OA is controversial according to the literature. Comparatively, both ibuprofen phonophoresis and conventional ultrasound in knee OA are effective for pain, joint movement, and functionality.[23] In

TABLE 1: Between group comparisons of demographic data and variables.

	Group I Combined treatment with US (n=39)	Group II Combined treatment with SW (n=38)	Group III Control Group (n=30)	p value
Age	59.45±8,64	58.61±7±6,82	58.1±7.74	0,742
Female/male	26/13	25/13	19/11	0,562
BMI (kg/m2)	29,54±5,41	29,41±5,14	28.3±6.04	0,523
Smoking (n)	9	7	6	0.871
Education Level (n)				
Elementary School	25	27	21	0.574
High School	10	10	7	
University	4	3	3	
Employment (n)				
Homemaker	21	22	16	0.472
Employed	18	16	14	
Symptoms of duration (year)	6.01±2.2	6.32±3.1	6.15±2.9	0.910
Kellgren-. Lawrence stage 2/3	19/20	18/20	15/15	0.847

TABLE 2: Evaluation of the group before and after treatment.

	Group I N=39	Group II N=38	Group III N=30	p value
Knee flexion degree (right)				
Baseline	116.17±11.03	115.28±10.50	116.92±10.14	p=0.457
After treatment	121.89±10.04	120.77±10.48	121.88±10.97	p=0.547
After 4 week treatment	124.21±9.31	124.04±11.18	124.65±9.97	p=0,77
P Value	***p¹0,001***	***p¹0,001***	***p¹0,001***	
	p²0,001	***p²0,001***	***p²0,001***	
Knee flexion degree (left)				
Baseline	115.47±9.14	116.31±10.24	115.11±10.2	p=0,941
After treatment	120.84±9.93	121.77±10.71	121.79±10.35	p=0,745
After 4 week treatment	123.98±7.54	124.71±9.44	124.18±11.14	p=0,284
P Value	***p¹0,001***	***p¹0,001***	***p¹0,001***	
	p²0,001	***p²0,001***	***p²0,001***	
Time up go test duration (min)				
Baseline	7.75±1.23	8.05±2.12	7.94±2.07	p=0,547
After treatment	6.41±1.55	7.27±1.64	7.01±1.95	p=0,884
After 4 week treatment	6.21±1.84	6.99±1.25	6.91±1.50	p=0,14
PValue	***p¹0,001***	***p¹0,001***	***p¹0,001***	
	p²0,001	***p²0,001***	***p²0,001***	
Repeated sit up time(min)				
Baseline	15,78±4,47	16,02±5,32	15,92±4,51	p=0,715
After treatment	13.24±3.88	14.12±4.05	13.74±3.62	p=0,652
After 4 week treatment	12.57±3.57	13.41±3.84	12.29±3.32	p=0,411
P Value	***p¹0,001***	***p¹0,001***	***p¹0,001***	
	p²0,001	***p²0,001***	***p²0,001***	
VAS				
Baseline	6,73±1,20	6,77±1,48	6,77±1,57	p=0,065
After treatment	4,42±1,48	4,62±0,91	5,47±1,50	p=0,035
After 4 week treatment	3,42±1,13	2,95±0,79	4,27±1,31	p=0,001
P Value	***p¹0,001***	***p¹0,001***	***p¹0,001***	
	p²0,001	***p²0,001***	***p²0,001***	
Paracetamol intake				
Baseline	3,14±0,76	3,15±0,90	3,17±0,63	p=0,814
After 4 week treatment	1,27±0,75	1,31±0,60	1,43±0,71	p=0,041
P Value	***p¹0,001***	***p¹0,001***	***p¹0,001***	
Lequesne index				
Baseline	11,71±1,97	11,59±1,73	11,67±1,73	p=0,958
After treatment	9,13±1,42	9,44±1,19	9,50±1,28	p=0,584
After 4 week treatment	7,50±1,13	7,74±1,02	7,57±1,17	p=0,538
P Value	***p¹0,001***	***p¹0,001***	***p¹0,001***	
	p²0,001	***p²0,001***	***p²0,001***	
Patients' Satisfaction Scores				
After treatment	3.14±1.40	3.11±1.84	2.4±1.73	p=0.044
After 4 week treatment	3.01±1.2	3.04±1.41	2.3±1.65	p=0.048
	p¹0,042	***p¹0,036***	***p¹0,001***	

Indicates significant differences ($p \leq 0.05$).

p^1 Comparison of baseline and after treatment; p^2 Comparison of baseline and after treatment 4 weeks.

another study, 5 minutes of ultrasound treatment and 1.5 w/cm^2 increases the effect of isokinetic exercise treatment in knee OA.[24] However, in Welch et al.'s study of knee OA, ultrasound is no better than a placebo for pain, ROM, and functionalty.[25] According to Özgönenel et al.'s study, between the continuous and sham ultrasound has better values than placebo group in knee OA as pain, WOMAC scores and 50 meter walking times.[26] In Zeng et al.'s meta-analysis, pulsed ultrasound was recommended for knee OA because it's more effective for pain and functional healing; continous ultrasound is only for pain relief in knee OA.[27] In our study, continuous ultrasound was applied. There was a big difference in pain between the ultrasound group and the only exercises group, but there was no difference in functionality.

There are some concerns about the effects of short-wave diathermy on knee OA but there are some studies that have shown positive effects. In one study, four weeks of short-wave diathermy had a positive effect on pain and functionality in symptomatic knee OA, and this effect continued up to 12 weeks.[28] Rabini et al.'s study of 54 mid-grade knee OA patients showed that short-wave diathermy 3 times a week for 4 weeks had a positive effect on pain and functionality that continued for a one-year period.[29] Controversially, some studies have shown that short-wave diathermy has no positive effects on exercises in knee OA. In a study of 113 female primary OA patients who received 20 minutes of continuous short-wave diathermy 3 times a week for 3 weeks, no difference was found between the study subjects and the control group in the WOMAC index, global evaluation, patient satisfaction, and 100-meter walking speed.[30] Studies show that continuous application has better effects than pulsing for pain and range of knee flexion healing.[31] In our study, short-wave treatment was applied continuously. Compared with the control group, the combined treatment group experienced better effects on pain.

In our study, at the end of treatment, each group had good clinical results. This is not surprising because each group took an education and exercise program. Previous studies have also shown that with education and exercise programs, there is progress in healing disability and reducing pain.[6,32] There is no difference between ultrasound and short-wave diathermy treatment in pain and functionality. Jan and Lai's study of 61 women showed that ultrasound and short-wave diathermy for gonarthrosis treatment yield the same results.[33] Boyacı et al.'s study showed that ketoprofen phonophoresis, ultrasound, and short-wave diathermy, which are types of deep heating treatments, have positive effects on treatment when combined with hot pack application, but there is no difference between them.[34] A study at Taiwan University showed that short-wave diathermy treatments combined with exercise had better effects than ultrasound with exercise.[35] In Hazneci et al.'s study of knee OA patients, 30 patients were given only exercise and 30 patients were given physical treatment (SWD, interferential current, massage) and exercises.[36] Values were taken from the VAS and the Lequesne index. The group that received physical treatment with exercise had better progress on functionality and pain. This indicates that combined use of physical treatment and exercise has better effects on knee OA patients.

Our study's strength is that the three groups are homogeneous with respect to socio-demographic characteristics and pre-treatment evaluations. Our limitations are that the number of patients is low and our tracking time was only 4 weeks. Our study shows that the two treatment plus exercise groups had better effects than the only exercises group based on VAS score differences and analgesic needs. These results indicate that in mid-grade knee OA, combined physical treatment applications have positive effects on exercise pain. There was no difference between short-wave diathermy and ultrasound as deep heaters in combination with physical treatments on pain and functionality. Combined physical treatment had positive effects on pain symptoms which raises questions about the effect of this treatment on progressive structural damage to cartilage More studies on this subject are needed.

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