Effectiveness of a 10-week training intervention with MBT for patients with hip disease

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Keywords: Hip Arthrosis, Hip-TEP, MBT, Coordination, Quality-of-Life, Strength, Mobility Training Intervention

I. Introduction

More and more people suffer from degenerative joint diseases, for example, arthrosis of the hip joint. Such symptoms lead to reduced mobility, difficulties with gait, steadiness and security while standing and last, but not least, a decrease in quality-of-life due to the occurrence of pain. Numerous therapies can alleviate pain associated with the abovementioned conditions and delay the need for an artificial joint. However, the patient who has already undergone an operation must come to terms with the above-mentioned problems. MBT assures alleviation for many of the conditions described. To what degree MBT actually fulfils this requirement should be investigated with an examination at the Department of Sports Medicine in Tuebingen. Various tests for mobility, coordination and strength endurance, as well as questionnaires to record pain and the health-related quality-of-life should answer this question.

II. Masai Barefoot Technology (MBT)

Masai Barefoot Technology is based on the Kenyan Masai people. They walk barefoot, take small steps, maintain an upright posture and are resilient while walking through fields, forests and meadows. Through this active walking, the muscles are exercised, the locomotive apparatus is strengthened, and the joints are protected.

The wearing of MBT shoes should also permit such a natural gait, even in an environment with hard and level surfaces. The European population increasingly suffers from lack of movement; work is often carried out in a way which leads to unbalanced stress on the body, for example: sitting or standing for long periods with monotonous movements. Accordingly, the musculature atrophies, posture worsens and, frequently, degenerative joint diseases result. This is where MBT could help. With its special sole construction, an uneven surface is simulated, which makes active walking by the wearer necessary. The MBT does not use any guiding elements; instead it has a soft heel cushion (1) and a rolling edge (T), over which the wearer must use a rolling foot motion. The foot musculature must therefore actively compensate for this instability. Walking with MBT is connected with a concept of posture. Along with an upright body posture while walking, a lifting and falling step should be eliminated. Many people take large steps when walking in normal shoes and do not actively absorb impact on the heel. While walking with the MBT, the step should be actively placed near the body's balance point. As a result, the step will be pulled farther back. This hip extension should be emphasized. Walking with the MBT must be learned; an adjustment of the traditional concept of walking is frequently necessary. Therefore the manufacturing firm, Swiss Masai, offers introductory presentations and training programmes for this, in which one is trained to use the MBT. The wearing of the MBT could have many benefits, according to the manufacturer. Thus the company's advertising slogan: With every step fitter, healthier, better looking, faster, stronger… The joints should be protected, pain alleviated, posture should improve and the musculature strengthened.

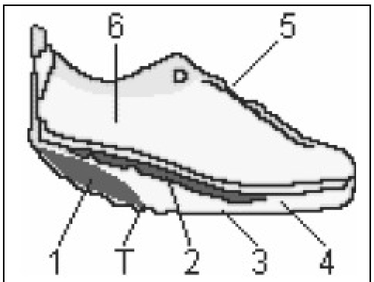


Fig. 1: MBT Construction

III. Objective of the Study

The advantages of the MBT which are mentioned by the manufacturer should be reviewed in the context of a study at the medical clinic, medical outpatient's clinic or department of sports medicine. The reason for this is the positive reports which had arisen from patients who were suffering from arthrosis of the hip, and who had worn MBTs.

The goal of the study was to verify the effect of a 10-week training intervention with MBT in terms of pain, quality-of-life, strength, balance and mobility.

IV. Study Design

Initial Investigation	**Measurement 1**	10 Weeks MBT-Training → Control Group →	Measurement 2
• Information	• Questionnaires	• Training Journal (MBT)	• Questionnaires
• Case History	• Coordination Tests	• Pain Journal (MBT and Control)	• Coordination Tests
• Clinic Signs • Resting ECG • Stress ECG	• Strength Test • Mobility Test • Walking Speed • **Randomisation**		• Strength Tests • Mobility Tests • Walking Speed

Figure 2: Research Design

In the **initial examination**, the participants were first informed of what the study involved, and could give their written consent to participate, or not. Subsequently, a case history and a clinical examination followed, in which, besides a resting echocardiogram, exercise stress on the treadmill was performed. On the treadmill, the participants had to maintain a speed of 5 km/h for three minutes. The incline of the treadmill was gradually increased to 2.5%. Cessation of exercise took place as soon as the participant was subjectively at his/her stress limit, i.e. discomfort, or pain occurred. During the stress test the stress was charted with an ECG. In the framework of the MBT training (endurance-oriented walking and running practise), it is required that an adequate physical resilience of the cardiovascular system is present, which necessitated such a criterion for acceptance in the programme. Those displaying existing, noticeable problems were excluded from the study and the recommendation for a physical examination was given.

On the **first day of testing** tests for the verification of static and dynamic balance security with walking, mobility and strength endurance were carried out. In addition, the participants were required to fill out a pain questionnaire (after Merle d'Aubergine) and a questionnaire for the health-related quality of life (SF36).

Finally, the participants were divided into random groups. While the training group in the 10 week period were required to participate in MBT training once a week, while also wearing MBTs at home during this time, no intervention was required for the control group. Pain and training were documented daily by the participants during this time, with the help of a journal.

Next, the training group was familiarized with the MBT. For this purpose various exercises were recommended by the company, Swiss Masai, (both every-day movements and sports exercises). The exercises with the MBT were combined, in part, with other aids from the training therapy. The programme was supplemented with endurance-oriented walking and running training.

On the **second day of testing**, the tests which were carried out on the first day of testing were repeated.

V. Sample

	MBT	CO	Total
Number	30	29	59
With prostheses	11	10	21
With arthrosis	19	19	38
Male	19	12	31
Female	11	17	28
Age	62.8	61.4	62.1

Table 1: Sample

Altogether 165 interested people applied to be included in the study. Out of these, 70 participants could participate. In the course of the investigation, 11 participants had to be excluded. The reasons for exclusion were due to operations, lack of compliance, reduced resiliency of the cardiovascular system, i.e. an additional training intervention over the course of the MBT programme. Regarding age, illness (arthrosis vs. total endoprothesis) and group membership participation (training vs. control) were the groups that were most balanced. Only with regard to the sexes did the groups show no homogeneity (Table 1).

In the following table the sample group for each particular method is shown. As a result of measuring technique problems, there was a significant decrease in the number of participants with the strength measuring platform and the Posturomed.

	MBT	KO	Total
Endurance	**25**	**25**	**50**
Mobility	**30**	**28**	**58**
Star Step	**30**	**29**	**59**
Speed	**29**	**27**	**56**
Posturomed	**17**	**15**	**32**
Strength measuring platform	**17**	**13**	**30**
Pain journal	**29**	**23**	**52**
SF 36	**30**	**29**	**59**

Table 2: Method Samples

VI. Survey of Methods

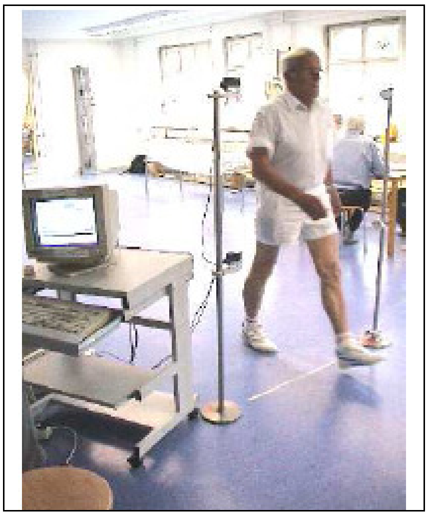
a. Strength Endurance Test

Procedure: The participants stand with one leg on a raised step (supporting leg). The free leg is lowered to the side without bending the supporting leg. The repetitions are counted to an allowed maximum of 100. With false execution or occurrence of pain, the test is terminated ahead of schedule.

Evaluation: Number of the repetitions

Figure 3: Strength endurance test

b. Gait Safety: 6 Metre: Speed chosen by participant



The walking speed is calculated with the help of light barriers over a distance of 6 metres.

Execution: The participant walks with a freely-chosen speed
(Instruction: uninterrupted speed). 3 repetitions.
Evaluation: The shortest time is considered for the evaluation.

Figure 4: Walking speed

c. Mobility

Execution: According to the Neutral-Null-Method, flexion of the hip joint is measured in °.

Extension ability of the ischiocrurale, the iliopsoas and the rectus femoris muscles are classified as follows:
- normal extension ability
- slight limitation of extension ability
- significant limitation of extension ability.

Figure 5: Hip Joint Flexion according to NN

d. Static Balance: Strength measuring platform

Execution: The participant must stand on the platform on one leg for 6 seconds. This is repeated 3 times for each side.

Evaluation: The median value is calculated from the x and y coordinates of the force points of all measuring times (30 Hz). This is defined as the 0-point in the coordinate system. Subsequently the distances of the single measurement points (resulting from the x and y direction) are added up, and divided by the total number of measured points of time. The median interval to the null point of the coordinate system is derived from this, and displayed in mm.

Figure 6: Strength measuring platform.

e. Static Balance: Posturomed

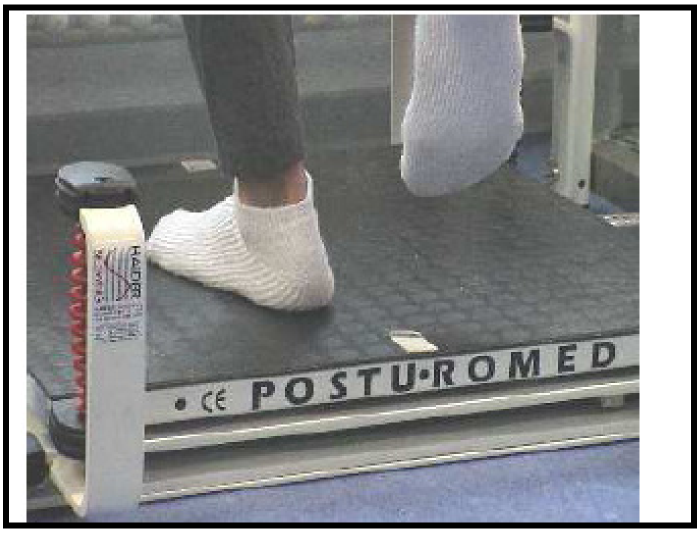


Figure 7: Posturomed

The Posturomed is a platform hanging from springs, which allows the platform to oscillate with the swinging motion of the participant. The participant should attempt to hold the platform as still as possible. The oscillations of the platform will be recorded as a path signal to start recording.

Execution: The participant will be asked to lift a leg. The path signal will record over a time period of 6 seconds. Subsequently a measurement is made, in which the participant performs a speed-step on the platform and should then hold the stand steady, standing on one leg. All measurements are performed three times on each side

Evaluation: The resulting distance obtained from the path signal in the x and y directions are summed up over each measured point-of-time and given as a total distance. Thereby the median value of successful attempts is included in the evaluation.

f. Dynamic Balance: The Star Step

Execution: Starting position: both legs in the middle field. Two clockwise turns beginning with the left leg, on tempo: left forward (left leg) – middle – right – forward (right leg) – middle – right back (right leg) – middle – left back (left leg) – middle. Time is up when both legs are back in the starting position. Each field has an area of about 40 cm. Each participant has a trial run and two test attempts.

Evaluation: The time is measured in seconds (1 decimal), which is required for two rounds. The better attempt is included in the evaluation.

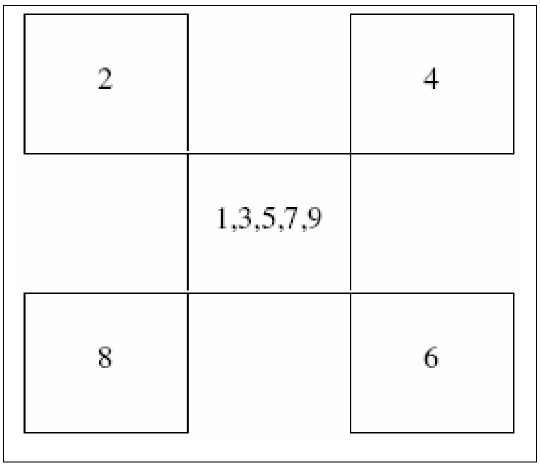


Figure 8: Execution of Star Step

g. Development of Pain

Execution: A pain questionnaire based on Merle d'Aubigné is filled out daily. This covers the categories of pain sensitivity, pain at night, pain with climbing stairs and pain in walking (Figure 10). 1 stands for no pain, 10 stands for maximum pain.

Evaluation: From the daily scores, weekly scores were added up (weekly average) and the course of pain over the training period was observed.

Pain Assessment

general pain sensitivity:

1	2	3	4	5	6	7	8	9	10

pain sensitivity in walking:

1	2	3	4	5	6	7	8	9	10

pain sensitivity when climbing stairs:

1	2	3	4	5	6	7	8	9	10

pain sensitivity at night:

1	2	3	4	5	6	7	8	9	10

Figure 10: Pain assessment

h. SF 36: Questionnaire for determining health-related quality-of-life

Execution: The participants mark the most applicable answer for each of the 36 questions.

Evaluation: The questionnaire which contains the categories of physical pain, physical functionality, general health, vitality, psychic sense of well-being and emotional role and social functionality, are then added to the named categories through a described evaluation routine. By transforming this information to a point system with a total value of 100 points, a sense of health is depicted. The higher the numerical value, the better the state of health is assessed. The questionnaire enables the comparison to a German norm group.

VII. Results and discussion

a. Strength endurance test

Result: Both groups were able to improve in the strength endurance test.

Discussion: The criteria for the termination of the test was difficult to control; the standardization of the test procedure is limited. An improvement is possible due to the training effect on the second day of testing due to the unfamiliar execution of movement. In the present study, it could not be proven that the MBT trains the abductor muscles of the hip. Admittedly, the problems with the test execution should be taken into account for the interpretation of the results.

b. Speed Chosen by participant

Result: Both groups showed an increase in speed on the second day of testing.

Discussion: Due to the training intervention, an increase in walking speed could be expected on the one hand, as an increase in gait safety could be reflected in the walking speed. On the other hand, a reduction of speed could also be an intepretation, since the wearing of MBT can lead to a shortening of stride and therefore to a reduced walking speed through change of gait. The results support neither of the two theories.

The changes of the walking speed are possibly too minor to be able to be detected with the methods described. The improvements in walking speed described in literature were shown with patients with recent operations. These start from a significantly lower level, and therefore have more room for improvement. Changes of walking speed through a changed gait are, likewise, currently too small to be displayed with the methods depicted.

c. Mobility test

Discussion: No systematic results could be demonstrated.

Result: The sample was too small for the depiction of systematic changes in the area of mobility. In both groups changes could be shown. These were, however, unsystematic. This can depend on the examination technique, which is oriented to three extension ability classes (normal, slight, significant). Above all, at the frontiers of the respective classes, it could, with another examination, produce a new distribution.

With a larger number of samples, the proportion of such divergent measurements would surely be smaller. In order to attain an improved extension ability of the musculature, regular training is necessary. The time period of observation was possibly too short for this purpose. The forced hip extension while walking with the MBT, which should lead to a decontraction of the iliopsoas and rectus femoris muscles, could thus not produce a visible improvement within our test sample.

d. Strength measuring platform

Result: While the training group improved, the control group showed no changes. Conspicuous was, above all, the diffusion of the data. On the first day of testing, the values in both groups ranged from about five to ten mm average deviation from the centre of the area. On the second day of testing, the training group showed themselves to be much more homogenous at a lower level, while the results for the control group did not change (Figure 11).

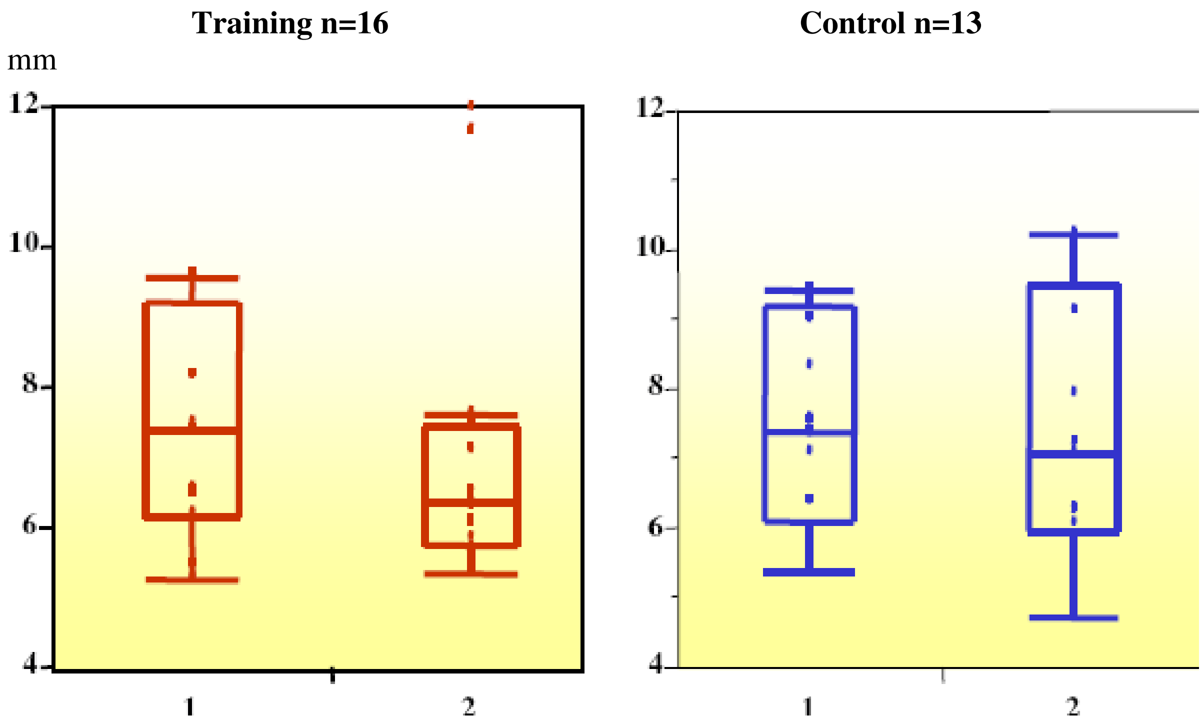


Figure 11: Results for strength measuring platform

e. Posturomed

Result: In the ‘stand on one leg’ exercise, the poor level of results attained in the training group was evident. The improvement here was all the more significant. On the second day of testing the training group in average achieved remarkably less distance with the Posturomed. The control group, however, confirmed their base level. The graphic depicted in Figure 13 denotes the changes of the two groups in relation to the median of the total group on the first day of testing.

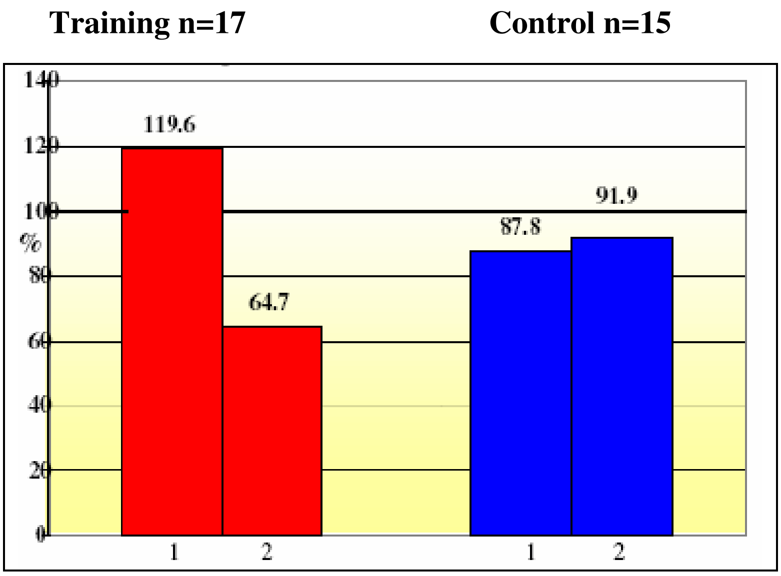


Figure 12: Results of Posturomed single-leg standing

Under the condition “warm-up step” a similar picture emerged. The training group started on a poor level, however, it improved beyond the level of the control group after the test phase. In the control group, on the other hand, the results showed only a small reduction of the path signal in comparison to the initial value (Figure 14).

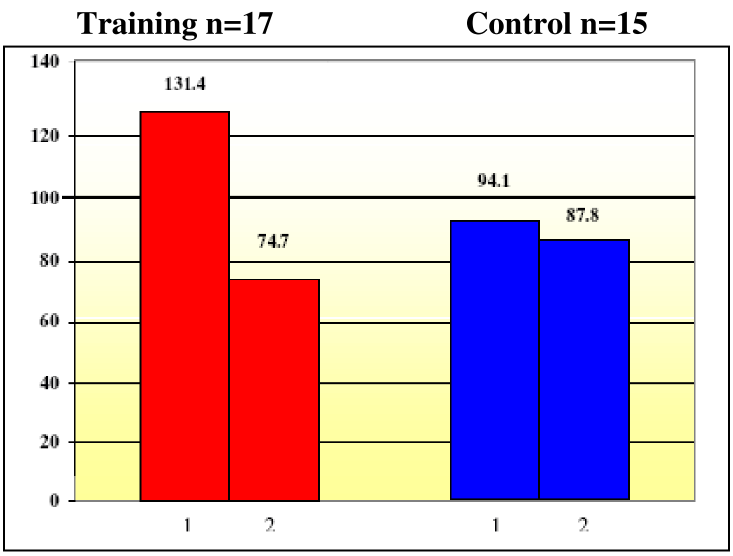


Figure 13: Results of Posturomed warm-up

f. Star Step

<u>Result:</u> With the Star Step, there was a decrease of time for the training group, which was necessary to complete the two rounds.

Discussion: In the interpretation of data, the strong scattering of measurements should be accounted for (Figure 15). In spite of positive developments in the training group, the results shown should not be overvalued, particularly because the control group also showed a slight improvement.

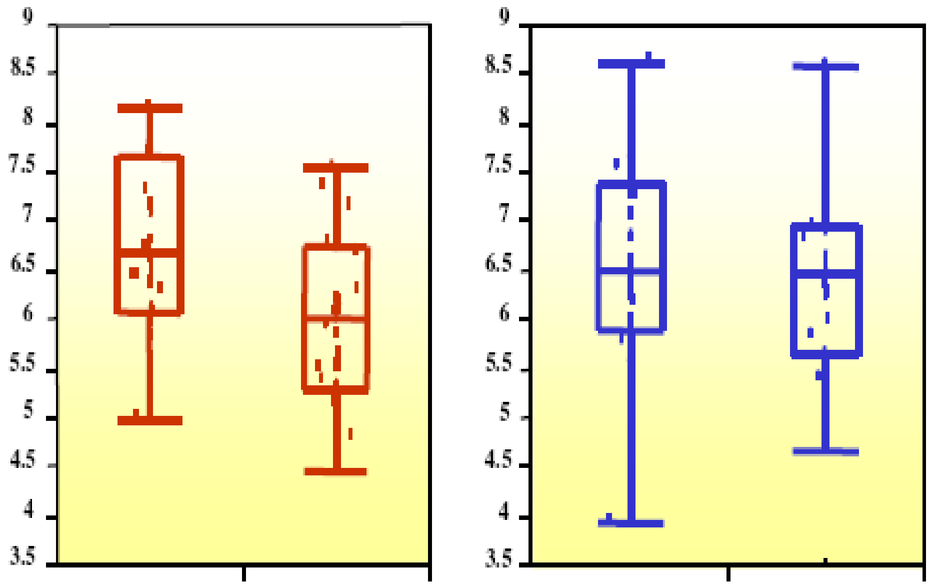


Figure 14: Results for Star Step

g. Development in pain

Result: In all areas the pain of the training group decreased. The values of the control group were, on the other hand, in the area of the basic level during the observation period.

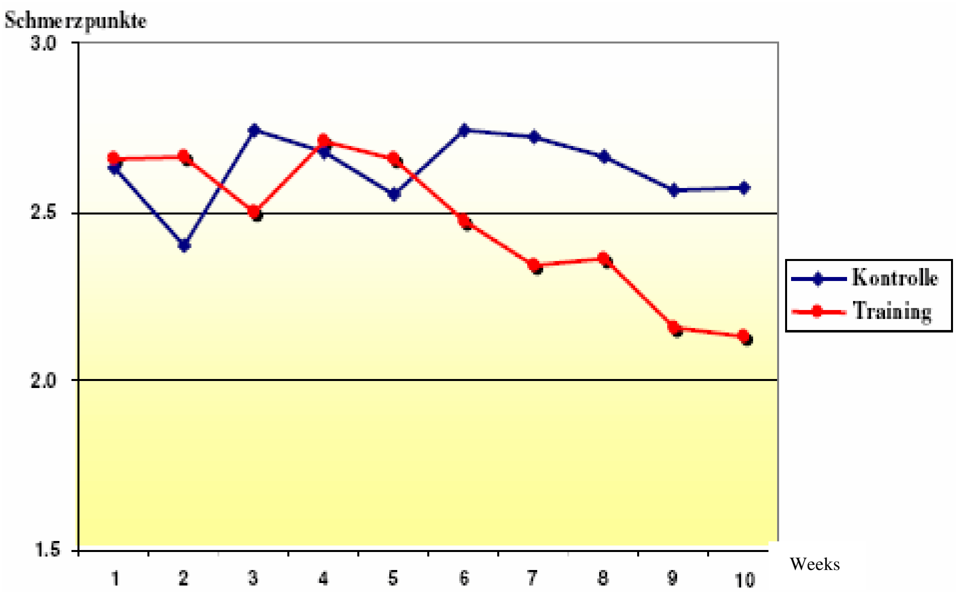


Figure 15: Development in pain – general

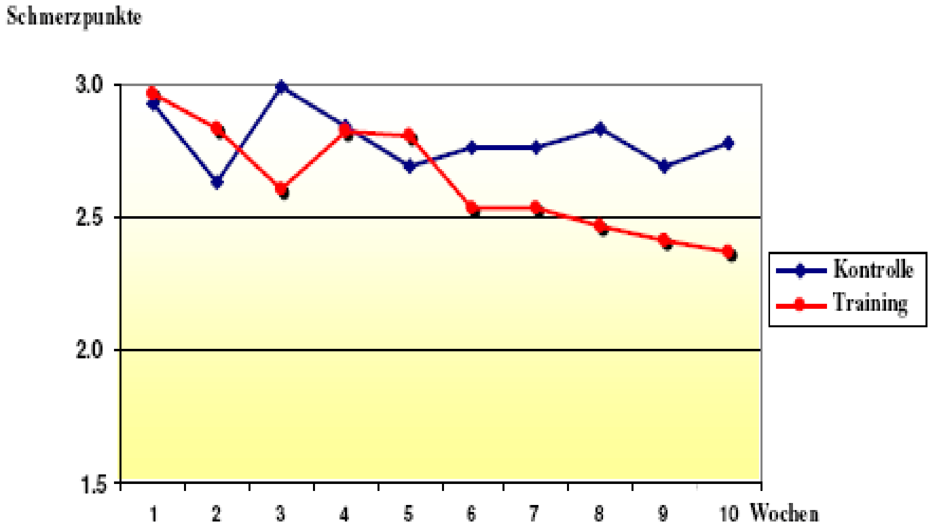


Figure 16: Development of pain in walking

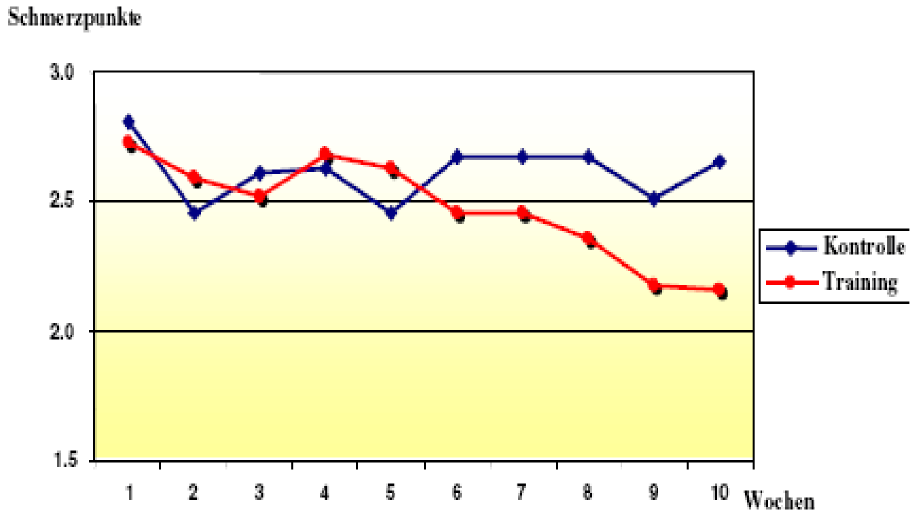


Figure 17: Development of pain in climbing stairs

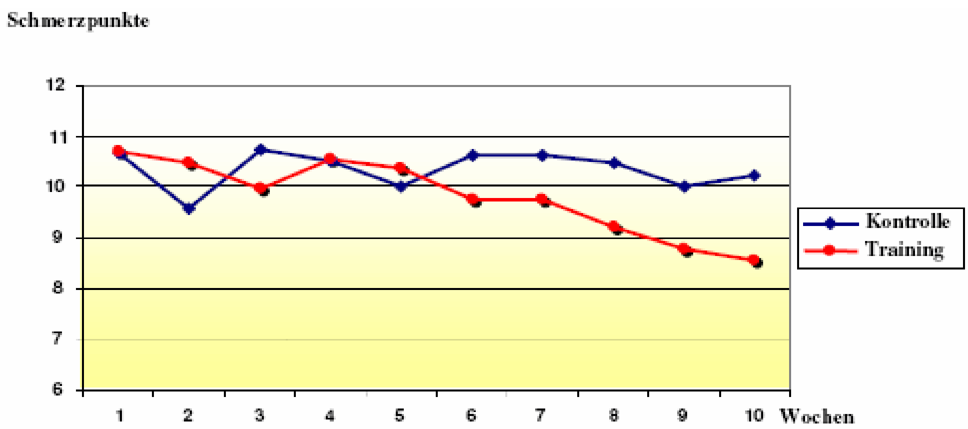
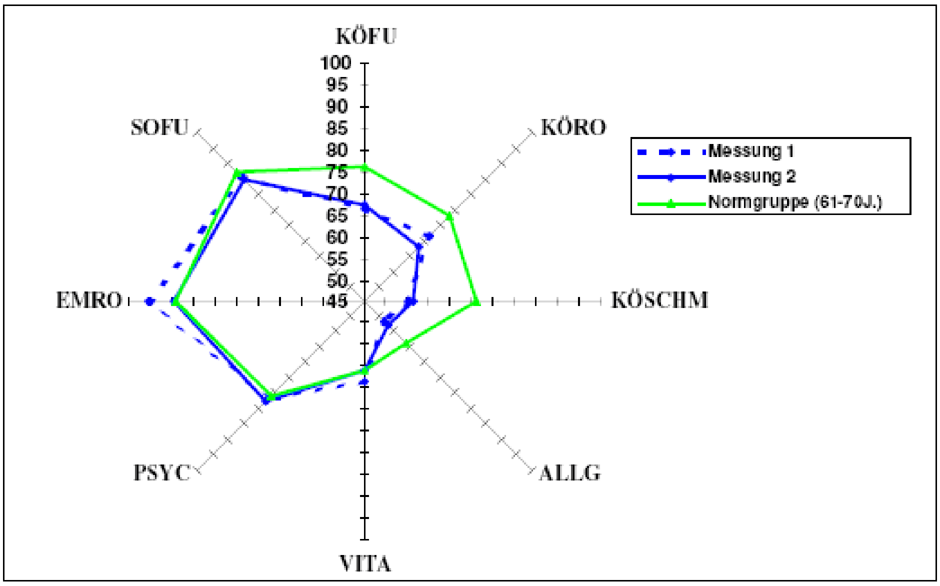


Figure 18: Development of pain in total

h. Health-related quality- of-life SF 46

<u>Result:</u> The training group could profit from the wearing of MBTs, particularly in the area of physical functionality, physical pain, vitality and the general state of health. Improvements emerged in all areas. The control group, on the other hand showed no changes. The graphic makes reference to the 61-70 year old, healthy, norm group from Germany.

KoFU	Physical functional ability
KoRO	Physical rolling function
KoSCHM	Physical pain
Allg	General health sensitivity
VITA	Vitality
PSYC	Psychic sense of well-being
EMRO	Emotional role function
SOFU	Social function ability



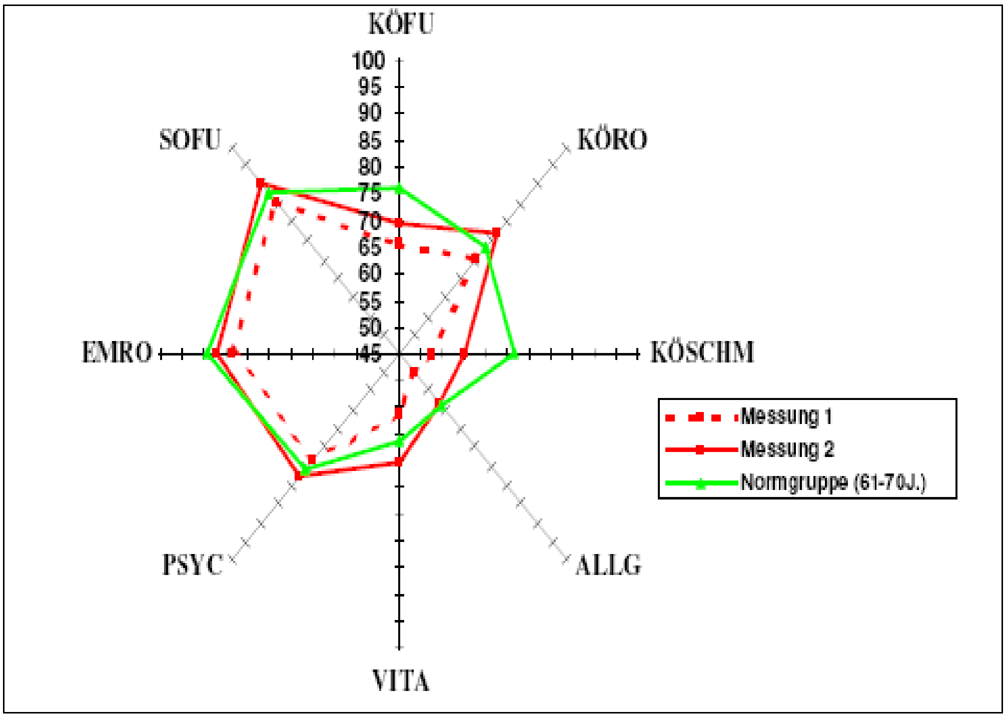


Figure 20: SF 36 Training Group

VIII Summary

While in the present study no improvement in strength, mobility and walking speed during a 10-week training intervention could be demonstrated, in the area of coordination abilities improvements were able to be achieved.

Additionally, pain was reduced in all areas of life for the training group; the health-related quality-of-life was furthermore able to be significantly improved.

The MBT seems to be able to support patients with arthrosis of the hip joint as well as those with artificial joints already implanted with their therapy. This relates particularly to coordination, the reduction of pain and an improved quality-of-life.