Praxisklinik Rennbahn AG

Orthopädie | Sportmedizin | Physiotherapie | Biomechanik

swiss olympic medical center

MBT as Therapeutic Shoe for Ankle Instabilities

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CONTENTS

1. INTRODUCTION

Today's management of ankle injuries is primarily conservative (6). It involves the use of various ankle orthoses, stabilising shoes and bandages (3, 10, 11, 12, 13). The range of orthoses extends from soft bandages to so-called semi-rigid orthoses and stabilising shoes to rigid stabilising aids (10, 12, 13). The most important intended effect of the orthoses is, of course, the mechanical limitation of the various ranges of movement (11, 14), which dominates the healing phase of the ligaments. Thus, in various products different restrictions of movement are the main goal, both with regard to the various directions movements (opening-up of the ankle joint, pronation, supination, flexion/extension of the ankle joint) and regarding the extent of the restrictions (4, 14). At the same time, physiotherapeutic measures are taken which subsequently shift from the completion of the healing phase of the ligaments to focus specifically on the training of the muscles.

Despite these measures, approximately 20% of the ankle joints remain instable, which is then referred to as a chronic instability. In chronic instabilities with associated symptoms, in principle, an intensive physiotherapeutic treatment is again carried out, which aims at compensating for the partially lost stabilising effect of the ligaments by a specific training of the muscles surrounding the ankle (peroneus muscles, tibialis posterior muscle/flexors of the toes, triceps surae muscle, tibialis anterior muscle). In sports, external stabilising aids are typically used at the same time to reduce the danger of renewed supination traumas. The effect of these external stabilising aids is either proprioceptive (soft orthoses; 4, 10, 15), or stronger stabilising (semi-rigid orthoses). However, the disadvantage of stronger stabilisation is that due to the intended restriction of movement on the one hand, sporting activity can only be performed to a limited extent, while on the other hand the stabilising muscles are relieved, which is counterproductive in the long run.

Consequently, top priority in the treatment of chronic ankle instability is given to the optimum strengthening of the muscles surrounding the ankle joint -- initially in physiotherapeutic sessions, later in daily training -- so that the malfunction of the ligaments can be dynamically compensated and the ankle joints can be functionally re-stabilised (2, 6, 11).

Various studies have shown that MBT has great potential as a training device for the musculature, especially in the region of the lower extremities (1, 5, 7, 8, 9). In addition, there is the advantage that it can be worn every day for several hours. It is thus possible to train the corresponding musculature without having to invest in additional therapy or training time. The question arises of whether the MBT can be usefully integrated in physiotherapeutic treatment and in the following training program with diagnosed chronic ankle instabilities and thus obtains a better efficiency in primary treatment. To answer this question, the existing standardised performed therapy should be compared with the MBT therapy.

The aim of the present study is to investigate whether the subsequent functional treatment of patients with chronic ankle instabilities using MBT has a better, equal or worse outcome in comparison to the existing therapy, which has been carried out to date at the Praxisklinik Rennbahn.

2. METHOD

2.1 General concept of the study

In order to study the functional effectiveness of two different therapies, a sample of 30 voluntary patients was selected. These subjects had a diagnosed chronic ankle instability with corresponding symptoms, and were therefore receiving physiotherapeutic treatment as prescribed by their doctors. The clinical assessment was performed by a doctor (approximately 15 min.). It included initially an accurate diagnosis, later the clinical evaluation of the functional ankle stability, based upon the AOFAS-Hindfoot-Score and the examination scheme of the Praxisklinik Rennbahn. The sample was randomised for gender, age and sporting activity and divided into one active treatment group (15 subjects with MBT) and into one control group (15 subjects with conventionally therapy and without MBT).

Both groups received 9 sessions of physiotherapeutic treatment, each having the same duration, for approximately four weeks. In the active treatment group, the MBT was integrated into the physiotherapeutic treatment. This means that all therapeutic exercises were performed with the MBT. Immediately before starting the therapy, the subjects of the active treatment group received professional instructions on how to use the MBT in everyday life by staff of the company AMANN.ch AG Orthopädie-Schuhtechnik, Basel, Switzerland. During the therapy phase, the subjects of the active treatment group could gradually begin wearing the MBT in their normal everyday life as well. The control group carried out the therapeutic exercises conventionally (without MBT) on a soft surface or on the soft therapy mat.

After the four-week long physiotherapeutic treatment block, the active treatment group had to wear the MBT during three months, as often as possible, in everyday life. The control group had, likewise over a period of three months, to carry out the established therapeutic exercises independently at home every day (home programme). This conforms to the routinely-performed procedure at the Praxisklinik Rennbahn.

The subjects of both groups were examined as to biomechanical/functional parameters immediately before the physiotherapeutic treatment, immediately after completion of the nine therapeutic sessions, and three months after completion of the therapeutic measure; in this way, the functional stability of the ankle joints could be objectively quantified.

2.2 Physiotherapy

The following exercises were carried out by the subjects of both groups during the nine physiotherapy sessions (in the active treatment group with the MBT, in the control group with the mat):

3-point load on the foot (= basic exercise)

- Pressure underneath the great toe/little toe/lateral heel (foot is "twisted ")
- Knee and ankle joint axis are vertically aligned
- Longitudinal arch of the foot raised
- Starting position:
    - Seated
    - Seated-standing transition
- Variation of the support area: hard - soft
- **This foot load applies to all further exercises!**

Stabilised one-legged stance

- 3-point foot load
- Leg axis: foot/knee/hip vertically aligned
- Mirror control
- Support area: hard (floor)
- Variation:
    - Unsupported leg movements. (lateral, forwards-backwards etc.)
    - Arm movements (lateral, forwards-backwards)

One-legged stance on soft surface

- Same exercise as above but on soft supporting area
  - e.g. folded bath towel

Lunges

- Step position
- Injured side forward
- Foot- and leg axis control (mirror)
- Static: hold step position
  - vary flexion position
- Dynamic: 90° knee flexion, then returning to starting position

"The flyer"

- 3-point foot load (foot raised)
- Leg axis: foot/knee/hip stance Vertically aligned
- Pelvis stabilisation: pelvis reference points should remain horizontal (not tilted towards unsupported leg)
- Body longitudinal axis should remain stable, pointed slightly forwards
- Static exercise: hold position (vary knee position)
- Mobilising version: move from flexed-knee position to extended-knee position

Figure 1:
Physiotherapeutic exercises which were performed during therapy by the control group. The active treatment group performed the same exercises with the MBT instead of the soft mat.

2.3 Biomechanical Quantification

2.3.1 Maximum force test inversion/eversion, flexion/extension

Quantification of functional stability is based on measuring the maximum strength of the muscles surrounding the ankle joint. Therefore, the maximum torques which the subjects were able to produce at an isokinetic machine (Cybex), both in flexion/extension and in inversion/eversion of the foot, were measured. The torques were measured with a limitation of the angular velocity to 30°/s. The mean of 5 test runs was used as the parameter. The test set-up is depicted in figures 2 and 3.

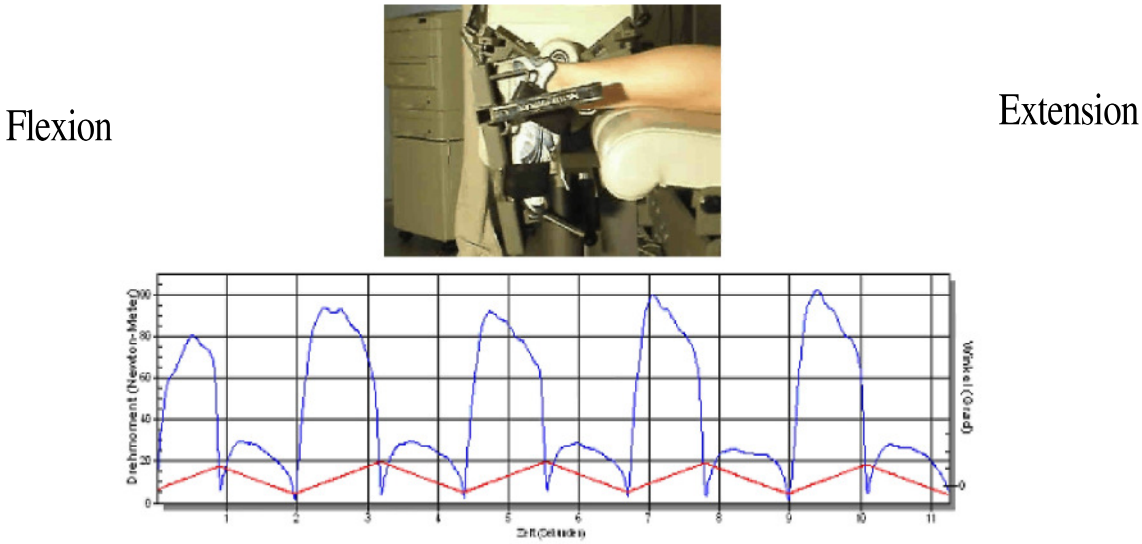


Figure 2:
Test set-up for measuring the maximum torques in flexion and extension of the foot.
[time (hours); ankle (degree)]

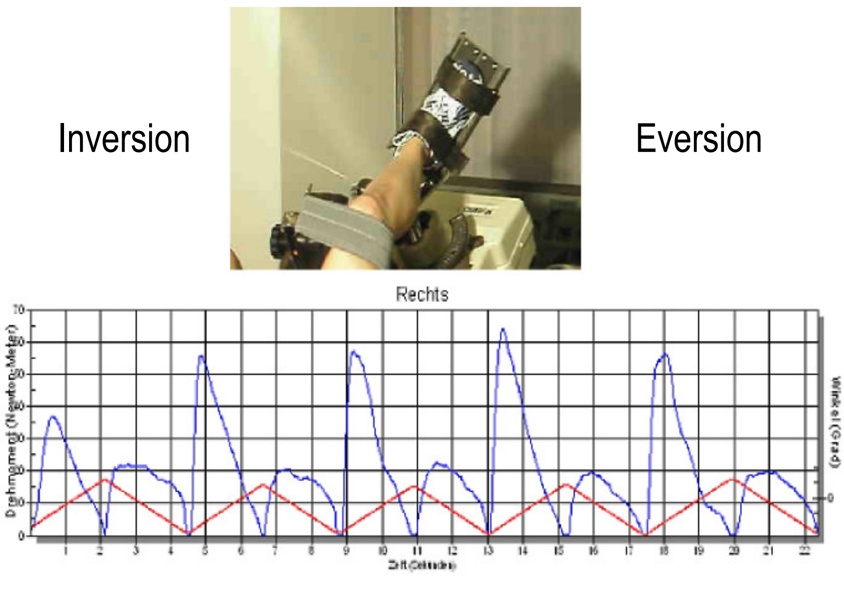


Figure 3:
Test set-up for measuring the maximum torques in inversion and eversion of the foot.

The following parameters were analysed:

1. Average maximum torque during flexion (muscles of the calf)
2. Average maximum torque during extension (tibialis anterior muscle)
3. Average maximum torque during inversion (tibialis posterior muscle and flexors of the toes)
4. Average maximum torque during eversion (peroneus longus and brevis)

2.3.2 Stabilometry

Based on the results of earlier studies (Kälin et al, 1992), it could be expected that the fluctuations of the centres of pressure in one-legged stance (stabilometry) would show different results depending on the training condition of the muscles. Therefore, this test method was selected for this study as well. The subjects had to stand in one-leg stand on the measuring plate of the FootScan hybrid system for one minute. During this period, the fluctuations of the centre of force were measured at six subsequent 10-second-intervals (measuring frequency: 60 Hz). The measurement set-up is depicted in figure 4.

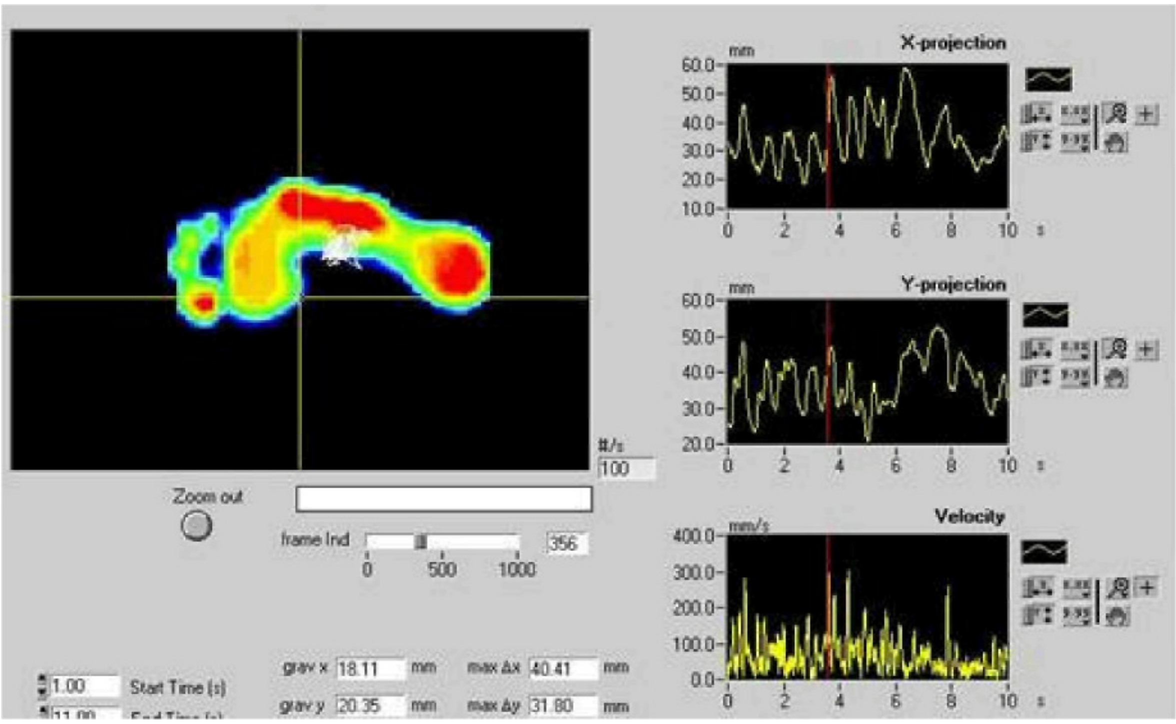


Figure 4:
Stabilometry measurement on hard surface.

For each of the 6 intervals, the following parameters per measurement were determined (median of the 6 intervals). As parameter for this measurement, the median of the 6 ellipse areas measured was used.

1. Average area of the ellipse covering 50% of the fluctuations of the centre of pressure.
2. Average maximum fluctuation of the centre of pressure along the forward-backward axis.
3. Average maximum fluctuation of the centre of pressure along the mediolateral axis.
4. Average total distance of fluctuations of the centre of pressure.

2.3.3 Pressure distribution while walking barefoot on a hard surface

Because of the different muscular activities of the foot/lower-leg muscles to be expected before and after the therapy, it could also be assumed that the pressure distribution measurement while walking on a hard surface would lead to a different plantar pressure distribution during ground contact. Therefore, plantar pressure distribution while walking barefoot was measured in all subjects using the FootScan hybrid system (figure 5).

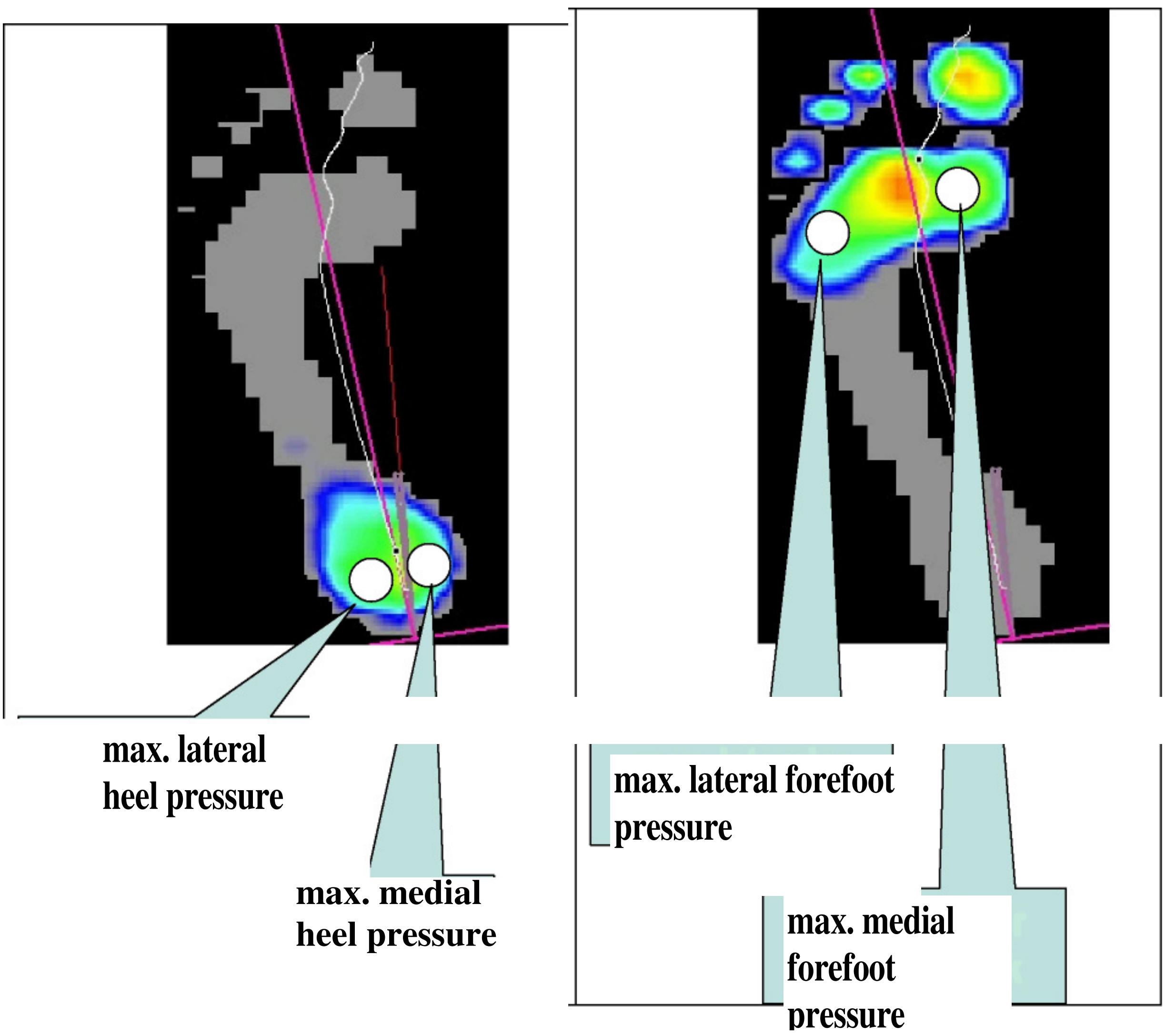


Figure 5:
Test set-up for walking on a hard surface.
[max. lateral heel pressure; max. medial heal pressure; max. lateral forefoot pressure; max. medial forefoot pressure]

Because of the expected different muscular activities – especially of the peroneus muscles and the tibialis posterior muscles / toe flexors – it could be assumed that especially the mediolateral pressure distribution would show differences. Therefore, the following parameters were determined from this measurement (central value/median of three valid attempts):

1. Pressure ratio heel lateral/heel medial (pressure zones)
2. Pressure ratio forefoot lateral/forefoot medial (pressure zones)

2.3.4 Kinematics while walking barefoot on a soft surface

Because of the diagnosis “ankle instability“, which led to constantly recurring sprains, it could be assumed that the ankle joint movements, especially pronation/supination movements while walking on an insecure/soft surface, would be uncontrolled and thus would show a wider range of motion than in a healthy person. Therefore, it could also be expected that with increasing success of the therapy, the range of motion of pronation and supination, respectively, would also decrease. Hence, a kinematic analysis (2-D, recording frequency 150 Hz) of the subjects from behind was carried out. For technical reasons, the subjects did not walk on a soft foam mat while the measurements were taken, but were provided with a sock which had 4-cm-high, very soft foam on the lower surface. In this way, the subjects virtually walked on insecure, instable soles, simulating the soft walking surface (figure 6).

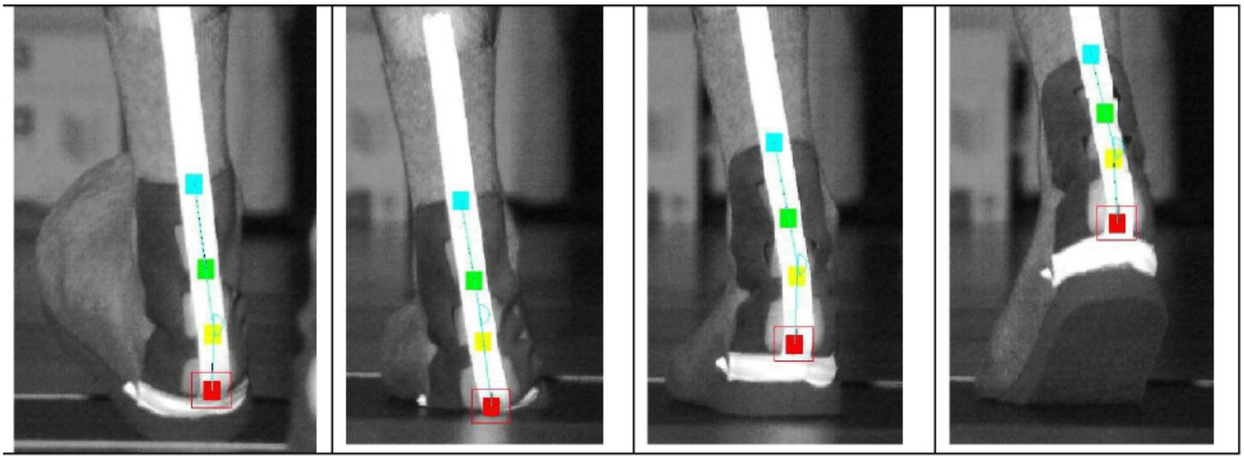


Figure 6:
Test set-up kinematics while walking on a “soft surface”

Three valid attempts were analysed each time. As parameters per measurement, each time the central values (medians) of three valid attempts were calculated. The following parameters were analysed:

1. ROM pronation (Achilles tendon angle, difference between the first image before ground contact and the maximum pronation position, see image 3)

2. ROM supination (Achilles tendon angle, difference between the first image before ground contact and the maximum supination position, see image 2)

2.3.5 Hypotheses

To answer the question of whether MBT can be usefully integrated into physiotherapeutic management of chronic ankle instabilities, and whether the therapeutic success with MBT is eventually superior to that without MBT, the following working hypotheses should serve as the point of departure:

1. The basis for the therapeutic success is the increase in strength and coordination ability of the lower-leg and foot muscles. Thus, it was expected that the increase in strength in the lower extremities, especially in the muscles of the calf, the tibialis posterior muscles and the flexors of the toes, as well as the peroneus muscles, after therapy with MBT would be greater than with conventional therapy (both immediately after the therapy (time of measurement 2) and also three months after the end of the physiotherapeutic sessions (time of measurement 3).

2. Because of the efficient development of strength with MBT, it could also be expected that at the same measurement times, the active treatment group (with MBT) would show less fluctuations of the centres of pressure (COP) in stabilometry compared to the control group.

3. Furthermore, it was expected that the active treatment group would show – due to the strengthened lower-leg and foot muscles (stirrup muscles) – a different ratio between the medial and lateral maximum pressure while walking on a hard surface, both under the heel and under the forefoot.

4. And finally, it could be expected that the active treatment group compared to the control group would also show - because of the improved muscle work – lower movement fluctuations in pronation (ROM) and in supination (ROM).

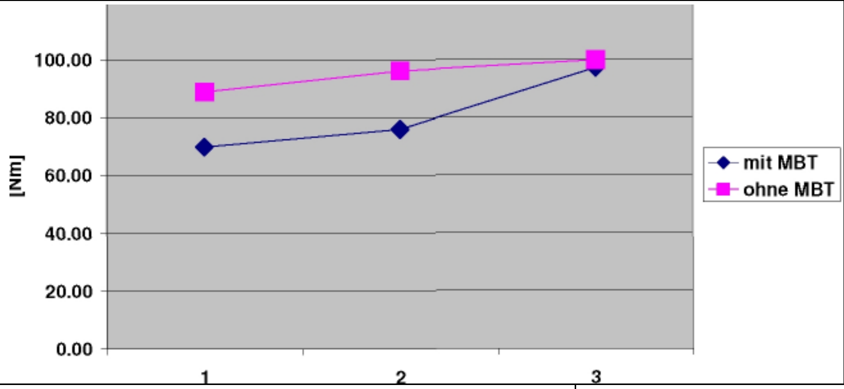
2.3.6 Statistics

In principle, the experimental design allows for two types of comparisons: on the one hand, the improvement in the parameters due to the therapy within the control group and within the active treatment group respectively could be studied (what progress was made because of the therapy). This type of question is a comparison of three independent samples (three different times of measurement). Therefore, the Friedman test (non-parametric test for comparatively low numbers of subjects) was used for analysis.

On the other hand, however, it was possible to directly compare the active treatment group (with MBT) and the control group (without MBT) at the respective times of measurement. The design of the study enables a direct comparison of two independent samples with a comparatively low number of subjects. Therefore, a non-parametric test was used here as well. For this reason, these questions were analysed with the Mann-Whitney U test. For both statistical tests, the significance level was set to be 5%

3. RESULTS 3.1 Results at maximum strength of flexors

Maximum strength of foot flexion



Friedman Test Flexion without MBT

Ranks

	Mean Rank
M_flex_1	1.75
M_flex_2	2.11
M_flex_3	2,14

Test Statistics (a)

N	14
Chi Sqare	1.432
Df	2
Asymp.Sig	.491

a Friemann Test

Friedman Test Flexion with MBT

Ranks

	Mean Rank
M_flex_1	1.69
M_flex_2	1.69
M_flex_2	2.63

Test Statistics (a)

N	16
Chi Sqare	9.375
Df	2
Asymp.Sig	.009

a Friedman Test

Mann-Whitney Text Flexion
Ranks

	MBT	N	Mean Rank	Sum of Ranks
M_flex_1	No	14	17.86	250.00
	Yes	16	13.44	215.00
	Total	30		
M_flex_2	No	14	18.11	253.50
	Yes	16	13.22	211.50
	Total	30		
M_flex_3	No	14	16.46	230.50
	Yes	16	14.66	234.50
	Total	30		

Mann-Whitney Test Flexion
Test Statisics (b)

	m flex 1	m flex 2	m flex 3
Mann Whitney U	79.000	75.500	98.500
Wilcoxon W	215.000	211500	234.500
Z	-1.373	-1.519	-.561
Asymp.Sig (2-tailed)	.170	.129	.575
Exact Sig. [2*(1-tailed Sig.)]	.179 (a)	.131 (a)	.580 (a)

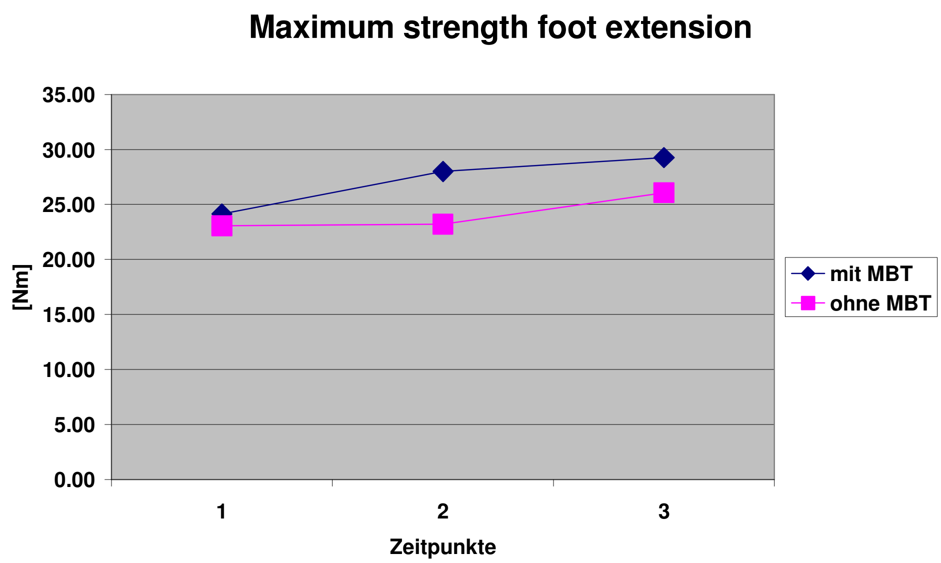
a Not corrected for ties. B Grouping Variable: mbt

Figure 7: Results of maximum strength test of the foot flexors.

The results of the maximum strength of the foot flexors are depicted in figure 7. They show that the baseline maximum strength value was on average higher in the control group at the start of the study (torque 89 Nm) compared to the active treatment group (torque 70 Nm). However, the difference was not significant. The increase in strength in the first four weeks of physiotherapy was comparatively small, both in the active treatment group and in the control group, and not significant. Nevertheless, in the subsequent phase of the home programmes, the active treatment group and the control group behaved differently. While the control group was not able to significantly improve their strengths with the home programme ($p = 0.491$, Friedman test, figure 7), the increase in strength three months after the end of therapy brought about by wearing the MBT was significant ($p = 0.009$, Friedman test, figure 7). At the end of the study period, both groups had reached the same level of strength and achieved a maximum torque of 100 Nm. Thus, in the phase of physiotherapy, no differences between the active treatment group and the control group could be measured.

However, intensive wearing of the MBT had led to a significantly greater increase in strength of the foot flexors (mainly triceps surae muscle) compared to the conventional home programme in the three months after physiotherapy.

3.2 Results at maximum strength of extensors



Friedman Test Extension without MBT

Ranks

	Mean Rank
m_ext_1	1.96
m_ext_2	1.46
m_ext_3	2.57

Test Statistics(a)

N	14
Chi-Square	9.269
df	2
Asymp. Sig.	.010

a Friedman Test

Friedman Test Extension with MBT

Ranks

	Mean Rank
m_ext_1	1.59
m_ext_2	2.00
m_ext_3	2.41

Test Statistics(a)

N	16
Chi-Square	5.828
df	2
Asymp. Sig.	.054

a Friedman Test

Mann-Whitney Test Extension

Ranks

	mbt	N	Mean Rank	Sum of Ranks
m_ext_1	No	14	15.64	219.00
	Yes	16	15.38	246.00
	Total	30		
m_ext_2	No	14	14.04	196.50
	Yes	16	16.78	268.50
	Total	30		
m_ext_3	No	14	13.50	189.00
	Yes	16	17.25	276.00
	Total	30		

Test Statistics(b)

	m_ext_1	m_ext_2	m_ext_3
Mann-Whitney U	110.000	91.500	84.000
Wilcoxon W	246.000	196.500	189.000
Z	-.083	-.855	-1.170
Asymp. Sig. (2-tailed)	.934	.392	.242
Exact Sig. [2*(1-tailed Sig.)]	.951(a)	.400(a)	.257(a)

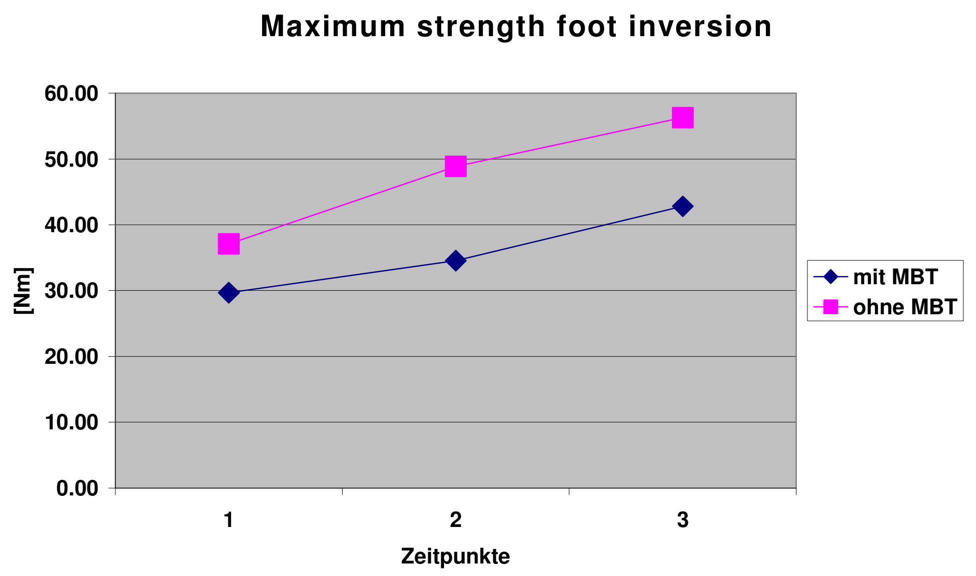
a Not corrected for ties.
b Grouping Variable: mbt

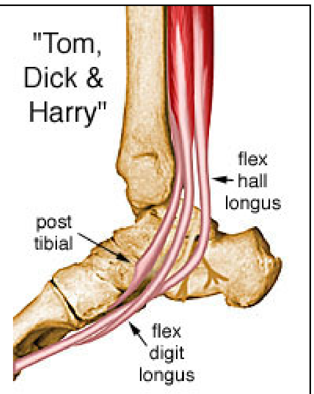
Figure 8: Results of maximum strength test of the foot extensors.

The results of the maximum strengths of the foot extensors are depicted in figure 8. The baseline values of the active treatment group and the control group were only slightly different, and this difference was not significant (mean torque active treatment group: 24 Nm, mean torque control group: 23 Nm). In the course of the therapy and of the home programme, the maximum strength of foot extensors were significantly increased, both in the active treatment group and in the control group (Friedman test: active treatment group: $p = 0.05$, CG: $p = 0.01$). However, no significant differences were found between the active treatment group and the control group at any of the times at which measurements were carried out.

This means that wearing the MBT had no significant effect on the course of therapy with regard to the maximum strength of the foot extensors.

3.3 Results at maximum strength of invertors





Friedman Test Inversion without MBT

Ranks

	Mean Rank
m_inv_1	1.29
m_inv_2	2.21
m_inv_3	2.50

Test Statistics(a)

N	14
Chi-Square	11.286
df	2
Asymp. Sig.	.004

a Friedman Test

Friedman Test Inversion with MBT

Ranks

	Mean Rank
m_inv_1	1.47
m_inv_2	1.94
m_inv_3	2.59

Test Statistics(a)

N	16
Chi-Square	10.548
df	2
Asymp. Sig.	.005

a Friedman Test

Mann-Whitney Test Inversion

Ranks

	mbt	N	Mean Rank	Sum of Ranks
m_inv_1	No	14	17.39	243.50
	Yes	16	13.84	221.50
	Total	30		
m_inv_2	No	14	18.36	257.00
	Yes	16	13.00	208.00
	Total	30		
m_inv_3	No	14	18.86	264.00
	Yes	16	12.56	201.00
	Total	30		

Test Statistics(b)

	m_inv_1	m_inv_2	m_inv_3
Mann-Whitney U	85.500	72.000	65.000
Wilcoxon W	221.500	208.000	201.000
Z	-1.104	-1.664	-1.955
Asymp. Sig. (2-tailed)	.270	.096	.051
Exact Sig. [2*(1-tailed Sig.)]	.275(a)	.101(a)	.052(a)

a Not corrected for ties.
b Grouping Variable: mbt

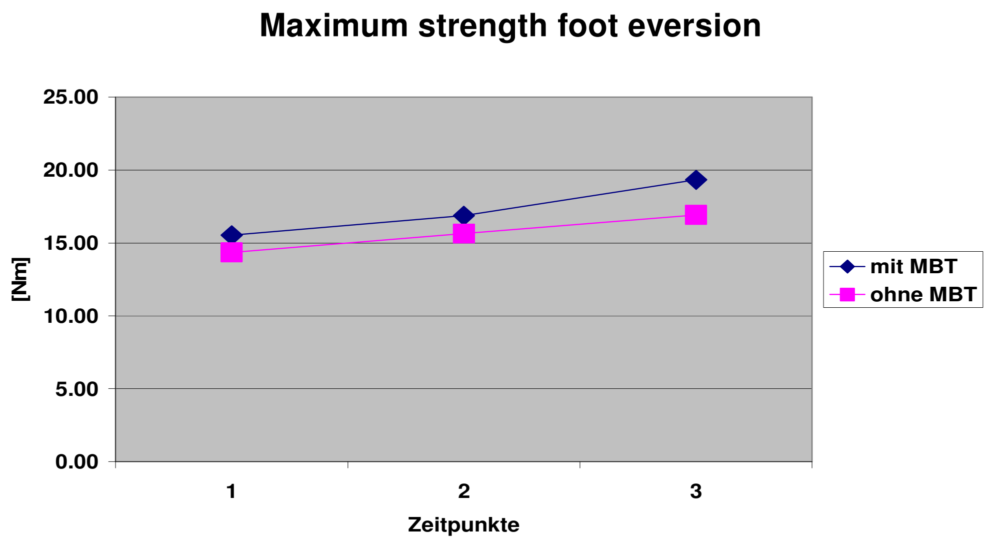
Figure 9:Results of maximum strength tests of the foot invertors.

The results of the maximum strength of the foot invertors are depicted in figure 9. They show that there was a marked, although not statistically significant, difference with regard to the mean baseline values, between the active treatment group and the control group already at the start of the study (on average 30 Nm and 37 Nm, respectively). The control group showed higher strength levels. Both groups were able to increase the maximum strength of the foot invertors significantly to 43 Nm and 56 Nm, respectively, during the physiotherapy phase and the subsequent months (Friedman test: ATG: $p = 0.005$, CG: $p = 0.004$). The increase in the control group, however, was slightly higher than in the active treatment group in the end; therefore, the Mann-Whitney test even showed in direct comparison a significant difference in favour of the control group ($p = 0.05$).

Altogether, this means that MBT had no significantly greater effect on the increase in maximum strength of the invertors than the conventional therapy or the subsequent conventional training.

3.4 Results at maximum strength of evertors

The results of the maximum strength of the evertors are depicted in figure 10.



Friedman Test Eversion without MBT

Ranks

	Mean Rank
m_ever_1	1.68
m_ever_2	1.89
m_ever_3	2.43

Test Statistics(a)

N	14
Chi-Square	4.333
df	2
Asymp. Sig.	.115

a Friedman Test

Friedman Test Eversion with MBT

Ranks

	Mean Rank
m_ever_1	1.66
m_ever_2	1.88
m_ever_3	2.47

Test Statistics(a)

N	16
Chi-Square	5.839
df	2
Asymp. Sig.	.054

a Friedman Test

Man-Whitnev Test Eversion

Ranks

	mbt	N	Mean Rank	Sum of Ranks
m_ever_1	Nein	14	14.57	204.00
	Ja	16	16.31	261.00
	Total	30		
m_ever_2	Nein	14	14.71	206.00
	Ja	16	16.19	259.00
	Total	30		
m_ever_3	Nein	14	11.71	164.00
	Ja	16	18.81	301.00
	Total	30		

Test Statistics(b)

	m_ever_1	m_ever_2	m_ever_3
Mann-Whitney U	99.000	101.000	59.000
Wilcoxon W	204.000	206.000	164.000
Z	-.543	-.458	-2.214
Asymp. Sig. (2-tailed)	.587	.647	.027
Exact Sig. [2*(1-tailed Sig.)]	.608(a)	.667(a)	.028(a)

a Not corrected for ties.
b Grouping Variable: mbt

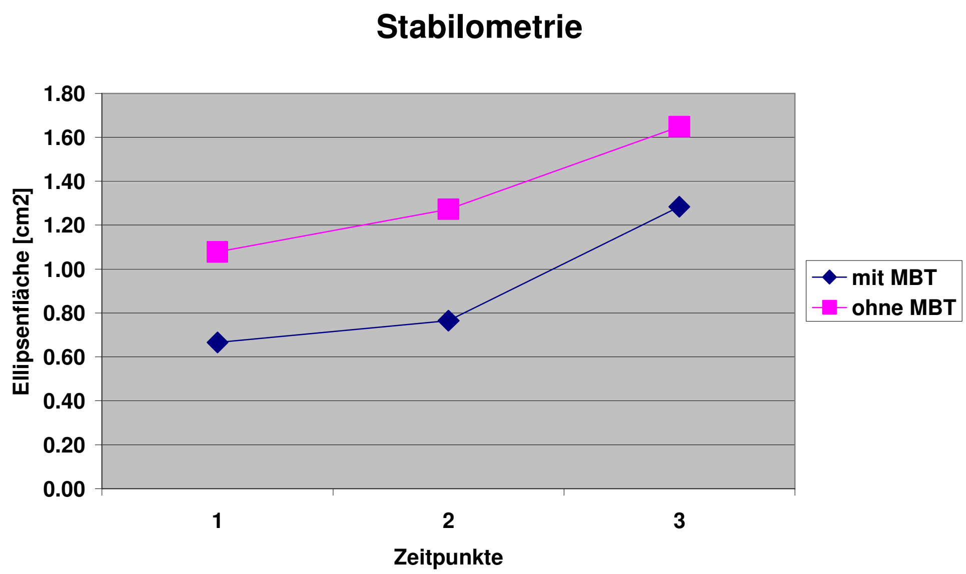
Figure 10: Results of the maximum strength tests of the foot evertors.

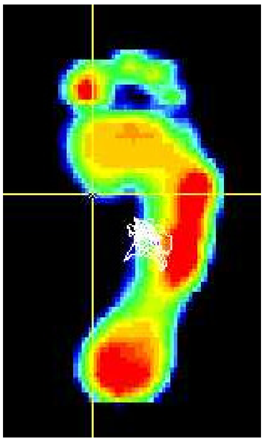
The results of the foot evertors show that both in the active treatment group and in the control group the maximum strength of the peroneal muscles prior to the start of therapy had virtually the same baseline value (approx. 15 Nm) and that no significant differences could be demonstrated. However, the Friedman test showed that no significant increase in strength was measured in the control group (increase of mean to 16.9 Nm, $p = 0.12$), while the same statistical test showed a significant increase in strength in the active treatment group at the end of the study period (increase of mean in the active treatment group to 19.3 Nm, $p = 0.05$).

A direct comparison between the two groups again reveals that prior to physiotherapy ($p = 0.61$) and immediately after it ($p = 0.67$) no significant differences were measured, while three months after discontinuing the physiotherapeutic intervention the active treatment group with MBT had a significantly greater strength in the peroneal muscles compared to the control group ($p = 0.28$). This means that that until the end of physiotherapy, there had only been a mild increase in strength in both groups which did not significantly differ, and that consequently both therapies had the same success.

By wearing MBT intensively, the active treatment group showed a significantly greater increase in strength compared to the control group, three months after the end of the physiotherapeutic intervention. This shows that the long-term therapeutic success with MBT regarding the training of the peroneal muscles was significantly greater.

3.5 Results of Stabilometry





Friedman Test Ellipsenfläche without MBT

Ranks

	Mean Rank
ellipse1	2.00
ellipse2	2.14
ellipse3	1.86

Test Statistics(a)

N	14
Chi-Square	.571
df	2
Asymp. Sig.	.751

a Friedman Test

Friedman Test Ellipsenfläche with MBT

Ranks

	Mean Rank
ellipse1	1.84
ellipse2	1.75
ellipse3	2.41

Test Statistics(a)

N	16
Chi-Square	4.095
df	2
Asymp. Sig.	.129

a Friedman Test

Man-Whitney Test Eversion

Ranks

	mbt	N	Mean Rank	Sum of Ranks
ellipse1	No	14	17.32	242.50
	Yes	16	13.91	222.50
	Total	30		
ellipse2	No	14	18.36	257.00
	Yes	16	13.00	208.00
	Total	30		
ellipse3	No	14	14.71	206.00
	Yes	16	16.19	259.00
	Total	30		

Test Statistics(b)

	ellipse1	ellipse2	ellipse3
Mann-Whitney U	86.500	72.000	101.000
Wilcoxon W	222.500	208.000	206.000
Z	-1.060	-1.664	-.457
Asymp. Sig. (2-tailed)	.289	.096	.647
Exact Sig. [2*(1-tailed Sig.)]	.294(a)	.101(a)	.667(a)

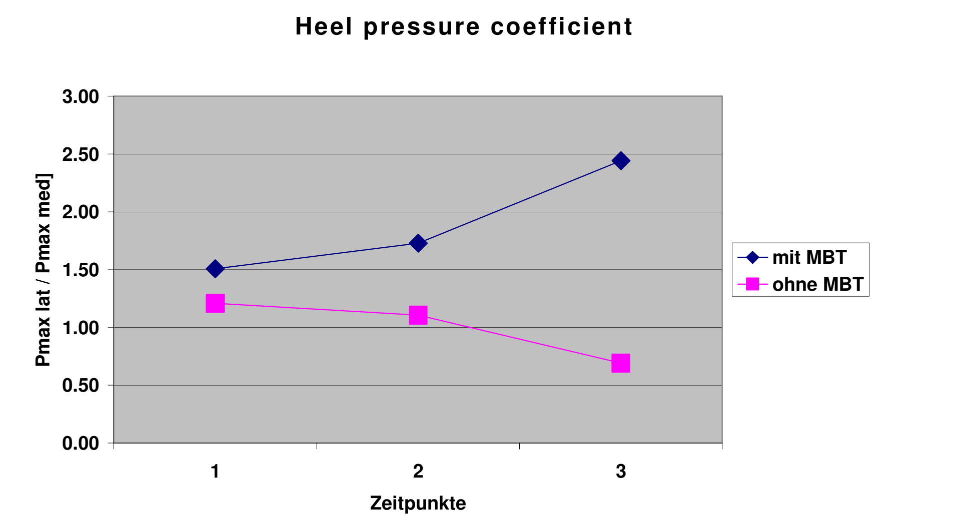
a Not corrected for ties.
b Grouping Variable: mbt

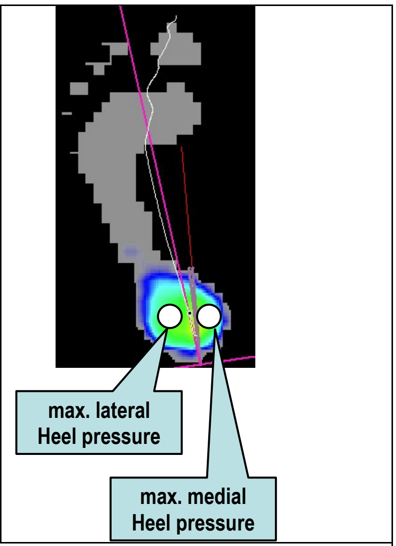
Figure 11: Stabilometry results.

The results of the stabilometry (area of the ellipse) are depicted in figure 11.The graphic representation gives the impression that with increasing duration of therapy, the area of the ellipse slightly increased; however, neither the Friedman test nor the Mann-Whitney test revealed any significant differences. This means that the magnitude of individual scattering of the stability measurements interfered with possible differences to such an extent that results which could be reasonably interpreted were obscured. The same result was also found for all other stabilometry parameters. Therefore, these parameters are not presented separately in the present report.

3.6

Results of the mediolateral heel pressure distribution





Friedman Test Heel pressure coefficient without MBT

Ranks

	Mean Rank
P_F_QU_1	2.57
P_F_QU_2	2.21
P_F_QU_3	1.21

Test Statistics(a)

N	14
Chi-Square	13.857
df	2
Asymp. Sig.	.001

a Friedman Test

Friedman Test Heel pressure coefficient with MBT

Ranks

	Mean Rank
P_F_QU_1	1.94
P_F_QU_2	1.75
P_F_QU_3	2.31

Test Statistics(a)

N	16
Chi-Square	2.625
df	2
Asymp. Sig.	.269

a Friedman Test

Man-Whitney Test Heel Pressure Coefficient

Ranks

	mbt	N	Mean Rank	Sum of Ranks
P_F_QU_1	No	14	14.57	204.00
	Yes	16	16.31	261.00
	Total	30		
P_F_QU_2	No	14	13.36	187.00
	Yes	16	17.38	278.00
	Total	30		
P_F_QU_3	No	14	10.00	140.00
	Yes	16	20.31	325.00
	Total	30		

Test Statistics(b)

	P_F_QU_1	P_F_QU_2	P_F_QU_3
Mann-Whitney U	99.000	82.000	35.000
Wilcoxon W	204.000	187.000	140.000
Z	-.540	-1.247	-3.201
Asymp. Sig. (2-tailed)	.589	.212	.001
Exact Sig. [2*(1-tailed Sig.)]	.608(a)	.224(a)	.001(a)

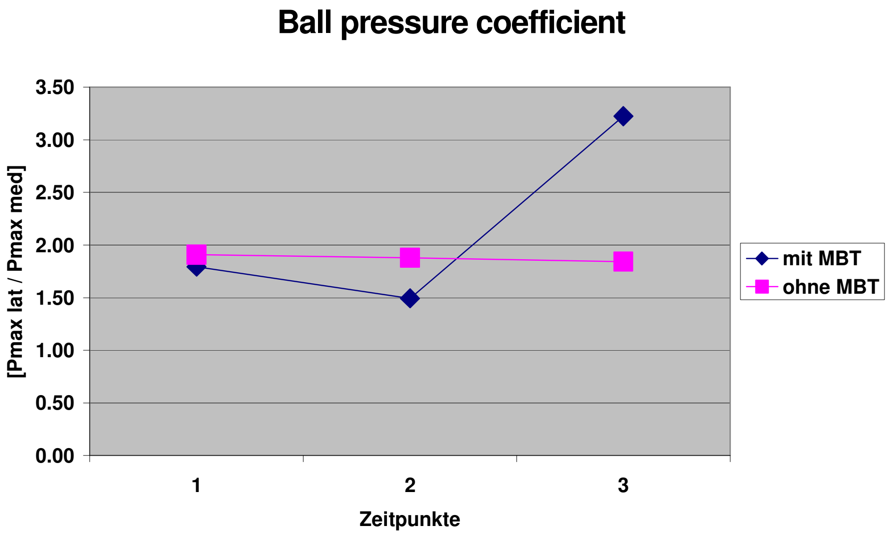
a Not corrected for ties.
b Grouping Variable: mbt

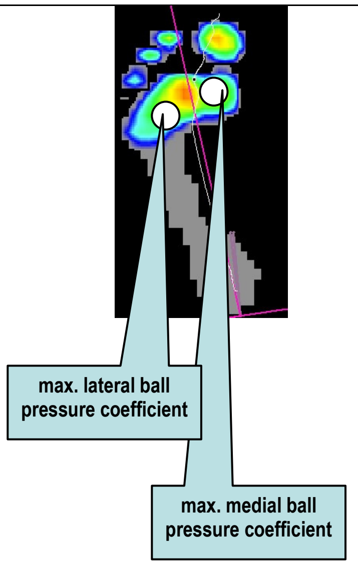
Figure 12:
Results of the mediolateral pressure distribution under the heel.

The results of the heel pressure coefficient are depicted in figure 12. In the course of the therapy of the control group, a statistically significant decrease of the heel coefficient from 1.21 to 0.69 (deterioration of the situation) was found (Friedman test, $p = 0.01$). Primarily, this finding is associated with the increase in strength of the tibialis posterior muscles. In contrast, the heel pressure coefficient increased from 1.51 to 2.44 in the active treatment group; however, this increase was not statistically significant.

The direct comparison between the active treatment group and the control group showed that the baseline values prior to the start of physiotherapy only differed insignificantly, by 1.04 (active treatment group) and 1.21 (control group) ($p = 0.61$). This still applied for the situation immediately after the physiotherapeutic intervention. Three months after the therapy, however, the difference between the pressure coefficient of the active treatment group and that of the control group was significant (Mann-Whitney test, $p = 0.01$). This can be traced back to the fact that the values in the active treatment group increased slightly, while they significantly dropped in the control group at the same time.
Altogether, this means that at the end of the study period – three months after the end of the physiotherapeutic intervention – the active treatment group using MBT had significantly increased the load in the medial heel region in the brake phase, while the mediolateral pressure distribution remained unchanged in the control group.

3.7 Results of the mediolateral ball of the foot pressure distribution





Friedman Test Ball Pressure-Coefficient without MBT

Ranks

	Mean Rank
P_B_QU_1	2.21
P_B_QU_2	1.93
P_B_QU_3	1.86

Test Statistics(a)

N	14
Chi-Square	1.000
df	2
Asymp. Sig.	.607

a Friedman Test

Friedman Test Ball Pressure-Coefficient with MBT

Ranks

	Mean Rank
P_B_QU_1	1.81
P_B_QU_2	1.50
P_B_QU_3	2.69

Test Statistics(a)

N	16
Chi-Square	12.125
df	2
Asymp. Sig.	.002

a Friedman Test

Man-Whitney Test Ball Pressure Coefficient

Ranks

	mbt	N	Mean Rank	Sum of Ranks
P_B_QU_1	No	14	17.00	238.00
	Yes	16	14.19	227.00
	Total	30		
P_B_QU_2	No	14	16.50	231.00
	Yes	16	14.63	234.00
	Total	30		
P_B_QU_3	No	14	13.00	182.00
	Yes	16	17.69	283.00
	Total	30		

Test Statistics(b)

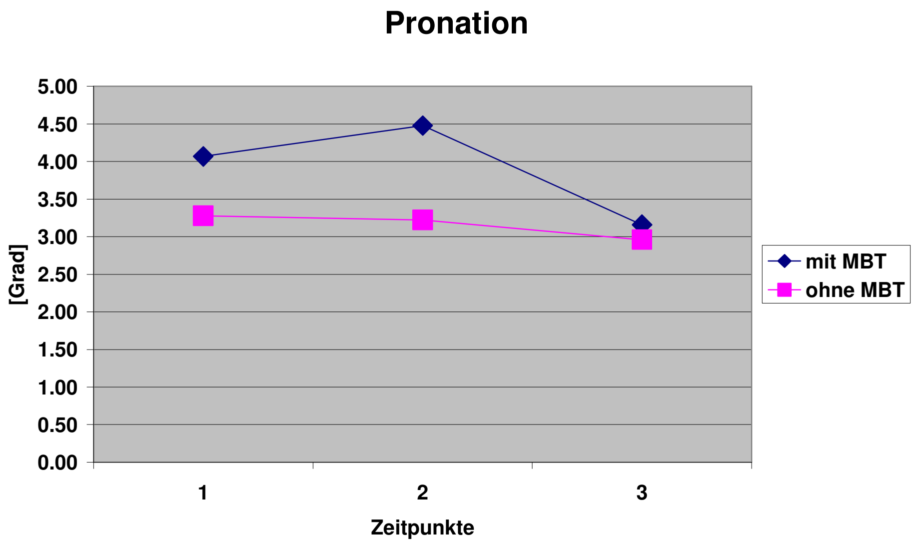
	P_B_QU_1	P_B_QU_2	P_B_QU_3
Mann-Whitney U	91.000	98.000	77.000
Wilcoxon W	227.000	234.000	182.000
Z	-.873	-.582	-1.455
Asymp. Sig. (2-tailed)	.383	.561	.146
Exact Sig. [2*(1-tailed Sig.)]	.400(a)	.580(a)	.154(a)

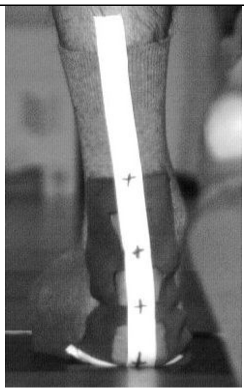
a Not corrected for ties.
b Grouping Variable: mbt

Figure 13: Results of the mediolateral ball of the foot pressure distribution

The results of the ball of the foot pressure coefficient are depicted in figure 13. A trend similar to that for the heel pressure coefficient was found. This time, only the increase of the medial ball pressure from 1.79 to 3.22 in the active treatment group with MBT was significant (Friedman test, $p = 0.002$). Because at the same time the medial heel pressure of the control group had not decreased (mean baseline value 1.91, mean end value 1.88), no significant difference was found in the direct comparison at the time three month after physiotherapy (Mann-Whitney, $p = 0.15$).
This means that the active treatment group at the end of the study period has pushed off markedly stronger with the medial forefoot, while the pushing-off on the forefoot remained unchanged in the control group.

3.8 Results of pronation





Friedman Test Pronation without MBT

Ranks

	Mean Rank
rom_p1	2.07
rom_p2	2.21
rom_p3	1.71

Test Statistics(a)

N	14
Chi-Square	1.857
df	2
Asymp. Sig.	.395

a Friedman Test

Friedman Test Pronation with MBT

Ranks

	Mean Rank
rom_p1	1.81
rom_p2	2.56
rom_p3	1.63

Test Statistics(a)

N	16
Chi-Square	7.875
df	2
Asymp. Sig.	.019

a Friedman Test

Man-Whitney Test Pronation

Ranks

	mbt	N	Mean Rank	Sum of Ranks
rom_p1	No	14	14.21	199.00
	Yes	16	16.63	266.00
	Total	30		
rom_p2	No	14	11.93	167.00
	Yes	16	18.63	298.00
	Total	30		
rom_p3	No	14	15.21	213.00
	Yes	16	15.75	252.00
	Total	30		

Test Statistics(b)

	rom_p1	rom_p2	rom_p3
Mann-Whitney U	94.000	62.000	108.000
Wilcoxon W	199.000	167.000	213.000
Z	-.748	-2.079	-.166
Asymp. Sig. (2-tailed)	.454	.038	.868
Exact Sig. [2*(1-tailed Sig.)]	.473(a)	.038(a)	.886(a)

a Not corrected for ties.
b Grouping Variable: mbt

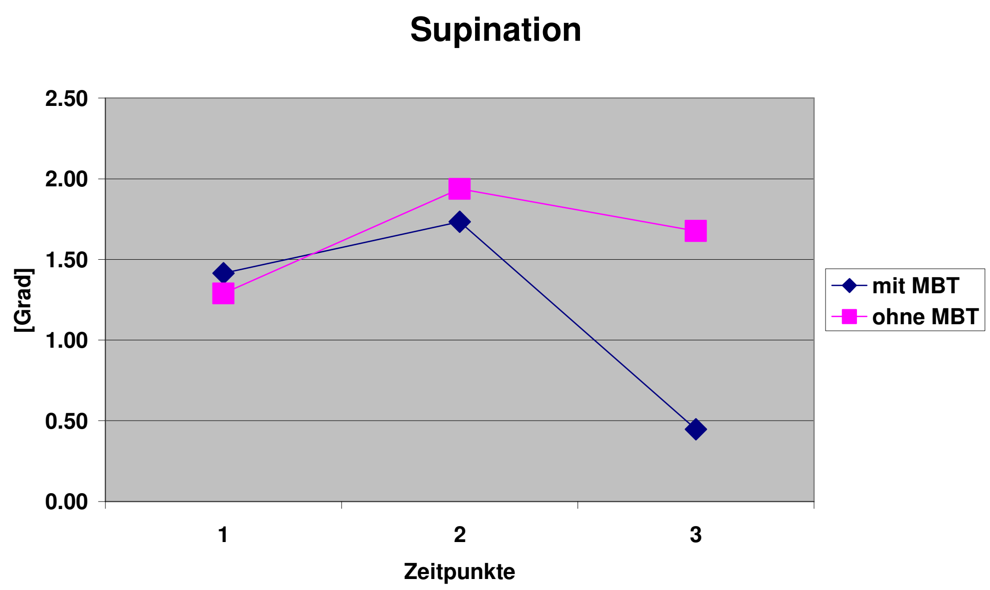
Figure 14: Results of pronation (kinematics).

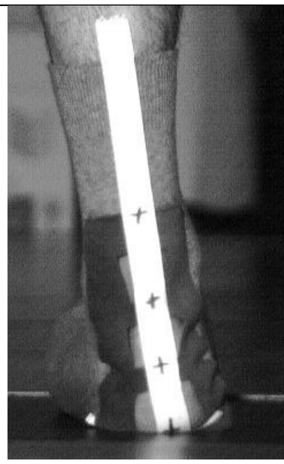
The results of the pronation movement (ROM) are depicted in figure 14. The baseline values of the pronation movement differed at the beginning of the study. The active treatment group with MBT showed a mean pronation angle change of 4.07º, while in the control group the mean pronation angle change was 3.28º. However, the differences were not significant (Mann-Whitney, $p = 0.45$). Immediately after the physiotherapeutic intervention, pronation with MBT even showed a mild increase, so that the difference between control and active treatment group became significant (Mann-Whitney, $p = 0.04$). Yet three moths later, the active treatment group had dramatically lowered the mean pronation angle change to 3.16º, while in the control group only a slight reduction to 2.96º was found so that at the end of the study period a significant difference was no longer measured between the two groups.

The Friedman test showed that the pronation angle change in the active treatment group with MBT at end of the study period was significantly lower, compared to the baseline and immediately after physiotherapy ($p = 0.02$), while the pronation angle change in the control group showed no statistically significant difference across the entire study period ($p = 0.40$).

Altogether, this means that wearing MBT in the three months after physiotherapy resulted in a significant reduction of the pronation movement, while the conventional training did not bring about any further improvement.

3.9 Results of supination





Friedman Test Supination without MBT

Ranks

	Mean Rank
rom_s1	1.64
rom_s2	2.29
rom_s3	2.07

Test Statistics(a)

N	14
Chi-Square	3.000
df	2
Asymp. Sig.	.223

a Friedman Test

Friedman Test Supination with MBT

Ranks

	Mean Rank
rom_s1	2.09
rom_s2	2.63
rom_s3	1.28

Test Statistics(a)

N	16
Chi-Square	14.889
df	2
Asymp. Sig.	.001

a Friedman Test

Man-Whitney Test Supination

Ranks

	mbt	N	Mean Rank	Sum of Ranks
rom_s1	No	14	14.68	205.50
	Yes	16	16.22	259.50
	Total	30		
rom_s2	No	14	17.43	244.00
	Yes	16	13.81	221.00
	Total	30		
rom_s3	No	14	21.64	303.00
	Yes	16	10.13	162.00
	Total	30		

Test Statistics(b)

	rom_s1	rom_s2	rom_s3
Mann-Whitney U	100.500	85.000	26.000
Wilcoxon W	205.500	221.000	162.000
Z	-.479	-1.123	-3.589
Asymp. Sig. (2-tailed)	.632	.262	.000
Exact Sig. [2*(1-tailed Sig.)]	.637(a)	.275(a)	.000(a)

a Not corrected for ties.
b Grouping Variable: mbt

Figure 15:
Results of supination (kinematics).

The results of the supination movement (ROM) are depicted in figure 15. The mean supination angle change was 1.41º in the active treatment group; in the control group, it was 1.29º. The differences were not significant (Mann-Whitney, $p = 0.64$). Immediately after physiotherapeutic intervention, the supination angle change even increased slightly to 1.73º in the active treatment group and to 1.94º in the control group. Again the differences were not significant when using the Mann-Whitney test ($p = 0.28$). Three months after the end of physiotherapy, however, the active treatment group with MBT was able to noticeably reduce the supination movement to a mean value of 0.45º, while the control group remained at a relatively high value of 1.68º. Thus, the difference between the active treatment group and the control group was highly significant at the end of the study period (Mann-Whitney, $p = 0.00$).

Looking at the therapeutic course in the two groups it becomes apparent that the active treatment group was able to almost completely eliminate the supination movements which it showed at the start of the study period. Therefore, the Friedman test also revealed a highly significant difference ($p = 0.01$). In contrast, the supination movement in the control group even increased slightly in the course of the therapy; however, this result was not significant (Friedman test, $p = 0.22$).

Altogether this means that wearing MBT three months after the end of physiotherapy led to a significant reduction of the supination movement, while at the same time the conventional home training resulted in an increase of the supination movement.

4. INTERPRETATION

The starting point of this study was the fact that the therapy of chronic ankle joint instabilities is above all a training of the muscles surrounding the ankle joint. Here, on one hand, maximum strength or endurance is improved. On the other side, however, the inter- and intramuscular coordination of the muscles is trained as well. Thereby it is achieved that the lost stability in the ankle joints, caused by the injured ligamentous apparatus, is compensated for by the muscles. Intensive wearing of the MBT led in the period after the physiotherapy to a significantly higher increase in maximum strength of the peroneal muscles on the one hand and in the triceps surae muscle on the other hand, as compared with the usually performed home training programme. From this, it can be concluded that the always present destabilisation caused by the sole of the MBT which is soft in the rearfoot area is constantly demanding especially of the above mentioned muscle groups to undertake stabilisation work. This contributes to a higher maximum strength in these muscle groups and constantly challenges and enhances the intra- and intermuscular coordination ability of the patient. Here, it is important that in contrast to the home training programme, which takes merely about 15 minutes per day, the MBT can be worn for hours without interfering with the usual daily activities. In this way the MBT enables the patient to train not only over prolonged periods of time with many repetitions but also at a slightly lower stress level compared with the exercises of the home program.

The increase in maximum strength, especially in the peroneal muscles, led to changes in the control of movement during walking on soft, insecure or unstable surfaces in the present study. Whereas prior to the therapy a large number of subjects of the active treatment group and the control group showed a supination movement in the first half of the ground contact, the subjects of the active treatment group with MBT were able to control or virtually completely eliminate this supination movement at the end of the study period, while this was not achieved in the control group. This shows that the longer-term, MBT-induced improvement of muscle coordination in the region of the lower leg / foot indeed results in a higher dynamic stability of the ankle joints and, consequently, reduces the risk of further supination traumas.

That this higher functional stability is not only due to the development of peroneal muscle strength is also shown by the results of the maximum strength of the supinators and the results of the pronation movements. Because not only the peroneal muscles but also the tibialis posterior muscles and the flexors of the toes became stronger due to the therapy/training process, not only a reduction of the supination movement but also a reduction of the pronation movement could be achieved. Thus, there was not simply a shift from the supination movement towards pronation, but altogether an improved mediolateral movement control.

The change of the muscle work in the area of the ankle joints did not only show in kinematics as an improved movement control, but also in a change of the mediolateral pressure distribution. By increased peroneal muscle activity during ground contact, the improved movement control brought about by MBT manifested itself at the end of the study period in such way that in the heel area the lateral maximum pressure was reduced while the medial maximum pressure increased. The same pattern, although to a slightly lesser extent, was seen during the push-off (increased maximum pressure coefficient under the forefoot).

Altogether, the MBT-enhanced functional stability could be quantified objectively three months after the physiotherapeutic intervention by three independent measurements in three different dynamic test set-ups. The control measurements immediately after the nine physiotherapy sessions showed no significant differences. Consequently, the positive effect of MBT became relevant only when the MBT could be worn intensively in daily living. On the other, the use of MBT in physiotherapy resulted by no means in poorer functional results than those achieved by conventional physiotherapy. Thus, MBT can be easily integrated in the physiotherapeutic management of chronic ankle joint injuries. Here the advantage is that patients are able to already familiarise themselves with the use of the new training device during therapy. However, professional instructions on how to use the training device in daily life are essential.

5. SUMMARY

The top priority in the management of chronic ankle instability is the optimal strengthening of the muscles surrounding the ankle joint, initially in physiotherapy, then in daily training, so that the impaired function of the ligaments is dynamically compensated for, and the ankle joints can be functionally re-stabilised. According to previous studies, MBT has a significant potential to train the muscles surrounding the ankle joint. Therefore, the present study aimed at investigating whether the use of MBT as a therapeutic training device in cases of chronic instable ankle joints results in superior mid-term and long-term dynamic stability compared to conventional therapy.

30 subjects with diagnosed, chronic ankle instabilities were randomised in an active treatment group (therapy with MBT) and a control group (without MBT). The active treatment group received subsequently nine physiotherapy sessions – each lasting 30 minutes – in which MBT was used for the various exercises. Likewise, the control group received nine physiotherapy sessions – each of 30 minutes duration – during which all exercises were carried out in the traditional way on a soft surface, without MBT. Subsequently, the active treatment group had to wear MBT over a period of three months during daily living as frequently as possible. During the same period of time, the control group had to carry out the home training programme usually prescribed by the Praxisklinik Rennbahn every day. The two groups were biomechanically and functionally examined and quantified in a at the following times: a) immediately prior to the start of physiotherapy, b) immediately after the end of the nine physiotherapeutic sessions and c) three months after the end of the physiotherapeutic intervention. The following biomechanical relevant parameters were measured:

- The maximum strength during inversion/eversion of the foot and the maximum strength during flexion/extension of the foot, using isokinetics.

- The extent of the pronation and supination movement of the foot while walking barefoot on a soft, insecure surface (2-D kinematics).
- The fluctuations of the centre of force in the one-legged stance, barefoot on a hard surface using a pressure measuring system (FootScan, ellipse area covering
  50% of measuring points and other parameters).
- Maximum pressure coefficient (medial/lateral) under the rearfoot and forefoot, respectively, while walking on a hard surface.

The results showed that immediately before and immediately after the physiotherapeutic intervention no significant differences between the active treatment group and the control group were measured. However, three months after the end of the physiotherapeutic intervention the active treatment group showed a significantly higher maximum strength both in the pronators (peroneal muscles) and in the muscles of the calf (triceps surae). Accordingly, a significantly smaller supination movement in the first half of ground contact and a significantly higher mediolateral pressure coefficient (higher medial pressure), both under the heel and under the forefoot, were found. The pronation movements were reduced in both groups at the end of the entire study period.

Thus, three independent measurements showed that the use of MBT over a period of three months after the end of the physiotherapeutic intervention resulted in a functionally superior stabilisation of the ankle joints compared to conventional therapy.

Thus MBT can be easily integrated into the physiotherapeutic management of chronic instable ankle joints without any negative effects, although a professional introduction into the use of MBT is essential. However, the impressive benefits of wearing MBT only become apparent in the phase after the physiotherapy. At that stage, patients have the opportunity to daily wear the MBT over several hours. In this way, by far better and more efficient stability training can be carried out compared to conventional home training programmes.

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7. RAW DATA

MBT	Score	Ellipse 1	HPress 1	Fpress 1	M Ext 1	M Flex 1	M Inv 1	M Evers 1	Pron 1	Supin 1
0	71	1.42	0.78	2.93	26	144	47	14	1.208	1.78
0	74	0.21	1.33	1.31	21	117	59	18	1.24	0.90
0	64	1.06	0.87	1.38	25	101	45	19	5.48	0
0	71	3.09	0.66	0.66	17	64	24	9	5.453	0
0	69	0.22	0.9	2.41	32	116	51	22	2.298	1.65
0	71	1.42	0.78	2.93	26	144	47	14	1.208	1.78
0	51	1	1.95	1.23	10	19	11	5	2.398	4.84
0	42	2.52	1.61	1.38	23	30	5	5	4.559	0
0	61	0.53	0.6	1.47	27	119	64	24	2.602	1.44
0	65	0.84	0.6	3.43	18	44	15	9	3.429	2.73
0	72	1.24	0.62	0.99	27	71	45	14	4.951	0
0	87	0.6	1.06	1.37	19	64	23	9	2.857	1.05
0	71	0.27	1.59	2.48	25	104	47	23	6.591	0.00
0	74	0.66	3.56	2.75	27	107	36	16	1.626	1.84
1	60	1.94	0.56	0.49	19	44	33	22	1.485	2.95
1	59	0.62	1.51	1.33	30	77	32	13	8.449	0.99
1	55	0.52	0.5	0.37	20	39	14	8	4.008	1.79
1	70	0.59	3.37	2.89	30	85	27	26	4.726	0.23
1	67	0.85	4.05	2.46	20	79	39	14	4.603	0.65
1	57	0.94	1.34	1.17	18	53	17	10	0	4.55
1	64	1.34	1.23	2.7	21	21	9	14	3.857	0.39
1	64	0.53	0.87	4.96	33	105	51	22	3.912	0
1	75	0.43	1.15	1.52	24	33	15	13	6.223	0.14
1	87	0.58	0.85	0.88	23	117	57	19	2.889	1.32
1	54	0.74	1.34	1.53	25	56	15	10	3.403	1.64
1	81	0.65	0.28	1.37	24	80	38	16	1.034	4.37
1	80	0.55	0.68	0.51	23	66	37	18	7.732	0.00
1	61	0.41	2.52	1.46	26	77	23	15	4.793	0.75
1	87	0.93	1.39	2.45	26	116	56	22	3.513	2.62
1	57	0.31	1.54	1.31	19	44	15	13	1.867	1.72

	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
MBT	67.87	0.67	1.51	1.79	24.13	69.87	29.67	15.53	4.07	1.41
	SD	SD	SD	SD	SD	SD	SD		SD SD	SD
	11.30	0.41	1.04	1.16	4.40	28.97	15.60	5.12	2.27	1.46
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
without	67.36	1.08	1.21	1.91	23.07	88.86	37.07	14.36	3.28	1.29
	SD	SD	SD	SD	SD	SD	SD		SD SD	SD
	10.81	0.85	0.80	0.87	5.58	40.32	18.37	6.36	1.82	1.36

MBT	Ellipse 2	HPress 2	Fpress 2	M Ext 2	M Flex 2	M Inv 2	M Evers 2	Pron 2	Supin 2
0	2.98	0.52	0.51	27	144	63	22	1.625	1.236
0	0.74	0.59	0.8	20	121	79	20	2.427	1.074
0	2.66	0.78	2.61	22	124	85	24	5.546	1.922
0	1.14	1.03	0.72	23	83	35	15	3.381	1.842
0	0.23	0.83	1.33	30	126	64	17	2.725	1.468
0	2.98	0.52	0.51	27	144	63	22	1.625	2.036
0	0.49	0.77	1	25	59	21	11	2.77	2.379
0	1.18	3.66	1.51	22	33	8	7	4.368	1.741
0	0.66	0.6	1.96	29	125	87	26	0.518	2.603
0	0.9	0.85	2.54	16	56	24	10	8.22	2.3
0	1.18	0.58	3.55	23	68	28	9	2.304	1.793
0	0.52	1.43	6.16	15	63	34	8	1.407	2.388
0	0.97	0.86	0.85	22	89	46	14	3.61	2.212
0	1.18	2.46	2.26	24	111	47	14	4.594	2.121
1	0.54	0.62	0.41	14	18	13	10	4.209	1.232
1	0.48	1.46	1.16	23	70	38	17	8.931	2.215
1	1.54	1.49	1.33	20	56	30	15	3.116	0.592
1	0.27	3.74	1.62	31	108	28	27	4.869	1.396
1	1.28	2.27	1.75	20	62	39	12	5.808	0.678
1	0.07	5.42	1.97	21	73	29	14	0.575	1.835
1	0.67	1.18	3.21	28	52	12	14	4.639	1.952
1	0.69	1.73	1.24	27	73	34	16	4.521	1.793
1	1.07	0.94	3.13	32	102	41	24	7.047	2.094
1	0.28	0.27	0.46	28	126	76	25	3.832	2.875
1	0.93	0.36	1.03	20	42	16	12	3.076	2.858
1	0.73	1.67	1.31	29	72	34	17	3.731	2.018
1	2.02	0.4	0.8	66	18	41	20	5.375	2.149
1	0.26	0.75	0.53	27	68	27	8	2.917	1.468
1	0.94	3.36	1.94	29	146	47	21	5.514	0.892
1	0.25	0.9	0.92	19	70	26	11	3.23	1.189

Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
with MBT	0.77	1.73	1.49	28.00	75.87	34.53	16.87	4.48	1.73
SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
	0.53	1.42	0.84	11.56	34.74	15.28	5.61	1.90	0.69
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
without MBT	1.27	1.11	1.88	23.21	96.14	48.86	15.64	3.22	1.94
SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
	0.92	0.89	1.54	4.35	36.17	25.15	6.30	1.99	0.45

MBT	Ellipse 3	HPress 3	Fpress 3	M Ext 3	M Flex 3	M Inv 3	M Evers 3	Pron 3	Supin 3
0	0.3	0.3	0.81	33	157	61	18	3.721	0.314
0	0.05	0.46	2.83	23	113	78	21	0.698	1.347
0	0.48	0.41	0.62	29	141	69	16	5.918	2.623
0	1.53	0.82	1.86	26	93	55	17	2.913	1.984
0	3.02	0.6	0.76	32	115	83	21	2.185	0.455
0	0.3	0.3	0.81	33	157	61	18	3.721	0.314
0	0.55	0.84	3.1	27	106	50	17	1.778	0.878
0	0.33	2.58	1.26	23	33	13	11	4.296	2.301
0	0.19	0.25	0.66	28	118	97	26	0.705	2.106
0	0.56	0.39	0.62	19	59	33	16	4.383	2.068
0	10.46	0.57	3.59	23	65	43	14	3.69	1.41
0	1.77	0.56	5.38	18	64	54	11	0.735	2.666
0	1.87	0.69	1.86	24	91	40	16	2.814	1.73
0	1.67	0.89	1.64	27	86	51	15	3.872	3.278
1	0.67	0.46	0.58	14	16	52	21	3.148	0.836
1	1.24	2.58	3.52	32	91	47	22	2.936	0.426
1	3.95	0.43	0.47	23	61	20	9	3.026	0.001
1	1.33	4.97	9.21	28	114	39	23	1.355	1.277
1	2.02	2.95	4.38	33	97	42	19	2.976	0.001
1	0.93	2.19	3.06	30	95	51	21	4.163	0.001
1	1.53	1.93	3.52	29	103	41	18	2.763	0.385
1	0.19	0.73	0.81	39	111	42	23	3.679	0.001
1	0.79	0.73	1.93	32	123	70	27	3.366	0.948
1	0.37	0.62	1.19	28	151	62	22	3.53	0.18
1	3.5	1.96	2.77	23	62	24	19	4.655	1.243
1	0.97	2.64	3.39	37	89	39	18	2.891	0.001
1	0.89	1.58	2.86	32	114	48	24	2.214	0.001
1	1.02	3.25	0.92	24	52	20	7	3.248	1.159
1	0.22	7.82	8.32	28	108	47	21	4.542	0.232
1	0.31	2.24	2	21	87	50	17	2.057	0.862
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
with MBT	1.28	2.44	3.22	29.27	97.20	42.80	19.33	3.16	0.45
SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
	1.09	1.91	2.53	6.27	32.10	13.65	5.15	0.87	0.50
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
without	1.65	0.69	1.84	26.07	99.86	56.29	16.93	2.96	1.68
SD	SD	SD	SD	SD	SD	SD	SD	SD	SD
	2.68	0.58	1.42	4.75	37.16	21.45	3.95	1.58	0.93