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The effectiveness of a back school program in lower limb amputees: a randomized controlled study

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Background/aim: A few studies have been carried out in lower limb amputees (LLAs) and they examined the incidence of and reasons for low back pain. The aim of this study was to assess the effectiveness of a back school program in LLAs with mechanical low back pain (MLBP).

Materials and methods: Forty male unilateral transfemoral amputees with MLBP were randomly allocated into two groups. A back school program was applied to Group 1 over 2 weeks. A booklet for home use was given to each participant in Group 2. Pain was assessed using a visual analogue scale. Spinal flexibility measurements were obtained. For the assessment of back pain-related disability, the Oswestry Disability Index was used. Patients were assessed at baseline, at month 1, and at month 3.

Results: At the month 1 assessment, a reduction in pain intensity and disability, and increase in spinal flexibility measurements were detected in Group 1 only ($P < 0.05$). At the month 3 assessment, there were improvements in all measured parameters in both groups ($P < 0.05$). Group 1 had better results in all parameters compared with Group 2.

Conclusion: The back school program, combined with an exercise program, decreased pain and disability and improved the spinal flexibility significantly in LLAs with MLBP.

Key words: Low back pain, amputee, back school, exercise, physiotherapy

1. Introduction

Low back pain (LBP) is one of the most common problems that become chronic in people who use prostheses after lower limb amputation (1–3). The frequency of LBP among lower limb amputees (LLAs) varies from 52% to 71%, higher than that of the general population (1–5). Although some researchers (3,4,6) did not find any significant relationship between LBP and amputation level, other found that transfemoral amputees (TFA) may have a higher prevalence and severity of LBP, when compared with transtibial amputees (1,5,7,8). Almost one third of amputees with LBP rated their pain as severe and limiting their ability to work and perform their daily activities (3). LBP in LLAs mostly originates from mechanical factors. The risk factors for mechanical low back pain (MLBP) in LLAs have been defined as body asymmetry in the frontal plane, imbalance between trunk muscles in the sagittal plane, gait compensations, poor socket fit, and prosthetic alignment (1,7).

Eliminating risk factors affecting normal body biomechanics is the main treatment principle of MLBP. This can be achieved by being aware of the normal alignment of body structures, the risk factors that distort the alignment of these structures, and how to eliminate these factors for individuals with MLBP (9). To date, there has been only one study on the treatment of LBP among the amputee population. Esquenazi and DiGiacomo recommended specific activities to maintain trunk flexibility in the treatment of LBP in amputees (10).

The treatment of LBP includes analgesics, rest, exercises, different kinds of local interventions, manipulations, acupuncture, heat or cold, various physiotherapy modalities, local injections, and surgical interventions. Among all these therapeutic methods, patient education and exercise seem to be more effective (11,12). One study showed that the combination of two approaches had better results (13). Back school (BS) is a combination of patient education and exercises focused on postural alignment

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and protection of the spine (14,15). One Cochrane review revealed that BS was more efficient than placebo or other treatments on pain, functional status, and return to work (16).

Studies related to the LBP in LLAs have provided information about the properties of LBP and the factors causing back pain (1,3,7,8). There has been only one study about the treatment of LBP in LLAs. However, that study did not give specific information about the treatment of LBP in this population (10). The goal of the present studywas to investigate the effect of a BS program combined with an exercise program on pain, spinal flexibility, and back pain related to disability in LLAs with MLBP.

2. Materials and methods

2.1. Study design

A randomized controlled clinical trial was performed to assess the effectiveness of a BS program combined with an exercise program in LLAs with MLBP. This study was approved by the ethical committee of Hacettepe University, Ankara, Turkey, and registered under the ID LUT05/29. All participants gave informed consent before participating.

2.2. Participants

Forty male, posttraumatic, unilateral TFA patients, aged between 18 and 50 years, who used their prostheses regularly for at least 1 year participated in this study. All subjects were regularly attending patients at the Department of Physiotherapy and Rehabilitation, Prosthetics and Biomechanics Unit at the Hacettepe University Faculty of Health Sciences. All patients had a diagnosis of MLBP confirmed by a physician according to radiological imaging tests (antero-posterior and lateral lumbosacral spine X-ray). Amputees with a systemic disease, radiating pain, lumbar disc herniation, inflammatory back pain, clinical history of spinal surgery, structural deformities such as spondylolisthesis, or using any walking aid were excluded. The Figure illustrates the participants' selection and their assignment to two groups. The amputees were assigned to two groups by simple randomization. The randomization procedure was performed using an online randomization program (GraphPad Software QuickCalcs) before the study began. Each group consisted of 20 subjects.

The power analysis indicated (α value 0.05, β value 0.8) that a minimum of 12 participants in each group would be necessary to detect a difference between two interventions. According to the post hoc power analysis based on ODI scores, the power of the study was calculated as 94.8%.

2.3. Interventions

All the static and dynamic prosthetic assessments and adjustments of the subjects were done before the measurements to eliminate poor socket fit and prosthetic alignment. Ten sessions in 2 weeks (5 days/week) with

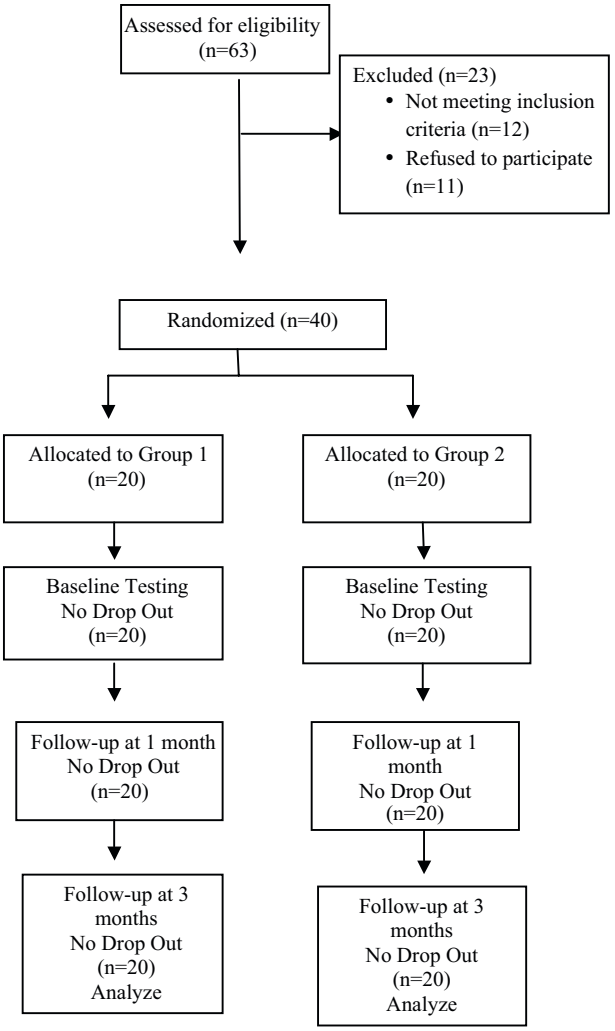

Figure. Flowchart of patient randomization and follow-up.

back health education and an exercise program involving theoretical and practical information with specific exercises were given to Group 1 (education group) (17). Each session, including 3–4 participants, lasted about 1 h under the supervision of a physiotherapist. The participants were advised to continue these exercises at home.

The theoretical part of the education consisted of information about anatomy, biomechanics, basic ergonomic principles related to the spinal column, and pelvis and mechanical changes due to amputation. Moreover, this part was supported with slide shows and study of spine models. The practical training session focused mainly on applying the basic ergonomic principles during daily activities. Specific exercises included strengthening of extremity muscles and trunk muscles; stretching of calf muscles, hamstrings, hip flexors, and lumbar extensors; spinal stabilization; and dynamic stump exercises.

Group 2 (control group) received a booklet including information on the theoretical part of the back health

education and exercise illustrations, which had been shown once to each patient individually. The participants in the control group were asked to perform the exercises at home once a day (3 sets, 10 repetitions) and to keep a self-report diary including the duration and quantity of the exercises (18).

All measurements were performed and back health education program booklets were given by the same physiotherapist (B.A.). At the end of each treatment session, the participants in both groups were asked to perform the same exercises at home once a day.

2.3.1. Exercise program

Strengthening exercises:

(1) Initially, subjects were taught to co-contract the multifidus, internal oblique, and transversus abdominis muscles with abdominal hollowing, first in supine and prone positions and then progressing to more challenging postures (basic spinal stabilization exercise) (16).

(2) Trunk flexion for rectus abdominis and trunk flexion and rotation for external and internal obliquus while keeping posterior pelvic tilt, knee, and hips flexed (amputated side was supported with pillows) in supine position (19).

(3) Trunk extension for erector spinae in prone position (19).

Stretching exercises:

(1) Bilateral maximum flexion of the hips for stretching the lumbar extensors in supine position (18).

(2) Maximum flexion of one hip while keeping the other in extended position for stretching the hip flexors in supine position (18,19).

(3) With the knee is fully extended, bending the trunk forward for global stretching of the posterior muscular chain (erector spinae, hamstring, triceps surae) in seated position (19).

Dynamic stump exercises:

(1) Anterior pelvic tilt with stump extension in supine position for learning to use hip extension at loading response.

(2) Stump abduction with pelvic elevation in side lying position for developing an effective midstance.

(3) Stump abduction and internal rotation with lateral pelvic tilt in side lying position for improving prosthetic terminal stance and stride length of the opposite limb (20).

2.4. Measurements

All measurements were performed before the interventions, and repeated 1 and 3 months after the treatment sessions finished.

2.4.1. Demographic and clinical characteristics

In the initial evaluation, we recorded demographic characteristics including age, height, weight, and body mass index (BMI). The clinical characteristic time after amputation was recorded in years and the stump length was recorded in centimeters.

2.4.2. Pain

The intensity of LBP was measured using a visual analogue scale (VAS), on which the patients could grade their pain along 100 mm line from 0 (no pain at all) to 100 (most severe pain) (7).

2.4.3. Flexibility

All spinal flexibility measurements were assessed three times using a tape measure and the mean value was recorded. The pelvis of the subject was fixed by a physiotherapist during all the flexibility measurements. Spinal flexion flexibility was measured by the sit-and-reach test. A standard sit-and-reach box was used to position the subjects. Each subject was seated with a knee fully extended and ankle in neutral dorsiflexion against the box. The hands were kept aligned evenly as the subject reached forward along the surface of the box. The reached distance was recorded as the final position of the fingertips on the ruler (21).

For spinal extension flexibility, subjects stood facing the wall with arms in neutral position, and knees and back straight. The first distance was recorded between the suprasternal notch and the wall. Subjects extended the lower trunk as far as they could, and the final distance was measured (22).

For spinal lateral flexion flexibility, subjects stood in the same position as the previous one. Subjects bent toward one side with elbow and fingers straight and attached hand on the lateral side of their leg. The distance between the tip of the third finger and the floor was measured.

For assessing spinal rotation flexibility, the patient stood 100 cm away from the wall, facing it. The distance of the shoulder of the turning side from the wall was measured after trunk rotation. One hundred centimeters was subtracted from the last value (23).

2.4.4. Back pain-related disability

The Oswestry Disability Index (ODI) was developed to assess pain-related disability in people with LBP. The ODI, designed to assess the influence of LBP on activities of daily living and leisure functions, was shown to have a high degree of test–retest reliability and internal consistency. The ODI consisted of 10 sections covering aspects of daily living that might be affected by LBP. The items in each section were scored from 0 to 5. Scores range from 0 to 50, and higher scores indicated greater levels of functional difficulties (24). ODI was translated into the Turkish language and validated by Yakut et al. (25).

2.5. Statistical analyses

The Friedman variance analysis test was used for the statistical analyses of both groups within all parameters. Pairwise comparisons were then assessed by using the Wilcoxon signed-rank test for repeated measures data. The Mann–Whitney U test was used for the statistical

analyses of differences between groups before and at the end of treatment and control. A value <0.05 for P was considered statistically significant. The Statistical Package for the Social Sciences version 15.0 (SPSS 15.0) was used to perform statistical analyses.

3. Results

Demographic and clinical characteristics of the participants are presented in Table 1. There were no statistically significant differences in demographic and clinical parameters between the two groups at baseline. BMI was within normal limits for each group. Twelve (60%) subjects in Group 1 and nine (45%) subjects in Group 2 were right side amputated. All the participants were regarded as active prosthetic users, which was defined as using their prostheses more than 7 h per day and 7 days per week. None of the participants were actively involved in regular sports activities.

The assessment results of pain perception, spinal flexibility, and back pain-related disability are shown in Table 2 for Group 1 and Table 3 for Group 2. After 3 months, the decrease in pain perception, ODI scores, and the improvement in spinal flexibility were statistically significant in both groups ($P < 0.05$). Although these improvements were observed in all parameters in Group 1 after 1 month ($P < 0.05$), there was no significant difference between the initial evaluation and the evaluation after 1 month in Group 2 ($P > 0.05$).

Table 4 shows the comparison for pain perception, flexibility, and back pain-related disability between the two groups. At the initial evaluation, there was no significant difference between the two groups. After 1 month, flexibility of trunk lateral flexion to the right improved and pain perception and disability scores decreased significantly in Group 1 compared with Group 2 ($P < 0.05$). There was a significant reduction in Groups 1's VAS and ODI scores compared with Group 2's after 3 months. Moreover, after 3 months, there was a significant improvement in flexibility measurements of trunk flexion, lateral flexion, and rotation to the right in Group 1 compared with Group 2 ($P < 0.05$).

4. Discussion

The results of this study revealed that the back health education program had positive short-term effects on the parameters measured in TFAs. We were unable to find any previous studies published in English or Turkish examining the results of treatment of LBP in LLAs. Our study may also be important because it was the first study examining the changes in physical measures with exercise and rehabilitation programs within a BS program in LLAs with LBP.

The loss of flexibility, which is one of the most important components of physical fitness, causes stiffness, and mechanical and degenerative changes that may increase the incidence of MLBP (26). In a study in which an exercise program was given to 86 patients with chronic LBP, exercise program improved spinal flexibility (27). In our study, spinal flexibility improved in both groups. When the two groups were compared, the improvements in flexibility were in favor of Group 1. Only one study recommending activities to maintain trunk flexibility

Table 1. Demographic and clinical characteristics of the study population.

	Group 1 X ± SD	Group 2 X ± SD	P value
Age (years)	38.00 ±10.78	36.00 ± 10.34	0.529
Height (cm)	171.00 ± 5.23	172.00 ± 5.53	0.799
Weight (kg)	71.00 ± 9.68	73.00 ± 8.30	0.779
BMI (kg/m^2)	24.33 ± 2.97	24.83 ± 3.27	0.461
Years since amputation	16.35 ± 13.46	13.35 ± 9.96	0.602
Stump length (bone end) (cm)	27.00 ± 8.39	25.67 ± 8.90	0.989
Stump length (soft tissue end) (cm)	29.33 ± 7.48	27.31 ± 8.13	0.820

Group 1: Education group, patients who participated in the back school program. Group 2: Control group, patients who received booklets.
$P < 0.05$ was considered significant based on Mann–Whitney U test
BMI: Body mass index
X: mean
SD: standard deviation

Table 2. Assessment results of pain perception, spinal flexibility, and back pain-related disability in Group 1.

Group 1		Initial evaluation X ± SD	After 1 month X ± SD	After 3 months X ± SD	P values
Pain	VAS (mm)	70.65 ± 11.33	34.10 ± 13.00**	12.80 ± 8.31**	<0.001*
Flexibility	Trunk flexion (cm)	15.67 ± 7.60	19.73 ± 7.26**	22.30 ± 6.99**	<0.001*
	Trunk extension (cm)	11.63 ± 4.79	13.36 ± 5.23**	14,28 ± 5,02**	<0.001*
	Trunk lateral flexion to the right(cm)	17.52 ± 5.92	19.51 ± 5.49**	20.68 ± 5.55**	<0.001*
	Trunk lateral flexion to the left (cm)	16.53 ± 6.89	17.91 ± 6.51**	19.65 ± 6.62**	<0.001*
	Trunk rotation to the right (cm)	13.57 ± 5.96	14.00 ± 6.41**	16.19 ± 5.92**	<0.001*
	Trunk rotation to the left (cm)	13.45 ± 7.71	15.27 ± 7.42**	16.40 ± 7.27**	<0.001*
Disability	ODI score	14.35 ± 6.61	9.55 ± 4.65**	4.65 ± 3.61**	<0.001*

Group 1: Education group, patients who participated in the back school program.
*: P < 0.05 was considered significant based on Friedman test
**: measurement providing the difference based on Wilcoxon signed-rank test
X: Mean
SD: Standard deviation
VAS: Visual analogue scale
ODI: Oswestry Disability Index

Table 3. Assessment results of pain perception, spinal flexibility, and back pain-related disability of Group 2.

Group 1		Initial evaluation X ± SD	After 1 Month X ± SD	After 3 months X ± SD	P values
Pain	VAS (mm)	66.20 ± 17.12	52.80 ± 15.68	30.60 ± 10.93**	<0.001*
Flexibility	Trunk flexion (cm)	15.10 ± 9.23	15.45 ± 9.22	16.10 ± 9.32**	<0.001*
	Trunk extension (cm)	11.60 ± 7.54	12.32 ± 7.85	12.62 ± 8.02**	<0.001*
	Trunk lateral flexion to the right (cm)	17.10 ± 7.52	17.20 ± 7.35	17.95 ± 7.35**	0.002*
	Trunk lateral flexion to the left (cm)	16.12 ± 6.15	16.40 ± 5.89	16.50 ± 5.88**	0.019*
	Trunk rotation to the right (cm)	12.40 ± 5.70	12.65 ± 5.61	13.05 ± 5.83**	0.005*
	Trunk rotation to the left (cm)	12.75 ± 5.96	12.50 ± 5.94	13.22 ± 6.09**	<0.001*
Disability	ODI score	16.45 ± 8.63	14.85 ± 7.97	9.85 ± 5.39**	<0.001*

Group 2: Control group, patients who received booklets.
*: P < 0.05 was considered significant based on Friedman test
**: measurement providing the difference based on Wilcoxon signed-rank test
X: Mean
SD: Standard deviation
VAS: Visual analogue scale
ODI: Oswestry Disability Index

for the treatment of LBP in LLA population was found (10). There have been no studies in the current literature assessing flexibility as an outcome measurement of rehabilitation in LLAs with LBP with which we could have compared our study's results..

Back pain occurs commonly in people with lower-limb amputation and can cause chronic disability. Kulkarni et al. (5) found that 63% of subjects with amputation experienced moderate to severe back pain and 60% had back pain that commenced within 2 years after amputation.

Table 4. Comparison of the groups for pain perception, spinal flexibility, and back pain-related disability.

		Initial evaluation			After 1 month			After 3 months		
		Group 1 X ± SD	Group 2 X ± SD	P values	Group 1 X ± SD	Group 2 X ± SD	P values	Group 1 X ± SD	Group 2 X ± SD	P values
Pain	VAS (mm)	70.65 ± 11.33	66.20 ± 17.12	0.341	34.10 ± 13.00	52.80 ± 15.68	<0.001*	12.80 ± 8.31	30.60 ± 10.93	<0.001*
Flexibility	Trunk flexion (cm)	15.67 ± 7.60	15.10 ± 9.23	0.551	19.73 ± 7.26	15.45 ± 9.22	0.054	22.30 ± 6.99	16.10 ± 9.32	0.009*
	Trunk extension (cm)	11.63 ± 4.79	11.60 ± 7.54	0.512	13.36 ± 5.23	12.32 ± 7.85	0.211	14.28 ± 5.02	12.62 ± 8.02	0.108
	Trunk lateral flexion to the right (cm)	17.52 ± 5.92	17.10 ± 7.52	0.383	19.51 ± 5.49	17.20 ± 7.35	0.043*	20.68 ± 5.55	17.95 ± 7.35	0.046*
	Trunk lateral flexion to the left (cm)	16.53 ± 6.89	16.12 ± 6.15	0.925	17.91 ± 6.51	16.40 ± 5.89	0.369	19.65 ± 6.62	16.50 ± 5.88	0.108
	Trunk rotation to the right (cm)	13.57 ± 5.96	12.40 ± 5.70	0.369	14.00 ± 6.41	12.65 ± 5.61	0.277	16.19 ± 5.92	13.05 ± 5.83	0.010*
	Trunk rotation to the left (cm)	13.45 ± 7.71	12.75 ± 5.96	0.883	15.27 ± 7.42	12.50 ± 5.94	0.221	16.40 ± 7.27	13.22 ± 6.09	0.231
Disability	ODI score	14.35 ± 6.61	16.45 ± 8.63	0.547	9.55 ± 4.65	14.85 ± 7.97	0.030*	4.65 ± 3.61	9.85 ± 5.39	0.001*

Group 1: Education group, patients who participated in the back school program.
Group 2: Control group, patients who received booklets.
*: $P < 0.05$ was considered significant based on Mann–Whitney U test
X: Mean
SD: Standard deviation
VAS: Visual analogue scale
ODI: Oswestry Disability Index

Among these subjects, 9% reported constant back pain and 38% said that it interfered significantly with their lifestyle. Friel et al. (7) used ODI to investigate functional capacity in relation to perceived back pain in LLAs. They found significant differences in self-perceived functional limitations in people with LBP as compared with those without LBP. Our study's participants' ODI scores (Group 1: 14.35 ± 6.61, Group 2: 16.45 ± 8.63) were similar to the ODI scores of TFA amputees in Friel's study (TFA group: 17.25 ± 13.60) (7). However, these results were lower than the results of the nonamputee population with LBP. Hammarlund (28) found a significant association between back pain and disability in LLAs. In his study, it was reported that the majority of the participants' back pain related disability scores were mild, which is similar to our study's results (28). There was no study examining the relationship between the results of treatment of LBP and disability in LLAs.

In the treatment of LBP, various exercise programs have been used. In the study by Deyo (29), the patients who were given stretching and relaxation exercises for 4 weeks demonstrated significant decrease in the intensity of LBP when compared with patients who received only transcutaneous electrical nerve stimulation. Another study showed that strengthening exercise reduces the severity of back pain significantly (30).

Moffet (31) found that the group that was given the BS program experienced less pain, better functional capacity, and was more aware about exercising and back health compared with the group that only received an exercise program. Studies showed that varied BS education programs and exercise programs distinctly reduced pain (16). In our study, the booklets used as a guide for our participants had positive effects on LBP. However, the decrease in the intensity of LBP was more significant in Group 1 after the 1 and 3 months.

Our study's results have shown short-term positive effects on pain perception, flexibility, and back pain-related disability. These results were similar with the results of the study by Hodselmans (32), who also used back health education programs.

The major limitation of our study is that both the measurements and interventions were carried out by the same person (B.A.). Another limitation is that the participants consisted of only of men. Future research is needed to determine the long-term effects of back health education programs on posture, gait, functional capacity, physical fitness, psychological status, health related quality of life, and daily living activities in amputees.

Regular outpatient monitoring of rehabilitated amputees should be taken into consideration in order to maintain the data from the follow-up and to obtain the outcomes of the effects of the rehabilitation process on their lives.

A few studies have been carried out in the LLA population and these studies examined the frequency of and the reasons for LBP. To date, our study is the only comprehensive study that included the treatment of LBP. Long-term effects of this program should be examined in future studies among the amputee population. Back health education programs in multidisciplinary treatment of low back pain should be changed individually in terms of content, length, and educational approach according to the needs of amputees.

The results of our study indicated that back health education and exercise programs increased flexibility and improved back pain-related disability scores. In addition, this program decreased pain perception and muscle shortness.

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