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Original Scientific Paper

FADI EVALUATION OF THE EFFECTS OF KINESITHERAPY AFTER ANKLE FRACTURE

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SUMMARY – The aim of the study was to analyze the values of Foot and Ankle Disability Index (FADI) after kinesitherapy in subjects with bimalleolar or trimalleolar fracture of the ankle after surgery treatment and the obtained values of manual muscle test (MMT) and range of motion (ROM) after rehabilitation, compared with the obtained values of FADI index and on that basis evaluate its possibility in assessing the functionality of the respondents after surgery for bimalleolar or trimalleolar fracture of the ankle. The sample included 60 subjects over the age of 18 who underwent surgery for osteosynthesis due to bimalleolar or trimalleolar fracture of the ankle. All subjects were treated with kinesitherapy as part of the postoperative rehabilitation program. The research was conducted from 2013 to 2018 at the Department of Orthopedics of Dr. Safet Mujić Cantonal Hospital in Mostar and Mostar University Clinical Hospital. A statistically significant correlation was found between FADI index values *per* group and average percentage recovery *per* MMT ($p<0.05$), as well as a statistically significant correlation between FADI score values *per* group and mean percentage ROM value ($p<0.05$). A statistically significant association was found between mean percentage recovery *per* ROM and MMT ($p<0.05$). The conducted research confirmed the working hypothesis of the conducted study. The effects of kinesitherapy after ankle surgery can be evaluated using the FADI index, as well as by manual muscle test and ROM measurement.

Key words: *Ankle; Fracture; Kinesitherapy; Foot and Ankle Disability Index*

Introduction

The ankle is one of the most commonly injured areas of the skeleton and the site of the most common internal fractures of the joint[1]. Young men between the ages of 15 and 24 and women over 40 have the highest incidence of ankle fractures[2]. An ankle fracture is treated by repositioning, sometimes with surgical fixation, followed by a period of immobilization until the fracture heals[3]. The aim of operating techniques is to restore anatomical structures and ensure stability, facilitating early mobilization[4]. The final aim is to provide pain-free movement and thus improve the patient's quality of life. Measuring quality of life is important in order to make a timely decision on how to treat and take measures to preserve all segments of the quality of life, primarily physical functions. For these reasons, great importance has been given to postoperative rehabilitation[5], in accordance with standard kinesitherapy procedures[6].

Physiotherapy assessments use specific instruments and interactions as procedures and methods of measurement and observation, which therefore includes

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examination of individuals and groups with present or potential impairments or limitation in the performance of the activity[7].

The outcome of the rehabilitation procedure/treatment is evaluated by functional tests that are part of the standard procedure, i.e., manual muscle test (MMT) and measurement of ankle mobility as the range of motion (ROM)[8]. Among the most commonly used systems for scoring functional status of the ankle is the Foot and Ankle Disability Index (FADI) as a standardized questionnaire for the assessment of foot and ankle disability, and presents a specific report on local function. FADI was first described in 1999 by Martin *et al*. It is designed to evaluate functional limitations related to foot and ankle conditions[9-11].

In 2005, Hale and Hertel studied 50 recreationally active subjects, including healthy and individuals with chronic ankle instability (CAI). A subgroup with CAI underwent a 4-week ankle rehabilitation program. Respondents scored significantly higher on FADI and FADI Sports after the rehabilitation program as compared to the initial values. The authors conclude that FADI and FADI Sports are reliable in detecting functional limitations in individuals with CAI. The aforementioned functional tests corresponded with improvements in post-rehabilitation function in participants with CAI. FADI and FADI Sports have been shown to be sensitive enough to detect differences between healthy participants and participants with CAI[12].

Several studies have addressed the effectiveness of various functional tests for the ankle. Based on the available literature, no studies could be found on the correlation of the FADI index, MMT, and ROM, but there are numerous studies on the correlation of other functional tests for the ankle[13,14].

The aim of this study was to analyze the values of FADI after kinesitherapy in subjects with bimalleolar or trimalleolar fracture of the ankle after surgery treatment, and to compare the MMT and ROM values obtained after rehabilitation with the FADI values in order to evaluate FADI feasibility in assessing the functionality of subjects after surgery for bimalleolar or trimalleolar ankle fracture.

Subjects and Methods

The study included 60 subjects of both sexes over the age of 18 who voluntarily agreed to take part in the study and who had surgery for osteosynthesis due to bimalleolar or trimalleolar ankle fractures. Postoperative rehabilitation at the Departments of Orthopedics began on postoperative day 0 under supervision of a physiotherapist; upon discharge, they were referred to the Departments of Physical Medicine and Rehabilitation, Dr. Safet Mujić Cantonal Hospital in Mostar and Mostar University Clinical Hospital for continuation of treatment (rehabilitation). The postoperative rehabilitation program at both hospitals is implemented according to postoperative protocols, one of which implies plaster immobilization and the other does not. Postoperative rehabilitation programs consist of breathing exercises, circulation exercises, isometric exercises of the operated leg, active movements of the surrounding joints of the operated leg, active exercises of the healthy leg, verticalization of the patient, and learning to walk non-reliant on the operated leg, learning to walk with aids up and down the stairs. After 4-6 weeks, the orthopedist estimates the allowable load, and the patient begins a physiotherapy program at the Department of Physical Medicine and Rehabilitation. All subjects were treated with kinesitherapy as part of a rehabilitation program, including subjects who had undergone a postoperative home rehabilitation program. Following the postoperative physiotherapy program, all subjects in the study group were examined on an outpatient basis or at home.

For the purposes of the study, approval was obtained from the Ethics Committee of the institutions where treatment was performed. After signing the informed consent form to participate in the research, each respondent completed a general questionnaire, designed as part of its own design for the purpose of this research, including general information on the respondent (gender, age, weight, height, fracture type and operative interventions, data on concomitant diseases, and location of rehabilitation).

Assessment of the ankle function with FADI was performed in each subject. Each subject was evaluated for gross motor power of the musculature responsible for the mobility of both ankles using MMT and ROM measurement on both ankles.

Upon data collection, ROM values in the ankle were recorded in all amplitudes individually measured with a goniometer and expressed in degrees. To adjust the values for statistical processing, they were expressed as percentage of the full ROM, and then expressed as a single value that represented the mean

percentage recovery for all amplitudes relative to the full/normal ROM against the standard values. When collecting data, recovery values of gross motor power *per* MMT were recorded as a score of 0-5 for each movement amplitude in the leg joint. Due to statistical processing, each MMT recovery value was converted to percentage over the maximum score, that is, full recovery. Then the values for all amplitudes were presented as one mean percentage of gross muscle strength *per* MMT compared to the normal finding, that is 5 *per* MMT.

The aforementioned original FADI was translated from English by Dimnjaković, which he used in his thesis[15].

Statistical processing of the collected data was performed using IBM SPSS Statistics 25.

The results were expressed as absolute and relative (%) frequencies. The χ^2-test was used to test for statistical significance. The level of statistical significance was set at p=0.05.

Results

Women predominated in the study sample. Most respondents were aged between 60 and 70 years ranging from 22 to 76 years. The mean age of the subjects was 54.4±12.9 years. Most respondents were married and had an increased body mass index (about 70% of respondents). Fracture of the right ankle joint was recorded in 35 (58.3%) and of the left ankle joint in 25 (41.7%) subjects. There were 34 (56.6%) total bimalleolar ankle fractures and 26 (43.4%) trimalleolar fractures. Bimalleolar fractures of the left and right ankles were found in 17 (28.3%) subjects, whereas trimalleolar fractures of the right ankle were found in 18 (30%) and trimalleolar fractures of the left ankle in 8 (13.3%) subjects.

Most respondents (n=56) reported fall as the cause of fracture, two cited ankle twist, one had sustained it in a traffic accident, and one in a fight.

The results of the ROM, MMT and FADI testing are shown in Table 1.

A significant difference was found in the distribution of subjects according to the results of all three

Table 1. Distribution of subjects according to ROM, MMT and FADI results

	Number (%) of respondents (N=60)	p*	M±SD	Min-max
ROM			88.40±7.11	70%-100%
70%-80%	8 (13.3)	<0.001		
81%-90%	26 (43.3)			
91%-100%	26 (43.3)			
MMT			85.83±15.15	15%-100%
<60%	2 (3.3)	<0.001		
60%-70%	8 (13.3)			
71%-80%	12 (20.0)			
81%-90%	15 (25.0)			
91%-100%	23 (38.3)			
FADI score			85.62±13.62	35%-100%
<50%	1 (1.7)	<0.001		
51%-60%	1 (1.7)			
61%-70%	6 (10.0)			
71%-80%	10 (16.7)			
81%-90%	13 (21.7)			
91%-100%	29 (48.3)			

*χ^2-test; ROM = range of motion; MMT = manual muscle testing; FADI = Foot and Ankle Disability Index

tests. In all three tests, most subjects had high scores. Statistical analysis revealed that there was a statistically significant correlation between the mean percentage recovery as *per* ROM and MMT ($p<0.05$), which is shown in Figure 1.

Statistical analysis showed that there was a significant correlation between FADI score *per* group and the mean percentage recovery as *per* MMT ($p<0.05$), which is shown in Figure 2.

Statistical analysis revealed that there was a statistically significant correlation between FADI score by groups and the mean percentage ROM ($p<0.05$), which is shown in Figure 3.

Discussion

In the study sample, the mean percentage recovery according to ROM was 88.40±7.11, minimum 70% and maximum 100%. Taking into consideration the high values of the mean percent recovery of the ankle ROM in most subjects, it appears that these protocols, which do not imply early postoperative load of the ankle, have been implemented in both hospitals and,

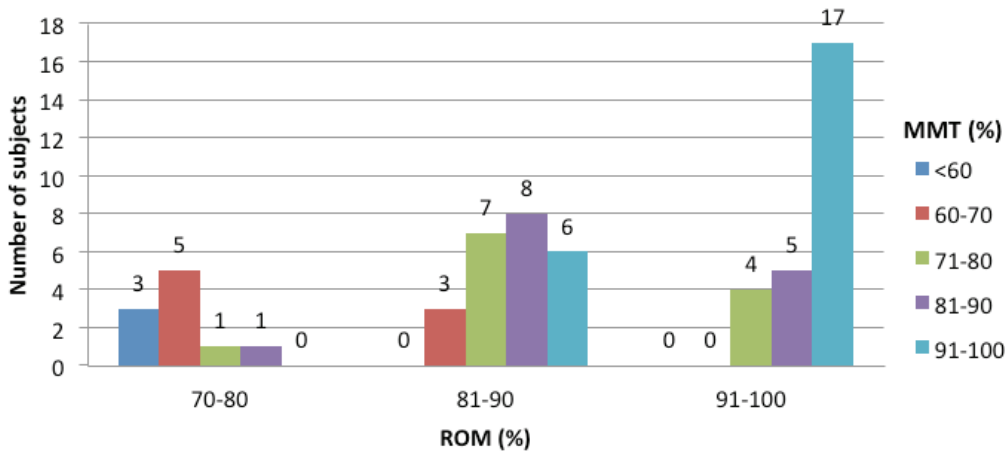

Fig. 1. Comparison of the number of subjects according to ROM and MMT results.

ROM = range of motion; MMT = manual muscle testing

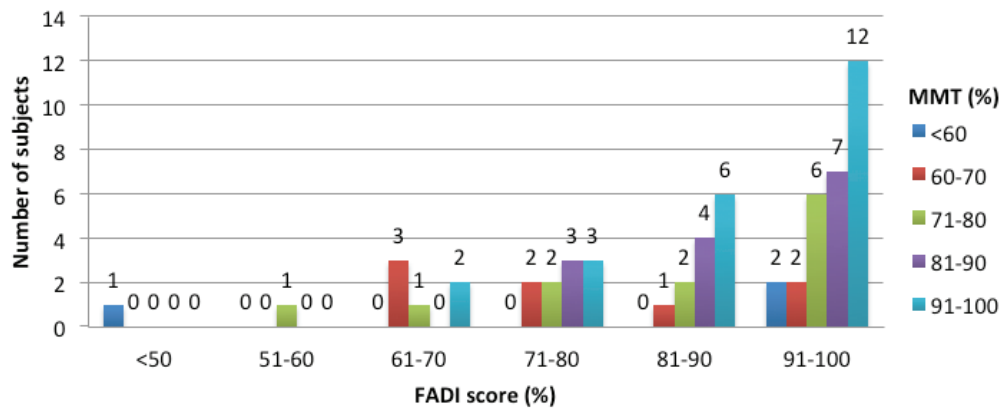

Fig. 2. Comparison of the number of subjects according to FADI score and MMT.

MMT = manual muscle testing; FADI = Foot and Ankle Disability Index

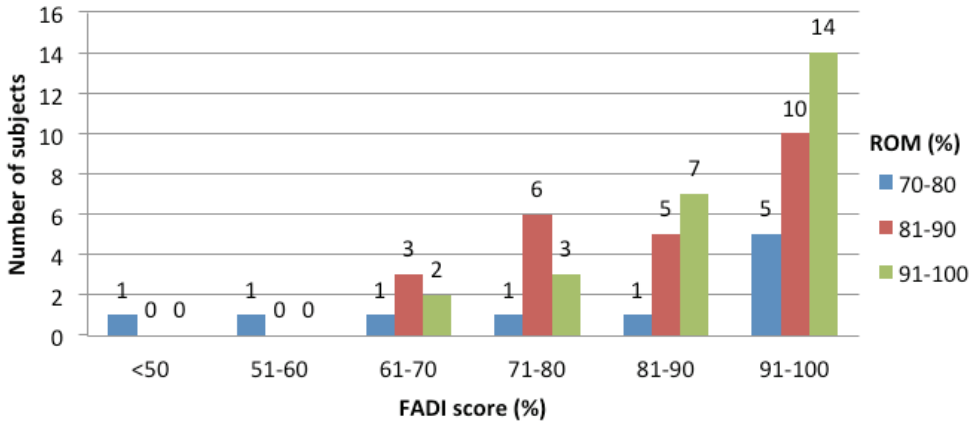

Fig. 3. Comparison of recovery by FADI score and ROM.

FADI = Foot and Ankle Disability Index; ROM = range of motion

although they differ in the type of immobilization, bring the same results related to functional outcome after the postoperative rehabilitation program of the subjects included in the study.

Dehghan *et al*. tested two rehabilitation protocols, i.e., early ankle load (early support) and ROM exercises for 2-week ankle movement range, and late load (no plaster immobilization support at 6 weeks). As a measure of the outcome of kinesitherapy, they used, among other tests, time to return to work (RTW) and ROM. Based on the results obtained with early improvement in functional outcome and no increase in the complication rate, the authors of the study recommend early postoperative loading and exercise to increase ROM of the ankle joint[16]. Haak *et al*. in their study also state that early loading of the ankle may be allowed immediately after osteosynthesis by tiles[17].

Analyzing the gross motor power of the operated limb, our results showed the highest number of subjects in the test sample (n=23, 38.3%) to have achieved a mean percentage recovery *per* MMT of 91%-100% as compared to complete recovery *per* MMT. The mean percentage recovery *per* MMT was 85.83±15.15, minimum 15% and maximum 100%.

The mean FADI value was 85.62±13.62, minimum 35% and maximum 100%. Based on the results obtained, it can be said that the highest number of subjects in this study had high values of the FADI, which also indicates a satisfactory degree of recovery of the operated ankle joint in most of the subjects in the study sample. Considering that this study was designed retrospectively and prospectively, as well as that most of the subjects had good functional outcome results, which were preserved even after a long period after the postoperative rehabilitation program, this can be compared with the study by Regan *et al*. suggesting that a decade after fixing the ankle, most of the subjects included in their study were fine. Thus, subjects who undergo operative fixation of unstable ankle fractures can expect functional outcomes that are sustainable over time[18].

In the group with FADI score 91%-100%, the mean percentage recovery on MMT of 91%-100% was recorded in the largest number of the subjects (12/29); in the group with FADI score 81%-90%, the mean percentage recovery on MMT of 91%-100% was found in 6/13 cases.

Statistical analysis revealed that there was a significant correlation between the values of FADI score *per* group and the mean percentage recovery according to MMT ($p<0.05$).

In the group with FADI score 91%-100%, a mean percentage ROM value of 91%-100% was recorded in 14 of 29 subjects. In the group with FADI score 81%-90%, a mean percentage ROM value of 91%-100% was recorded in 7 of 13 subjects. Statistical analysis yielded a statistically significant correlation between FADI score and mean percentage ROM value by groups ($p<0.05$).

In the group with the mean percentage recovery according to ROM of 91%-100%, those with the mean percentage recovery according to MMT of 91%-100% predominated (17 of 26 subjects). In the group with the mean percentage recovery according to ROM

of 81%-90%, a mean percentage recovery according to MMT of 81%-90% was recorded in 8 of 24 subjects.

Statistical analysis revealed that there was a statistically significant association between the mean percentage recovery *per* ROM and MMT ($p<0.05$). Higher ROM values indicated higher MMT values and *vice versa*.

The results obtained are consistent with those reported by Decker *et al.*, who retrospectively evaluated 88 subjects by total ankle replacement (TAR) performed over two years. The proposed benefit of TAR is to preserve its mobility, and the authors hypothesized that increase in ROM was positively correlated with the results of other measurements in subjects who underwent surgery (TAR). The authors used the following measuring instruments to assess functional outcome of the subjects: FADI, Short Musculoskeletal Function Assessment (SMFA), visual analog scale (VAS), and 36-item Short Form Health survey (SF-36) as a short questionnaire on health condition. The results of their study also showed that the ankle final ROM was significantly correlated with postoperative FADI and other measuring instruments they used in their study. The authors conclude that subjects who undergo TAR in the final stage of osteoarthritis, at the end of the ROM-enhanced values, show direct correlation with the higher values of other measurement instruments used to measure their functional outcome[19].

Conclusion

The rehabilitation program resulted in statistically significant recovery of the musculature after MMT in subjects with bimalleolar or trimalleolar fracture of the ankle after surgery. The increase in the mean percentage recovery *per* ROM in these subjects also was statistically significant. The subjects with higher mean percentage recovery *per* MMT and ROM had higher FADI values and *vice versa*. The results of the research indicated the possibility of applying FADI not only in the case of instability, pain and poorer function of the ankle, but also after its fracture. Based on the results obtained, it can be concluded that FADI can be used as a measuring instrument for the evaluation of function in rehabilitation after ankle fracture. The effects of kinesitherapy after ankle surgery can be evaluated by FADI, as well as by MMT and ROM measurement. Based on the results obtained, the working hypothesis of the study was confirmed.

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Sažetak

PROCJENA UČINAKA KINEZITERAPIJE METODOM FADI NAKON PRIJELOMA NOŽNOG ZGLOBA

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Cilj istraživanja bio je analizirati vrijednosti FADI (*Foot and Ankle Disability Index*) nakon kineziterapije kod ispitanika s bimaleolarnim ili trimaleolarnim prijelomom nožnog zgloba poslije operacijskog liječenja te dobivene vrijednosti manualnog mišićnog testa (MMT) i opsega pokretljivosti (ROM) nakon rehabilitacije usporediti s dobivenim vrijednostima FADI i na osnovi toga procijeniti njegovu mogućnost primjene u procjeni funkcionalnosti ispitanika nakon operacije bimaleolarnog ili trimaleolarnog prijeloma nožnog zgloba. Uzorak je obuhvatio 60 ispitanika oba spola u dobi iznad 18 godina koji su zbog bimaleolarnog ili trimaleolarnog prijeloma nožnog zgloba imali operacijski zahvat u cilju zbrinjavanja prijeloma osteosintezom. Svi ispitanici su bili tretirani kineziterapijom kao dijelom programa poslijeoperacijske rehabilitacije. Istraživanje je provedeno od 2013. do 2018. godine na Odjelu ortopedije Kantonalne bolnice "Dr. Safet Mujić" u Mostaru i Sveučilišne kliničke bolnice Mostar. Nađena je statistički značajna korelacija između vrijednosti FADI po skupinama i prosječnog postotnog oporavka prema MMT-u ($p<0,05$), kao i statistički značajna korelacija između vrijednosti FADI po skupinama i prosječne postotne vrijednosti ROM-a ($p<0,05$). Utvrđena je statistički značajna povezanost između srednjeg postotnog oporavka prema ROM-u i MMT-u ($p<0,05$). Provedenim istraživanjem potvrđena je radna hipoteza provedene studije. Učinci kineziterapije nakon operacijskog zahvata nožnog zgloba mogu se jednakovrijedno procijeniti pomoću FADI kao i pomoću MMT-a i ROM-a.

Ključne riječi: *Nožni zglob; Prijelom; Kineziterapija; FADI*