RESEARCH ARTICLE

Showing of functional ressources of Patients with bi- or trimalleolar ankle joint injury in comparison with a healthy, active, equally aged subject group

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Abstract

Background: Do have patients with a bi- or trimalleolar ankle joint injury in comparison to a healthy, active, equally aged subject group concerning functional resources? With advancing age, the number of bone fracture increases, especially of the ankle joint and in particular for elder women. The operative treatment is effective. The subsequent rehabilitation is satisfying as well. Nevertheless, there is no functional comparison to healthy people of the same age so far.
Study Design: prospective controlled cross-sectional study
Methods: Inclusion of 17 patients with bi- or trimalleolar ankle joint injury (mean: one and a half year post-surgery) und 23 healthy, active, equally old probands (fitness studio); measuring devices: motoric test procedures and questionnaire
Results: three observation areas (OA)
• OA I: no significant difference between the injured and intact ankle side within the patient group concerning the static balance and the strength endurance, measured at the functional press; only the strength endurance measured at the rope pull device shows a significant difference of the power
• OA II: comparison patients and probands
- static balance: patients < probands (p >.05)
- strength endurance: patients < probands (p <.002)
- life quality – mental health: patients < probands (p >.05)
- life quality – physical health: patients < probands (p=.039)
• OA III: patients are in the values of SF36` direct sum scores round about in the standards` range, probands even above

Conclusion: There are functional resources between patients and probands. These differences should be positively influenced by taking into account the enhancement of training or participation in sport courses with the aim of approaching to achieving the patients` capability and life quality to them of probands.

Key-words: ankle joint fracture, functional comparison, balance, strength, life quality

Introduction

With age, the probability of a fracture, especially of ankle fractures, is higher. Epidemiologically, an increasing number of these fractures, especially in older women, are assumed [2]. The operative treatment is effective and results in a satisfactory outcome of the affected joint with the subsequent rehabilitative therapy. However, the literature research for studies on postoperative interventions and training programs remained poor. For this reason, the research question is whether patients with a bi- or trimalleolar ankle injury show functional resources in comparison to a healthy, active, subject group of the same age. As part of a diploma thesis at the University of Jena in cooperation with the Institute of Physiotherapy at the University Hospital of Jena, this question was pursued [3].

Furthermore, the subjective condition of patients over the age of 65 is of interest in this study. This includes both physical and mental health. In addition, no study could be found, which had examined a patient group with a healthy, active, age-matched group. This was chosen as the control group because it represents the highest possible level of body and movement experience in this age segment.

Methods

In order to investigate this question, a controlled cross-sectional laboratory study was carried out with patients and subjects in higher adulthood (65+ years) (see table 1). In the patient group, 17 participants with bi- or trimalleolar ankle fracture were involved whose operative care averaged one and a half years back. In the subject group, 23 of the same age, but undamaged and sportingly active participants were recruited.

Division into three fields of observation

- I: Comparison of injured and uninjured ankle side of the patient
- II: comparison between patients and subjects
- III: comparison between patients and the standard values

Measuring instruments and assessment

Various motor test procedures and one questionnaire were used as measuring instruments.

The motor test procedures (tab. 2) were divided into the verification of the static balance by means of a coordination test on a force plate (Kistler company) and the measurement of strength endurance by means of the functional leg press (fig. 1 and 2) and the cable pull machine (fig. 3 and 4).

Fig. 1 Functional leg press start position

Fig. 2 Functional leg press End position

Fig. 3 Cable pull machine start position

Fig. 4 Cable pull machine end position

Tab. 1 Overview of the study particapiants

Patients	**Subjects**
17, therefrom 13 female and 4 male	23, therefrom 14 female and 9 male
→ bi- or trimalleolar ankle fracture	→ healthy, physically active, same-aged
→ received surgery at the Department of Accident, Hand and Reconstructive Surgery of the University Hospital Jena	→ sportingly active at the gym „Planet of Motion“ in Jena
→ on average: one and a half years postoperatively	→ training for two to three times a week
→ at the time of the study, the rehabilitative measures were completed and the patients were not receiving any therapeutic treatment	→ at the time of the study in any therapeutic treatment
→ exclusion criteria: further lower extremity trauma, operations or diseases in the last six months	

Tab. 2 Overview of the motor tests

What?	**Static balance**	**Strength endurance**	
How?	Coordination test on a force plate	Functional leg press	Cable pull machine
Prodcedure	calm standing; ten seconds in seven different positions 1. Two-Legged Stance (TLS) 2. TLS with closed eyes 3. TLS with closed eyes and head laid backwards 4. One-Legged Stance (OLS) right 5. OLS left 6 OLS right with closed eyes 7. OLS left with closed eyes	Lying on functional leg press with knee extension	Sitting on weight bench
		severity = 60% of body weight	severity = 10% of body weight
		Force development from deep dorsiflexion (heel position) to high plantar flexion (toe level)	weight attached to the forefoot by loop is to be pulled by plantar flexion in dorsal extension of the ankle
Measurement	With the aid of the piezoelectric effect, the vertical forces are shown in the form of ground reaction forces. The course of the body's center of pressure (COP) projected onto the floor and the confidence ellipse are recorded. The confidence ellipse describes the area in mm² that the COP covered during an experiment. The course of the COP shows the length of the track in mm.	maximum possible number of repetitions	maximum possible number of repetitions

The questionnaire "Short Form 36 Health Survey Questionnaire" (SF 36) was used as assessment to evaluate the quality of life. It asks for answers to 36 questions, which represent two component scores of four subscales each. The Physical Health Component Score (PCS) is divided into Physical Functioning (PF), Physical Role Functioning (RP), Bodily Pain (BP), and General Health Perception (GH). The mental health component score (MCS) specifies vitality (VT), social role functioning (SF), emotional role function (ER) and mental health (MH). The result is a self-assessment, with a score of 100 representing the highest possible quality of life.

The standardized examinations took place in the laboratory of the Institute of Physiotherapy of the University Hospital of Jena and the rooms of a fitness studio. These were only executed once and connected with a term of about half an hour for each participant. The patients were examined in a closed room, so that no external influences could lead to uncertainty or distraction. For the probands, a separate room or the free training area was chosen within the gym. Between the testing procedures, enough breaks were scheduled to prevent fatigue. The task regarding the motor tests aimed at the best possible result. The entire test battery consisted of independent tests. Subsequently, the participants obtained

the questionnaire and the inherent explanation for completing.

Statistics

Depending on normal distribution, means and accordingly standard deviations resp. medians and with range between the 25. and 75. perzentile were calculated by means of descriptive statistics. Significancies were computed by using the non-parmetric Mann-Whitney-U-Test or the T-Test, also accoring to normal distribution of the recorded data.

Results

The two groups did not show a significant difference in age, size or weight. However, the proportion of women was higher, both in the patient and in the subject group. The distribution of the affected ankle within the patient group was homogeneous.

Field I: The patients did not show any significant differences between the injured and the not affected side with regard to their static balance (with open eyes: OLS mean=680,45mm²[injured] and 825,24mm [uninjured] → p = .232; and closed eyes: OLS mean 1369,32mm [injured] and 1248,59mm [uninjured] → p = .445; fig. 5) as well as with regard to their endurance performance at the functional leg press (maximum repetition mean = 25 [inured] and 26 [uninjured] → p = .512; fig. 6). However, the results of the cable pull test showed a significant difference (maximum repetition mean = 29 [injured] and 37 [uninjured] → p = .045) for in the mean a higher maximum of repetitions was possible concerning the uninjured side. This reveals that patients can less often repeat these exercises with the injured leg side, and consequently the endurance of the affected side is worse.

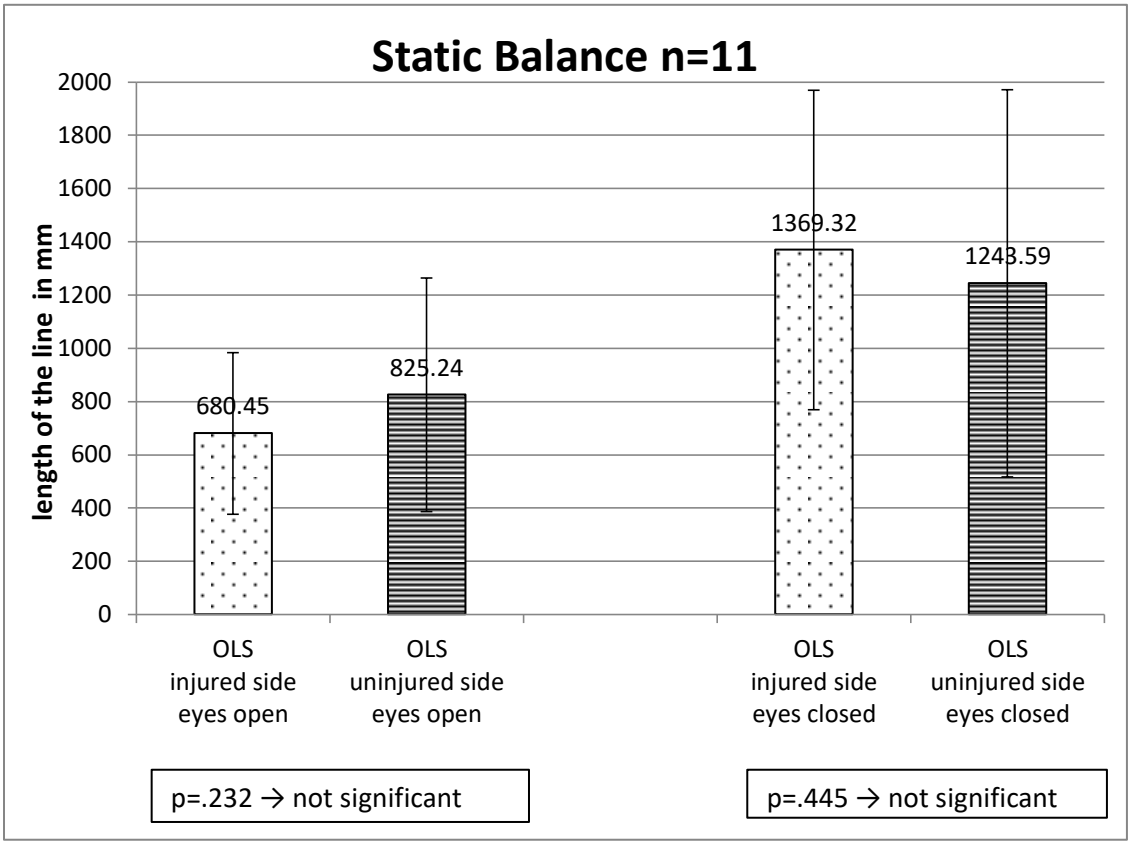

Fig. 5: Side comparison in the OLS of the patient group

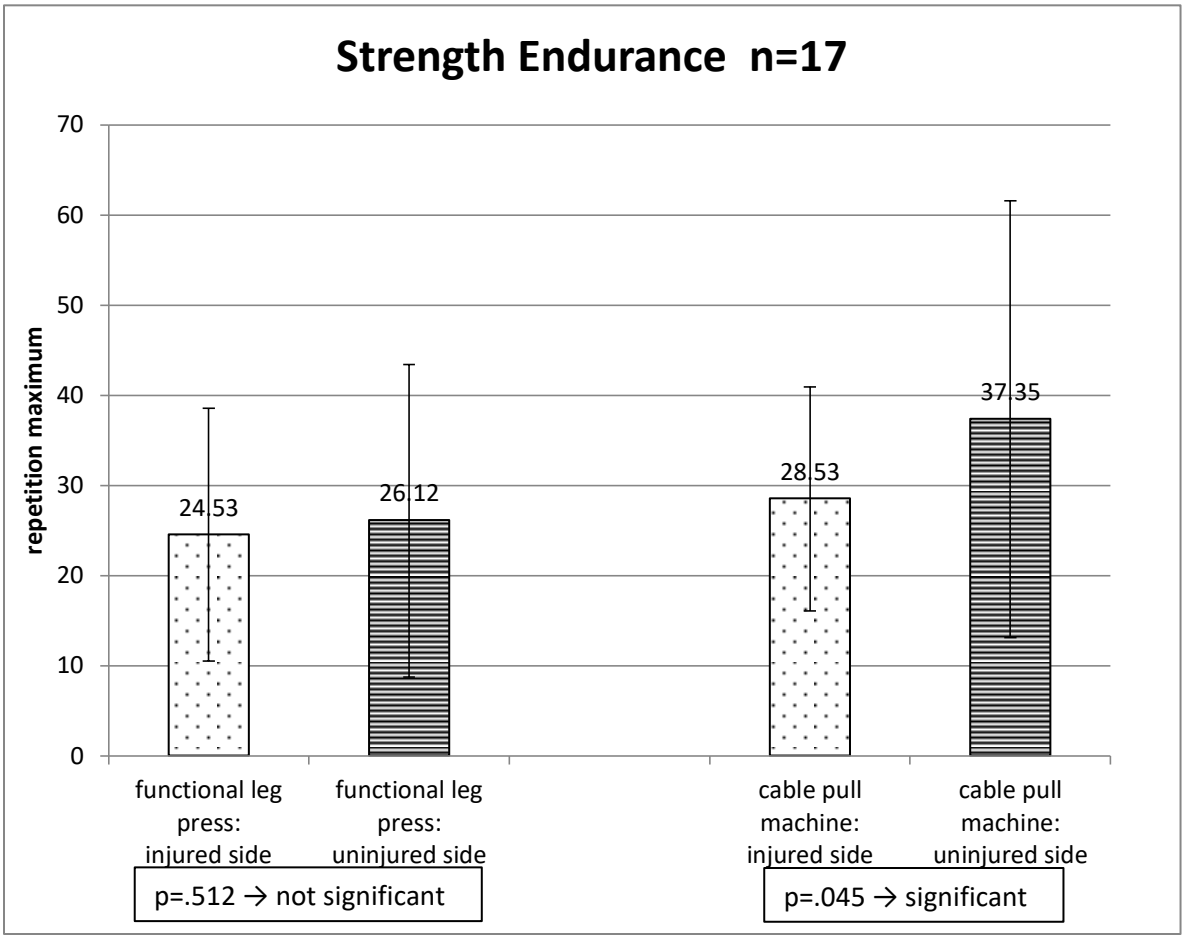

Fig. 6: Comparison of injured and uninjured ankle joint of the patients with regard to endurance

Field II: Compared with the subjects, significant differences in the strength endurance tests (p <.002) can be found. Subjects performed better regardless of the exercise equipment used and the side tested (fig. 7 and 8; functional leg press: patients median < 25 repetitions and probands median > 40 repetitions; cable pull machine: patients median < 35 repetitions and probands median > 65 repetions). The evaluation of the SF36' PCS clearly shows an increased quality of life of the subjects compared to the patients (patients score = 49 and probands score = 54 → p = .039). The subscale of the physical function (PF) shows the largest difference, the pain (BP) the lowest (fig. 9). In contrast, the result of the MCS in the evaluation of SF36 shows no group difference (patients score = 48,98 and probands score = 49,36 → p = .760; fig. 12). In the individual subscales, the subjects as well as the patients range around 50 in the mean. There are no significant differences between the intervention groups in terms of static balance (p > 0,05; fig. 10 [TLS] and 11 [OLS]). However,

the median score is always better on the subjects, only the patients' Two-Legged Stance has a slightly safer balance compared to the subjects. Field III: The standard values in the individual subscales or component scores are transformed to 50. The patients are, concerning the component scores, approximately in this range (MCS = 48.98 and PCS = 49.00, fig. 9 and 12). It is striking that the subjects are even above those of the normal population in the component score of the physical quality of life (PCS = 54.00, fig. 9).

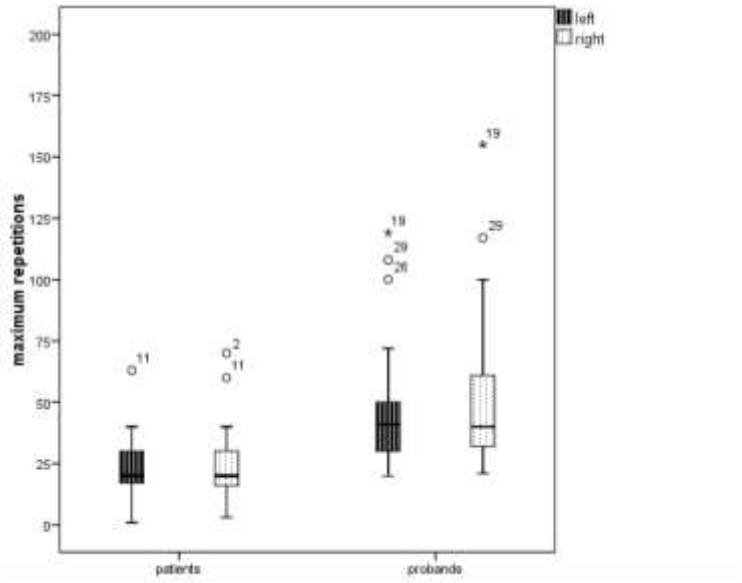

Fig. 7: Side comparison of functional leg press

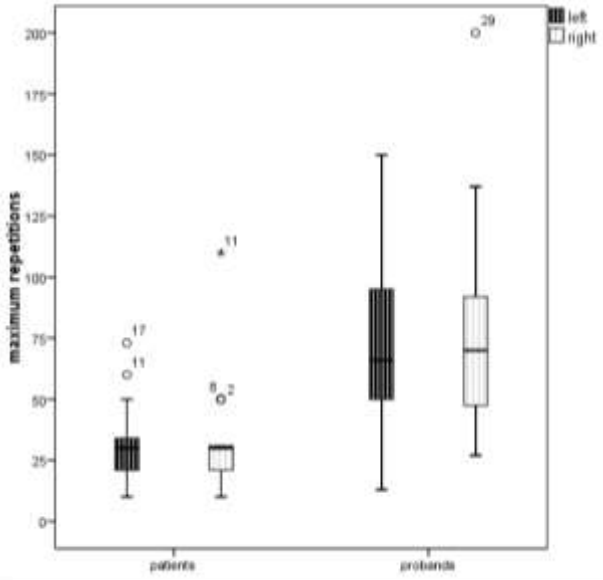

Fig. 8: Side comparison of cable pull machine

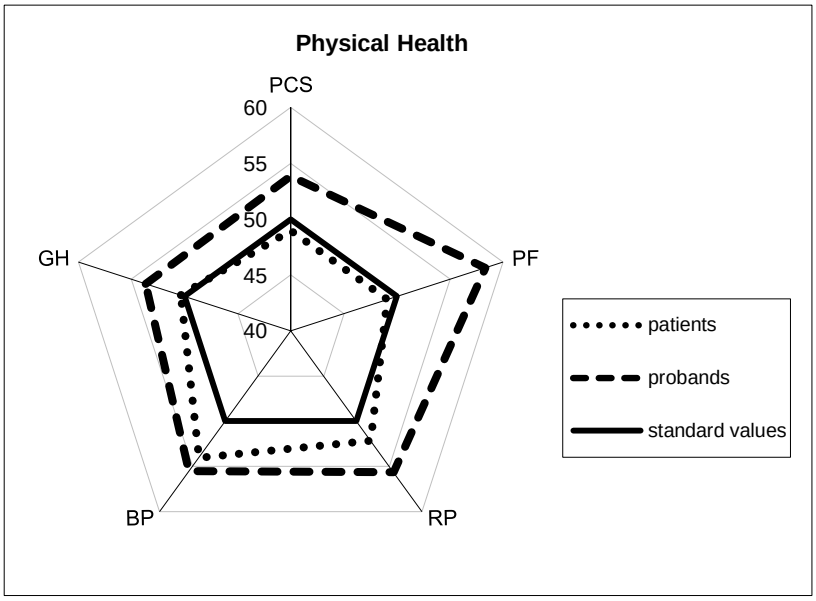

Fig. 9: Comparison of physical health

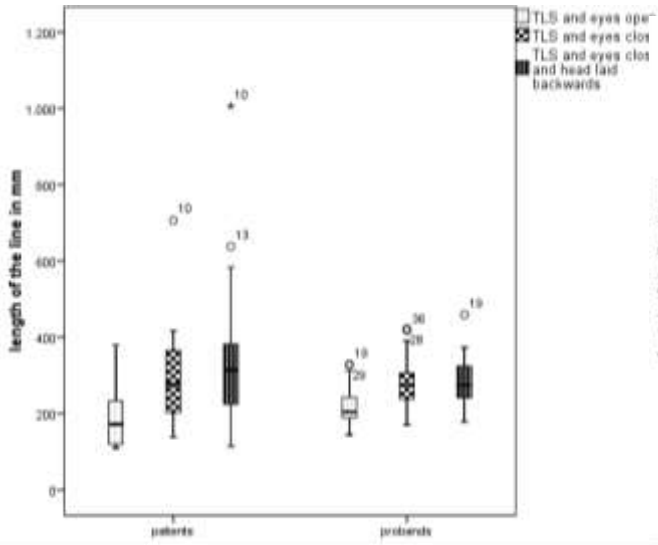

Fig. 10: comparison TLS

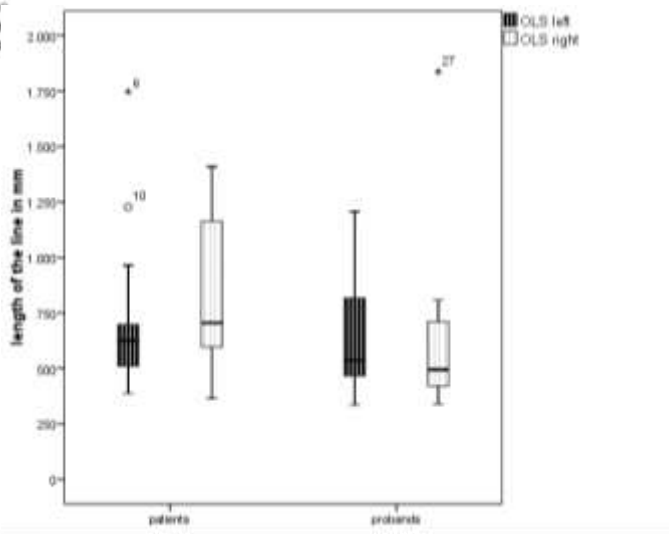

Fig. 11: comparison OLS with opened eyes

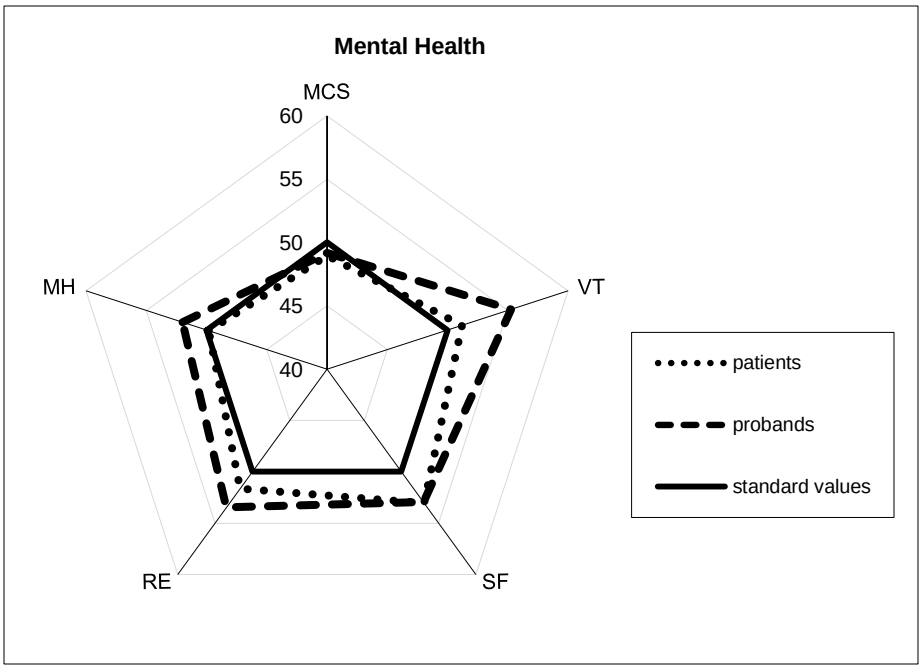

Fig. 12: Comparison of Mental Health

Discussion

Field I: The result of the side comparison shows that the static balance does not depend on the injured ankle side, both with eyes open and closed. In this aspect, the recovery of the function before the injury is achieved. The result of the functional leg press also shows no difference. Only the motor test on the cable pull

machine shows a clear difference between affected and unaffected side. Here, the patients with an operated ankle accomplish on average fewer repetitions. Nevertheless, this leads to the assumption that the patients have no functional limitations. Both, the One-Legged Stance on the force plate and the exercise on the functional leg press allow, seen muscular, a more global use or a higher compensation pattern to adjust the "weak point". However, the cable pull test requires a more localized muscle group, which clarifies the variation in power.

Field II: The measurable difference between the patient and the subject group with regard to the strength endurance tests spells out the functional discrepancy between those affected and healthy seniors. Accordingly, a restriction can be assumed, which must be remedied by targeted training. Only patient number 11 reaches the number of repetitions of the participants. The obvious explanation is the regular and multiple weekly training of healthy seniors in the gym. In a modified form, they complete an endurance training on the bicycle ergometer, crosswalker or treadmill of about 30 minutes. Accordingly, the subjects are able to continuously strain the entire body for a certain period of time. In addition, most perform a permanent exercise cycle once or twice a week. In summary, it can be seen that they primarily train the main muscle groups. It can be assumed that this type of training is a good starting point for the strength endurance tests conducted in this study. Moreover, the subjects' perceived willingness to exert themselves was higher with respect to the patients. This is probably due to the familiarity with the equipment given by visiting the gym. (For this, however, no parameter record was performed.)

The static balance test battery displays no difference. It becomes clear that the fracture after the previous operative as well as rehabilitative treatment with regard to the balance does not bring any permanent restriction for the patient. However, the result was not to be expected, since the subjects reported on the regular performance of balance exercises. Certainly, in the detailed consideration of the measured values, a smaller deflection of the body's center of pressure is to be observed for the subjects. Although not significant, there is still a slight motor gradation between the two test groups again. This raises the question of whether the measurement of static balance is a suitable investigation method to estimate the risk of falls.

The evaluation of the SF36 enables the differentiation in physical and mental health. While the groups in the MCS do not differ, there is a significant difference in the physical one in favor of the subjects. This reinforces the assumption that functional resources are

available to patients.

Field III: In general, the outcome of patients and subjects compared to the normal population allows a positive assessment of the quality of life. The corresponding mental as well as PCS are in the range of the norm values or even above it. The subjects are in the assessment of physical health always above the standard value, the patients are minimal below it. An explanation is the recruitment, because the healthy participants were all won in a gym. They train two or three times a week. Accordingly, it is realistic that the majority of the subscales, whether mental or physical, are on average above the norm. The general activation through sport courses or training in the gym has a very good influence on the physical health of the subjects. In the opposite case, as the patients' result shows, previous injuries reduce the physical well-being. The outcome reflects that quality of life does not necessarily depend on age, but rather on physical activity and social interaction. In order to feel healthy mentally as well as physically, it is advisable to move regularly, if possible in a continuous group constellation.

Subjectively, it can be said that the probands, because of their multi-activity, were strengthened mentally as well as feeling healthier. In a meta-analysis, which included a total of 18 studies, it could be established that fitness training has a positive influence on cognition, and thus in general on the persons' mind [4]. In a review of recent meta-analyses on "physical activity and mental health" is also confirmed that physical training, in addition to the relief of complaints, has a positive effect on well-being [5]. Despite the high incidence of ankle fractures in elderly patients, studies, especially for this age group, are poorly published. Nilsson et al. assessed the quality of life six and twelve months after the injury, respectively [6]. They found that the quality of life increases with a longer postoperative period. Various reasons, such as the learned dealing with the disease or the integration into their own everyday life, led to a positive change in the result. The patients involved in the present study had their surgery already one and a half years earlier. For this reason, it seems realistic that they have at least reached the level of the healthy control group with respect to the mental component score.

Conclusion

The comparison of the patients' balance and strength endurance results reveals no discrepancy between injured and uninjured ankle joints. The surgical treatment of bi- or trimalleolar ankle fracture is therefore appropriate, since the parameters are within the normal range or have no side difference. An exception is the endurance situation on the

cable pull machine. The significant difference may be seen in the more localized muscle work, while the force plate and functional leg press measurements are more global and allow more compensation mechanisms.

In contrast, the comparison between patients and volunteers shows significant differences. However, the category of pain is not decisive here, but the physical function is the limitation in the quality of life. This leads to the conclusion that the patients show functional resources in relation to the exercising subjects. It is necessary to address on these differences by appropriate enhancement of the training therapy or the participation in sports courses, because the optimal outcome is the approach or even the equality of performance and quality of life of patients to those of the subjects.

References

1. Kannus P, Palvanen M, Niemi S, Parkkari J, Jrvinen M. Increasing number and incidence of low-trauma ankle fractures in elderly people: Finnish statistics during 1970–2000 and projections for the future. *Bone*. 2002;31(3):430-433.
2. Court-Brown CM, McBirnie J, Wilson G. Adult ankle fractures—an increasing problem? *Acta Orthopaedica Scandinavica*. 1998;69(1):43-47.
3. Benkenstein M. Aufzeigen funktioneller Ressourcen bei Patienten mit einer bi- oder trimalleolären Sprunggelnksverletzung im Vergleich zu einer gesunden, sportlich aktiven, gleichaltrigen Personengruppe [unpublished diploma thesis]. Jena: Friedrich-Schiller-Universität; 2012.
4. Colcombe S, Kramer AF. Fitness effects on the cognitive function of older adults: a meta-analytic study. *Psychological science*. 2003;14(2):125-130.
5. Schulz K-H, Meyer A, Langguth N. Körperliche aktivität und psychische gesundheit. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz*. 2012;55(1):55-65.
6. Nilsson G, Jonsson K, Ekdahl C, Eneroth M. Outcome and quality of life after surgically treated ankle fractures in patients 65 years or older. *BMC musculoskeletal disorders*. 2007;8(1):127.

