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PREVENTION AND REHABILITATION: RANDOMIZED CLINICAL TRIAL

The effect of combined exercise therapy on knee proprioception, pain intensity and quality of life in patients with hypermobility syndrome: A randomized clinical trial

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ABSTRACT

Objective: Proprioception, the perception of limb movements and spatial orientation derived from body stimuli, plays a critical role in maintaining joint stability. This study aimed to investigate the effect of combined exercise therapy (closed kinetic chain exercises and proprioception exercises) on knee proprioception, pain intensity and quality of life in patients with hypermobility syndrome.
Design: Single-blind randomized clinical trial.
Setting: Shiraz School of Rehabilitation Sciences.
Participants: Twenty four patients with hypermobility syndrome.
Interventions: The patients were assigned to the control (no intervention) or intervention group (exercise therapy) by random allocation.
Measurements: Knee proprioception, pain intensity and quality of life were evaluated before and immediately after the intervention. Exercise sessions were held 3 days a week for 4 weeks.
Results: The results showed that knee proprioception improved significantly in the intervention group compared to the control group. Quality of life increased, and knee pain intensity decreased significantly in the intervention group compared to the control group.
Conclusion: Combined exercise therapy can reduce pain intensity and increase knee proprioception and quality of life in patients with hypermobility syndrome.

1. Introduction

Joint hypermobility syndrome, is a hereditary condition that can lead to musculoskeletal pain. It is caused by mutations in the genes that code for collagen, elastin and tenascin (Sahin et al., 2008a; Hakim and Grahame, 2003). Among adults the prevalence of hypermobility syndrome ranges from 0.6% to 31.0%, and it is five times more common in women than men (Everman and Robin, 1998; Hakim and Grahame, 2003). It increases joint mobility beyond the normal range, resulting in increased laxity that can lead to joint instability and traumatic injuries. Traumatic lesions caused by soft tissue instability may be related to musculoskeletal pain, especially in weight-bearing joints such as the knee (Sahin et al., 2008a, b).

The proprioceptive system plays an important role in joint stability (Lokhande et al., 2013). Studies by Mallik et al. (1994) and Jerosch and Prymka (1996) showed that proprioceptive acuity was reduced in the knee and proximal interphalangeal joints in patients with hypermobility syndrome. Impaired proprioception might make unstable joints more vulnerable to minor traumas as a result of joint laxity.

Previous studies showed that exercise therapy can improve joint instability and reduce symptom-related hypermobility (Sahin et al., 2008a; Ferrell et al., 2004). In previous research involving patients with hypermobility syndrome, exercises were not combined. Furthermore, comprehensive information on the most effective combination of exercise therapies is not available. Therefore the aim of this study was to investigate the immediate effects of combined therapy with closed kinetic chain exercises and

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proprioception exercises during 4 weeks in patients with knee hypermobility syndrome.

2. Patients and methods

This study was a single-blind randomized clinical trial. Twenty four women 18–30 years old who were diagnosed with hypermobility syndrome (according to the diagnostic criteria of Brighton 1998) (Grahame et al., 2000) were recruited via announcements posted on bulletin boards. They were all patients at physiotherapy, orthopedic knee and rheumatology clinics affiliated with Shiraz University of Medical Sciences. A computer-generated random number table was used to allocate the patients randomly into two groups: control (no intervention) and intervention (combined exercise therapy). Women who were athletes or who reported exercising regularly (3 times in a week) were excluded. Other exclusion criteria were any of the following: history of knee trauma, history of rheumatoid disease or knee osteoarthritis, knee ligament injury, knee arthroplasty, neuromuscular or musculoskeletal disorder. All participants signed a written informed consent form which was approved by the Ethics Committee of Shiraz University of Medical Sciences.

Pain intensity, quality of life and proprioceptive acuity were measured with a Visual Analog Scale (VAS), the Short Form 36 Health Survey (SF-36) and a goniometer, respectively, before and immediately after the intervention. All data were recorded when the participants were not at the beginning of their menstrual cycle (i.e., not during menstrual bleeding), because the increased secretion of sex hormones such as estrogen and progesterone at this stage of the cycle can increase joint laxity and instability (Shahin et al., 2012). A physical therapist supervised all patients in the intervention group, and another therapist who was blinded to the group allocation evaluated the participants immediately before and after the intervention.

To measure knee joint position sense, the error rate in joint angle repositioning was evaluated in two positions: weight-bearing (WB) and non-weight-bearing (NWB). The axis of the goniometer was positioned at the woman's lateral femoral epicondyle. One arm of the goniometer was positioned along the long axis of the femur, and the other was aligned with the leg (Lokhande et al., 2013).

In the NWB position, patients sat on the edge of a bed with their eyes closed. The passive–active method in sitting position was used. In this test, a 30-degree angle of knee flexion was produced passively, and after that the knee was extended. Then the participant was asked to bend her knee at a 30-degree angle actively.

In the WB position, the active–active method in the standing position was used. The patient was asked to actively bend her lower extremity to 30 degrees of knee flexion, and then to reproduce this angle actively (Lokhande et al., 2013).

Angle error was recorded after each assessment. Each measurement was repeated five times and the average of all five measurements was used for analyses.

After the initial evaluations in the intervention group, patients received exercise therapy for 4 weeks on 3 days a week under the supervision of an expert physical therapist. The exercise program in the first week consisted of squatting exercises, bridging, plié in one set of 5, backward walking (30 s), heel walking (30 s), walking on toes (30 s), walking with eyes closed (30 s), standing on one leg (30 s), and bending back and forth on one leg with eyes closed (30 s) and with eyes open (30 s).

In the second week the program consisted of squatting exercises, bridging, plié in one set of 10, front lunge and side lunge in five sets, backward walking (30 s), heel walking (30 s), walking on toes (30 s), walking with eyes closed (30 s), standing on one leg (30 s), bending back and forth on one leg with eyes closed (30 s) and with eyes open (30 s), and slowly sitting on a chair and standing up (10 times).

The program in the third week consisted of squatting exercises, bridging, plié in two sets of 10, side lunge and front lunge in one set of 10, backward walking (30 s), heel walking (30 s), walking on toes (30 s), walking with eyes closed (30 s), standing on one leg (30 s), bending back and forth on one leg with eyes closed (30 s) and with eyes open (30 s), slowly sitting down on a chair and standing up (10 times), and slow 8 exercises (5 times) (slow walk–broad circle, fast walk–broad circle, slow walk–narrow circle, fast walk–narrow circle).

The program in the fourth week consisted of squatting exercises, bridging, plié in two sets of 15, side lunge and front lunge in two sets of 10, backward walking (30 s), heel walking (30 s), walking on toes (30 s), walking with eyes closed (30 s), standing on one leg (30 s), bending back and forth on one leg with eyes closed (30 s) and with eyes open (30 s), slowly sitting down on a chair and standing up (10 times), and fast 8 exercises (5 times) (Sahin et al., 2008a; Ferrell et al., 2004).

Table 1
Characteristics of the intervention and control groups of patients with joint hypermobility.

Group	Intervention	Control	P value
Age (years)	22.25 ± 1.28	21.66 ± 196	.11
Height (m)	1.63 ± 0.04	1.64 ± 0.04	.87
Weight (kg)	55.20 ± 9.81	62.41 ± 10.47	.86

Values are mean ± SD.

Table 2
Angle error (degrees) in the weight-bearing position in the intervention and control groups of patients with joint hypermobility.

Angle error	Intervention (mean ± SD)	Control (mean ± SD)	P value[a]
Before	6.24 ± 5.39	5.62 ± 4.43	.88
After	2.53 ± 2.71	5.69 ± 4.69	.03*
P value[b]	0.005*	0.92	

* indicates significance level.
[a] Mann–Whitney *U* test.
[b] Wilcoxon signed rank test.

Table 3
Angle error (degrees) in the non-weight-bearing position in the intervention and control groups of patients with joint hypermobility.

Angle error	Intervention (mean ± SD)	Control (mean ± SD)	P value[a]
Before	3.84 ± 3.68	4.90 ± 3.41	.47
After	2.07 ± 1.81	5.02 ± 3.05	.009*
P value[b]	0.01*	0.70	

* indicates significance level.
[a] Independent-sample *t*-test.
[b] Paired *t*-test.

Table 4
Visual analog scale scores in the intervention and control groups of patients with joint hypermobility.

Pain intensity	Intervention (mean ± SD)	Control (mean ± SD)	P value[a]
Before	4.98 ± 1.32	4.87 ± 1.86	.90
After	2.25 ± 1.48	5.37 ± 2.07	P < .001*
P value[b]	0.001*	0.20	

VAS was evaluated between 0 and 10 mm.
* indicates significance level.
[a] Independent-sample *t*-test.
[b] Paired *t*-test.

Table 5
Quality of life scores based on the Short Form 36 Health Survey before and after the intervention.

Domain		Before (mean ± SD)	After (mean ± SD)	P value[a]
Physical functioning	Intervention group	59.90 ± 6.28	71.89 ± 9.39	P < .001*
	Control group	60.50 ± 9.70	60.55 ± 9.55	.94
P value[b]		0.86	0.01*	
Mental health	Intervention group	57.39 ± 16.75	58.05 ± 17.06	.31
	Control group	51.80 ± 17.49	52.56 ± 13.63	.69
P value[b]		0.46	0.42	

Quality of life was scored between 0 (worst possible) and 100 (best possible).
* indicates significance level.
[a] Paired *t*-test.
[b] Independent-sample *t*-test.

At the end of the fourth week, all outcomes were measured again in both the control and intervention groups.

2.1. Statistical methods

Power analyses were performed prior to the study to determine how many participants were needed in each group. The sample size was determined as 12 women in each group, according to an alpha value of 0.05, 80% power, and a beta value of 0.2 based on data for knee joint proprioception (data from Ferrell et al., 2004) (8).

Statistical analysis was done with the SPSS version 16 for Windows XP (SPSS Inc., Chicago, IL, USA). Data normality was verified with the Shapiro–Wilk test. The data were normally distributed, with the exception of joint angle repositioning in the WB position. Hence, nonparametric tests were used to analyze WB results. The Mann–Whitney test was used to compare angle error between groups, and the Wilcoxon signed-rank test was used to compare angle error before and after the intervention. Within-group and between-group comparisons of pain intensity, quality of life and joint angle repositioning in the NWB position were done with paired t-tests and independent-sample t-tests, respectively.

3. Results

Table 1 shows the demographic characteristics of the participants. There was no significant difference in age, height or weight between the intervention and the control groups ($P > .05$).

The results of joint angle repositioning showed that angle error was significantly reduced in the intervention group compared to the control group in both the WB and NWB positions (Tables 2 and 3).

Also, pain intensity was significantly reduced in the intervention group compared to the control group (Table 4).

At the end of the study period, quality of life had improved significantly in the intervention group compared to the control group (Table 5).

4. Discussion

The results of this study showed that combined exercise therapy can lead to significant improvement in knee joint proprioception in patients with hypermobility syndrome. This finding is consistent with the results of Ferrell et al. (2004) and Sahin et al. (2008a, b). These authors reported that closed kinetic chain exercises and proprioceptive exercises for 8 weeks can improve joint position sense (Ferrell et al., 2004; Sahin et al., 2008a, b). The improvement in proprioception was probably due to physiological and psychological changes. Because proprioceptive mechanisms play a critical role in joint stability, improvements in proprioception can help prevent joint laxity from re-injuries.

In the women who participated in this trial, pain intensity was reduced after 4 weeks of combined exercise therapy, which is in line with previous studies (Ferrell et al., 2004; Barton and Bird, 1996). The reduction in pain can be attributed to improvements in proprioception or deconditioning (Sahin et al., 2008a, b; Keer and Grahame, 2003).

The results from the SF-36 questionnaire showed that quality of life score, as an indicator of well-being, improved following combined exercise therapy in women with hypermobility syndrome. Pacey et al. (2013) showed that a physiotherapist-supervised exercise program can improve health-related quality of life after 8 weeks. Therefore, the improvement in quality of life scores can be attributed to pain reduction after exercise therapy in patients with joint hypermobility syndrome.

All previous studies reported the effectiveness of exercise therapy after 8 weeks, whereas the present study showed that combined exercise therapy can lead to similar results after 4 weeks. The findings reported here suggest that combined exercise therapy can help to achieve the anticipated outcomes in briefer periods than those used in previous studies.

A limitation of the present study was the lack of a follow-up period. Furthermore, participants in the control (no treatment) group were not blinded to their group allocation, and this might have affected the outcomes. Future studies should be designed to include follow-up evaluations of the results of the interventions, and to overcome potential methodological limitations.

5. Conclusion

In the present sample of patients with joint hypermobility syndrome, combined exercise therapy reduced pain intensity and improved joint proprioception and quality of life immediately after the intervention.

Conflict of interest

None declared.

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