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ORIGINAL ARTICLES

Comparison of The Mikhled Knee Exercise Program and a Gymnasium-Based Exercise Program Regarding Changes in Health Status and Life Quality of Subjects with Osteoarthritis of the Knee Joint

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ABSTRACT

Purpose: To compare the effects of the Mikhled knee exercise program (MKEP) and a gymnasium-based exercise program (GBEP) on people with osteoarthritis (OA) of the knee joint. Methods: This single-blinded, randomized clinical trial was conducted in the Physiotherapy Department of King Abdullah Hospital. Elderly subjects with OA of the knee were enrolled and randomized into the MKEP or GBEP group. The sessions were conducted for 1 h twice a week for 6 weeks. Subjects randomly assigned to the GBEP group performed knee extensions (pin-loaded machine), hamstring curls (pin-loaded machine), horizontal leg presses (pin-loaded machine), and bench step-ups/downs and utilized exercise bikes (variable resistance). The MKEP included 7 levels of isometric knee exercise. Each level included the same exercise, but the exercise was performed in different positions to allow for more contraction. The main outcome measures were weekly pain, health status, and quality of life, which were measured using the visual analogue scale (VAS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the Short Form (36) Health Survey, respectively. Data were analyzed using descriptive analysis and 2-way repeated-measures analysis of variance. Results: Twenty subjects were included in each group. The mean age, disease duration, height, and weight of the subjects included in this study were 66 ± 6 years, 7.58 ± 6.17 years, 171.08 ± 9.85 cm, and 77.56 ± 14.48 kg, respectively. Six weeks of the exercise intervention significantly improved the health status, quality of life, and weekly pain ($p < 0.05$) of the subjects. There were no significant differences between the groups for any of these variables. Conclusion: These findings indicate that the MKEP knee exercise program is a useful treatment for OA of the knee joint.

Key words: Osteoarthritis, Patellofemoral pain; Exercise therapy; Rehabilitation; Disability.

Introduction

Osteoarthritis (OA) of the knee is one of the most common forms of lower limb arthritis, especially in elderly people. Approximately 30–40% of people >60 years of age develop OA of their knee joints (Felson *et al*., 1997; Yelin, 1998; Meenan *et al.*, 1999 and Leardini *et al.*, 2001). A large number of individuals with OA exhibit pain, stiffness, and disability, which result in increased wage losses and healthcare costs (Hinman *et al.*, 2003 and Wang *et al.*, 2008). However, despite the high prevalence of OA, few reliable clinical measures and treatments are available (Salaffi, 2003).

Various exercises for OA of the knee improve joint range of motion, muscle strength, cardiovascular endurance, balance, and coordination (Hurley and Scott, 1998; Hurley, 1999; O'Reilly *et al.*, 1999; Petrella, 1999 and Richardson, 2001). Evidence indicates that the benefits of exercise are increased when used in combination with drug treatment (Rogind *et al.* 1998; Van Baar *et al.,* 1998; Petrella, 2000 and Blackham, 2008). However, no studies have compared the different effects of various exercise routines, nor is there a consensus on the proper exercise prescription for subjects with OA.

The Mikhled knee exercise program (MKEP) is a recently developed therapeutic technique to enhance joint health status, quality of life, range of motion, pain, balance, and muscular strength. The technique involves performing isometric movements of the hip, knee, and ankle from 7 therapeutic postures to strengthen the agonists and antagonists around the knee joint (i.e., quadriceps and hamstrings). However, no studies have examined the direct and residual effects of this technique on subjects with OA. Therefore, the current study compared the effects of 6 weeks of MKEP and a gymnasium-based exercise program (GBEP)

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on the pain, health status, and quality of life of subjects with knee OA. Subsequently, the residual effect was examined 6 weeks after the interventions were completed.

Methods:

Forty subjects who were referred to the Physiotherapy Department by an orthopedic consultant with a diagnosis of OA of the knee participated in the study. The study included subjects aged 15 to 80 years old with radiological evidence of OA (osteophytes, joint space narrowing, or bony enlargement). In addition, the subjects were required to meet one of the following American College of Rheumatology criteria: the presence of morning stiffness, crepitus, or bony tenderness in the knee joint margins. Subjects with any of the following disorders were excluded: active rheumatic diseases such as septic, gouty, and rheumatoid arthritis; uncontrolled hypertension; and any neuromuscular and cardiopulmonary disorders. Subjects were randomly assigned to the MKEP (n = 20) and GBEP (n = 20) groups by using a random number generator.

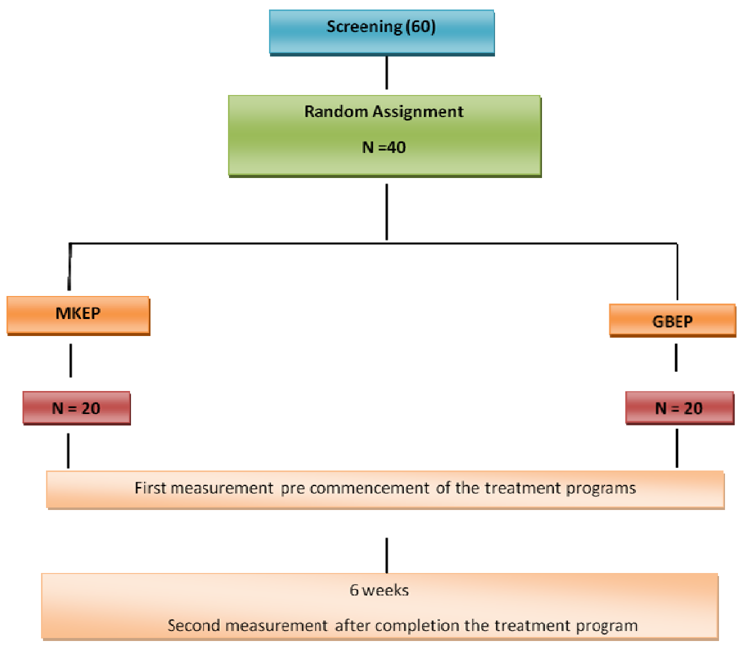


Fig. 1: Flow chart shows the measurements time for both groups.

The study was approved before the commencement of the exercise intervention by the Ethics committee of Jordan University of Science and Technology.

Interventions:

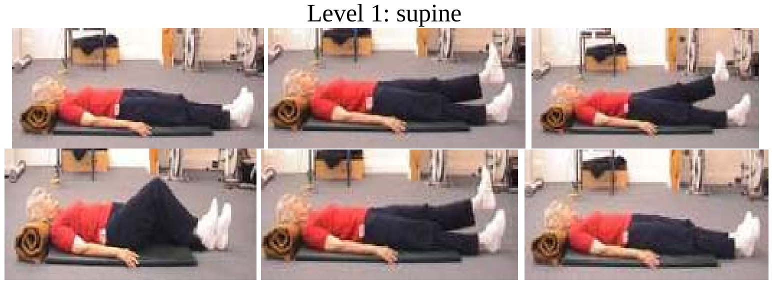
The interventions started immediately after the baseline evaluation. The MKEP and GBEP interventions lasted 12 sessions (twice per week). An experienced physical therapist conducted the one-on-one exercise sessions in the morning.

The MKEP involves a series of active gentle movements and postures designed to enhance the contraction of antagonist muscles, thus avoiding internal or external rotation. These therapeutic postures require the active involvement of the subject. The MKEP includes 7 therapeutic posture levels (Level 1: supine; Level 2: on the elbows; Level 3: half-sitting; Level 4: prone; Level 5: bench long sitting; Level 6: bench prone; Level 7: bench supine) that are held for 10 s each. Each level includes the same exercise performed in different positions as follows: (1) The subject was instructed to straighten his/her knee joint and pull his/her toes toward the body (dorsiflexion); (2) The subject was instructed to raise his/her leg up by 15 inches while keeping the knee straight; 3) The subject was instructed to take his/her leg outside the body in the abduction position while keeping the knee straight; (4) The subject was instructed to bend (flex) his/her knee by 30° while keeping the knee outside the body; (5) The subject was instructed to extend his/her knee while keeping the legs in a neutral position; (6) The subject was instructed to move his/her leg to an inside position similar to the first 5 steps to return to the initial position and relax for 30 s. After each isometric exercise, the subject was asked to hold for

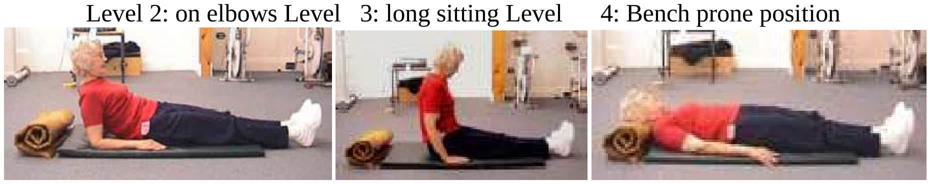
10 s or count to 10. The postures used are considered the most effective for strengthening the quadriceps and hamstring muscles, which are usually weak or atrophied in subjects with OA.

The physical therapist used verbal commands and manual contact to maintain the alignment and make the necessary postural corrections, with the aims of optimizing stretching and discouraging compensatory movements. Both lying postures were utilized by all subjects (Figs. 1–6). The total duration of the session was the same for all exercise levels. Each subject was asked to repeat the exercises at home in either the morning or the evening, according to their capabilities. Each subject was instructed to breathe normally while activating or holding muscular contraction.

Level 1: supine



Level 2: on elbows Level 3: long sitting Level 4: Bench prone position



Level 5: Bench long sitting Level 6: Bench supine position

Fig. 2: Mikhled knee exercise program.

The motor control exercise program was based on the treatment approach described in previous publications (Leardini *et al.*, 2001 and Pettrella., 2000). Exercises were proposed in different combinations and intensities on the basis of the clinical evaluation preliminarily performed by the physical therapist. In the initial phase of the GBEP, the physical therapist explained the anatomy of the local stabilizing muscles and described how to selectively activate them. The GBEP included knee extensions (pin-loaded machine), hamstring curls (pin-loaded machine), horizontal leg presses (pin-loaded machine), bench step-ups/downs, and the use of exercise bikes (variable resistance). Each subject was instructed to breathe normally while activating or holding muscular contraction. Progressively, the holding time and the number of contractions were increased up to 10 repetitions for 10 s each. Once the specific pattern of co-activation was achieved in the minimally loading positions and the subjects could comfortably perform 10 contractions for 10 s each, the subjects were advised to continue with their exercise regimen at home.

Subjects with increased knee pain or muscle soreness after exercising were instructed to ice their knee (s) or muscle (s) for 10 to 20 min and to elevate the affected leg(s) on a chair. If increased soreness or pain lasted for more than 2 h after exercising, the subjects were advised to reduce the number of repetitions of the strength exercises and then gradually increase the number of repetitions over time.

The outcome measures:

The primary outcome measures of this study were pain, health status, and quality of life. The WOMAC index, which was used to evaluate health status, was designed to measure dysfunction and pain associated with OA of the lower extremities. It consists of 24 items, including 5 items to assess pain, 2 items to assess stiffness, and 17 items to assess physical function, and it takes 5 min to complete. Each of the sections is scored individually for the 3 dimensions of pain, stiffness, and physical function by summing the coded responses, and the score range is 0–4, with a lower score indicating better health {Griffiths, 1995, 1}. Each question had 5 possible answers (0 = none, 1 = mild, 2 = moderate, 3 = severe, 4 = extreme). The maximum scores in the likert-type (LK) scale were 20 points for pain, 8 points for stiffness, and 68 points for physical function. Higher scores indicate more or worse symptoms, more limitations, and poorer health.

The SF-36, which was used to examine quality of life, is a self-administrated questionnaire containing 36 items and takes between 5 and 10 min to complete {Brazier, 1999, Hurley, 1999, Leardini *et al*., 2001}. The scores are based on responses to individual questions covering 8 categories (physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health), each of which measures a health concept (Ware *et al*., 1994; Ware *et al*., 1995). All items pertaining to each category (excluding health transition) are summed and scored on a scale of 0–100, in which a higher score indicates a better state of health or well-being (Ware and Sherbourne, 1992; Ware and Kosinski, 2001). The second measurement session occurred at the end of the 6-week period of the treatment programs. The third measurement session occurred 6 weeks after the second measurement session. The second and third measurement sessions were conducted in an identical manner as the first session. Throughout the study, all subjects were required to continue their normal medication regimen. A 10-cm visual analogue scale was used to assess pain.

Data analysis:

Statistical analysis was performed using the Statistical Package for Social Sciences for Windows (version 17, SPSS, Chicago, IL). A2 (treatment groups) × 3 (measurements) analysis of variance (ANOVA) was used to determine the effects of the 2 treatment techniques. Alpha was preset at 0.05. Data were presented as the mean ± standard deviation.

Results:

All subjects in both groups completed the baseline measurement, and they were admitted into the intervention stage of the study with 100% compliance. The subjects in both groups were comparable in terms of age (MKEP: 66 ± 6.5 years; GBEP: 63± 6.9 years), OA duration (MKEP: 8 ± 6.5 years; GBEP: 8 ± 6.3 years), body weight (MKEP: 77 ± 14 kg; GBEP: 77 ± 14 years), and height (MKEP: 172 ± 10.1 cm; GBEP: 170.2 ± 7.4 cm).

The WOMAC (pain, physical function, and stiffness scores) and SF-36 (general health, physical function, role physical, role emotional, bodily pain, and vitality) data were normally distributed. Data analysis included an examination of the 3 dependent variables of pain, physical function, and stiffness. ANOVA revealed a significant time-by-group interaction for each variable as well as a significant main effect of time for each variable. The ANOVA results are summarized in Table (4). Descriptive data for WOMAC and SF-36 presented in Table (2) illustrate the outcome of the WOMAC and SF-36 variables by group throughout the study period. WOMAC scores decreased significantly in response to treatment for pain (time $F = 86.70$, $p < 0.001$), physical function (time $F = 50.60$, $p < 0.001$), and stiffness (time $F = 86.70$, $p < 0.001$) (Table 2). These changes were different between groups (pain: group × time $F = 4.345$, $p < 0.001$; physical function: group × time $F = 11.44$, $p < 0.001$; stiffness: group × time $F = 10.81$, $p < 0.001$) (Table 2). Further examination of the data using repeated-measures ANOVA followed by linear contrasts comparing baseline data with follow-up measurements revealed that the improvements in WOMAC scores (pain, physical function, and stiffness) between the baseline and post-intervention measurements were significant in both groups. The improvement remained significant in both groups at the final follow-up ($p < 0.001$, Table 3).

The SF-36 scores decreased significantly in response to treatment for general health (time $F = 7.67$, $p < 0.001$), physical function (time $F = 36.02$, $p < 0.001$), role physical (time $F = 11.20$, $p < 0.001$), role emotional (time $F = 10.69$, $p < 0.001$), bodily pain (time $F = 44.48$, $p < 0.001$), vitality (time $F = 7.68$, $p < 0.001$), social functioning (time $F = 13.85$, $p < 0.001$), and mental health (time $F = 3.19$, $p < 0.047$) (Table 2). The changes were different between groups for general health (group × time $F = 1.7$, $p = 0.188$), physical function (group × time $F = 4.7$, $p < 0.001$), role physical (group × time $F = 5.5$, $p = 0.006$), role emotional (group × time $F = 2.12$, $p = 0.127$), bodily pain (group × time $F = 24.43$, $p < 0.001$), vitality (group × time $F = 8.04$, $p < 0.001$), social functioning (group × time $F = 3.85$, $p = 0.026$), and mental health (group × time $F = 2.93$, $p = 0.060$). Further, examination of the data using repeated-measures ANOVA followed by linear contrasts comparing baseline and follow-up measurements revealed significant improvements between the baseline and post-intervention and 6-week measurements in the MKEP group for a number of variables (physical function, $p < 0.001$; role physical, $p = 0.004$; role emotional, $p = 0.003$; bodily pain, $p < 0.001$; vitality, $p < 0.001$; social functioning, $p = 0.004$; mental health, $p = 0.764$; Table 3), but the change in general health was not significant ($p = 0.371$). In contrast, no significant improvement was observed in the GBEP group for most variables (role physical, $p = 0.297$; role emotional, $p = 0.359$; bodily pain, $p = 0.096$; vitality, $p = 1.000$; social functioning, $p = 0.087$; mental health, p

= 0.764; Table 3). However, the improvements in physical function (p = 0.013, Table 3) and general health (p = 0.013, Table 3) in the GBEP group were maintained at the end of the follow-up.

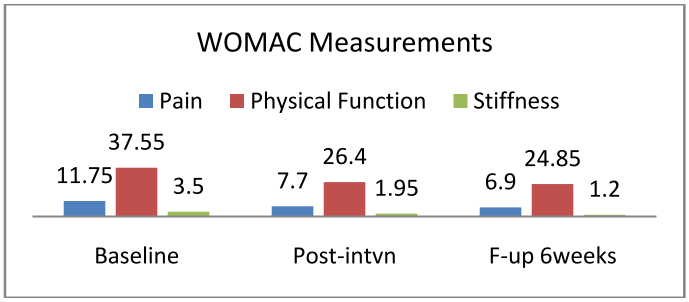


Fig. 2: The Pre & Post intervention (Mean ± SD) of WOMAC.

Table 1: Summary results of repeated measures ANOVA for WOMAC (Pain, Physical Function & stiffness).

1. WOMAC	Time		Time*Group	
	F (df1, df2)	P value	F (df1, df2)	P value
Pain	50.55 (1.90, 72.31)	< 0.001	4.345 (1.90, 72.31)	< 0.001
Physical Function	50.60 (1.5, 57.5)	< 0.001	11.44 (1.5, 57.5)	< 0.001
Stiffness	86.70 (2, 76)	< 0.001	10.81(2, 76)	< 0.001
2. SF-36				
General Health	7.67 (1.4, 52)	< 0.001	1.7 (1.4, 52)	0.188
Physical Function	36.02 (1. 4, 52)	< 0.001	7.4 (1. 4, 52)	< 0.001
Role Physical	11.20 (1.5, 57.5)	< 0.001	5.5 (1.5, 57.5)	0.006
Role Emotional	10.69 (2, 76)	< 0.001	2.12 (2, 76)	0.127
Social Functioning	13.85 (1.75, 66.4)	< 0.001	3.85 (1.75, 66.4)	0.026
Bodily Pain	44.48 (2, 76)	< 0.001	24.43 (2, 76)	< 0.001
Vitality	07.68 (2, 76)	< 0.001	8.04 (2, 76)	< 0.001
Mental Health	3.19 (1.66, 63.24)	0.047	2.93 (1.66, 63.24)	0.060

Table 2: Descriptive results of repeated measures ANOVA for WOMAC and SF-36.

Mikhled Knee Exercise Program	Baseline	Post-intvn	F-up 6weeks
WOMAC			
Pain	11.75 (4)	7.70 (2.70)	6.9 (2.77)
Physical Function	37.55 (10.6)	26.40 (7.6)	24.85 (7.1)
Stiffness	3.50 (1.50)	1.95 (1.50)	1.20 (1.28)
SF-36			
General Health	18.55 (3.3)	17.85 (2.74)	20.3 (2.1)
Physical Function	19.95 (3.2)	22.30 (2.75)	23.75 (2.8)
Bodily Pain	5.40 (0.99)	6.05 (0.76)	4.20 (0.77)
Vitality	17.05 (2.54)	18.35 (2.6)	19.9 (2.12)
Role Physical	6.6 (1.5)	7.2 (1.2)	7.6 (0.7)
Role Emotional	4.9 (1.23)	5.65 (0.93)	5.70 (0.47)
Social Functioning	8.2 (2.05)	9 (1.45)	9.4 (1.05)
Mental Health	24.8 (2.5)	24.85 (3.4)	26.25 (3.11)
Gymnasium Based Exercise Program			
WOMAC			
Pain	12.00 (4.11)	8.50 (3.66)	9.55 (2.77)
Physical Function	34.80 (10.5)	28.65 (7.9)	31.30 (10.1)
Stiffness	3.80 (1.57)	1.95 (1.28)	2.55 (1.320
SF-36			
General Health	18.70 (3.60)	18.20 (2.70)	19.15 (2.60)
Physical Function	19.55 (3.40)	22.20 (3.13)	21.15 (2.80)
Role Physical	05.80 (1.60)	06.60 (1.10)	06.00 (1.30)
Role Emotional	05.00 (1.10)	05.60 (0.94)	05.20 (1.00)
Social Functioning	08.20 (1.99)	09.05 (1.30)	08.60 (1.60)
Bodily Pain	05.40 (1.14)	06.05 (0.94)	05.65 (1.09)
Vitality	17.00 (3.20)	17.60 (4.25)	17.00 (3.20)
Mental Health	23.20 (2.50)	23.45 (2.99)	23.35 (2.45)

Table 3: Summary results of tests of within-subjects contrasts for muscle strength.

	MKEP		GBEP	
Time	F (df1, df2)	P value	F (df1, df2)	P value
WOMAC				
Pain	45.9 (1, 19)	< 0.001	17.4 (1, 19)	0.001
Physical Function	55.9 (1, 19)	< 0.001	10.10 (1, 19)	0.005
Stiffness	76,7 (1, 19)	< 0.001	50.5 (1, 19)	< 0.001
SF-36				
General Health	11.217 (1, 19)	0.371	0.252 (1, 19)	0.013
Physical Function	54.221 (1, 19)	< 0.001	7.437 (1, 19)	0.013
Role Physical	10.408 (1, 19)	0.004	1.152 (1, 19)	0.297
Role Emotional	11.472 (1, 19)	0.003	0.884 (1, 19)	0.359
Social Functioning	10.584 (1, 19)	0.004	3.251 (1, 19)	0.087
Bodily Pain	48.857 (1, 19)	< 0.001	3.065 (1, 19)	0.096
Vitality	80.066 (1, 19)	< 0.001	0.000 (1, 19)	1.000
Mental Health	15.089 (1, 19)	< 0.001	0.092 (1, 19)	0.764

Discussion:

The purpose of the study was to examine the effect of the MKEP and GBEP on knee OA. Pain, health status, and quality of life were improved in both groups following the 6-week intervention program. The improvement persisted after a 6-week follow-up period in the MKEP group, whereas the early improvements in most of the measured variables in the GBEP group were not maintained.

There were no significant differences between the groups regarding the characteristics of the subjects. The decline in pain after the 6-week exercise program is consistent with the findings in other studies.(Scott 1993; Ettinger, Burns *et al.* 1997; Rogind, Bibow *et al.* 1998; Van Baar, Dekker *et al.* 1998; Maurer, Sterm *et al.* 1999; O'Reilly, Muir *et al.* 1999; Van Baar 1999; Deyle *et al.* 2000a) These studies also indicated that the training programs did not worsen symptoms. In addition to an improvement in pain, stiffness, physical function, and quality of life were also significantly improved following the 6-week exercise program. Previous studies observed increased functional performance after exercise interventions. According to these results, the treatment for OA of the knee joint needs to evolve from the routine protocol toward a more dynamic and aggressive program involving the MKEP to strengthen the knee joint. The MKEP has proven useful in increasing the strength and functional ability of subjects with OA of the knee while lessening their pain. The advantages of the MKEP are that no specialized equipment is needed and subjects can perform the exercises at home. The results of the study indicate that this exercise program can alleviate symptoms, increase function, and enhance joint stability. Because of the lack of an effect of the training program on daily activity, cardiovascular fitness training should be performed concurrently. Increasing the volume of training, that is, the number of repetitions of contractions and the frequency of training, is encouraged, as it may result in greater changes and benefits. However, caution should be exercised by increasing the intensity of training gradually to provide the greatest benefit without aggravating joint symptoms.

This study has some environmental limitations that must be considered such as lifestyle, diet, and activity level changes could not be controlled. This study has confirmed the benefits of 6-week strengthening exercise intervention programs. However, the time-course and long-term changes in pain, health status and quality of life are still unknown. Therefore, future studies with larger sample sizes are needed, and measurement tools should be standardized to account for protocol differences. In addition, future studies should examine changes in measurement parameters with durations of the MKEP and GBEP interventions exceeding 6 weeks (i.e., 2–6 months) on a weekly or twice-weekly basis. Finally, we recommend the use of a GBEP for patients with knee OA excluding those with patellofemoral OA, sacroiliac joint OA, and ankle joint OA.

In conclusion no equipment is necessarily for the MKEP and it can easily be implemented at home, the findings of this study demonstrate that the MKEP might be considered a more appropriate treatment option for patellofemoral pain of the knee joint than the GBEP.

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