Comparing the effectiveness of mobilization techniques with movement and myofascial techniques in patients following distal radius fractures treated conservatively

Porównanie skuteczności stosowania technik mobilizacji z ruchem i technik mięśniowo-powięziowych u pacjentów po złamaniu dalszej nasady kości promieniowej leczonych zachowawczo

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Key words
myofascial techniques, forearm fractures, physiotherapy

Abstract
Introduction: Fractures of the distal radius are one of the most common types in the upper limb area. They lead to significant reduction in range of mobility, muscle weakness and the occurrence of serious pain.

Material and methods: The research involved 20 patients from the Specialist Hand Rehabilitation Centre in Krakow, who were rehabilitated after fractures to the distal radial bone. They were randomly divided into two groups. In group A (n = 10), there were patients who underwent mobilization techniques with movement according to the Mulligan concept as part of their manual work. Group B (n = 10) consisted of patients subjected to myofascial techniques. Functional examination of the hand was carried out twice before and after beginning rehabilitation. The range of active mobility, muscle strength and superficial feeling were examined. Based on the obtained results, functional loss was calculated according to Swanson’s method, Total Active Motion and the sensory index. The obtained results were subjected to statistical analysis using the Excel 10 programme.

Results: Significant improvement in hand and muscle strength was noted in both groups. In the group of patients treated with myofascial techniques, better rates of improvement for the tested parameters were obtained than in the group treated with the use of joint mobilization techniques.

Conclusions: 1. The applied programme of rehabilitating patients following fracture of the distal radial bone is characterized by statistically significant improvement in hand function. 2. The use of soft-tissue techniques is a more effective method of hand function restitution than the method of mobilization with movement.

Stwór kluczowe
techniki mięśniowo-powięziowe, złamania przedramienia, fizjoterapia

Słowa kluczowe
mięśniowo-powięziowe, złamania przedramienia, fizjoterapia

Udział autorów: A – projekt badania, pracy; B – zebranie danych, informacji; C – analiza statystyczna; D – interpretacja danych; E – przygotowanie manuskrypcji; F – przeszukiwanie literatury

Artykuł otrzymano / received: 18.09.2017; zaakceptowano do publikacji / accepted: 07.02.2018

Sposób cytowania. Jamka K., Szczewichcz J., Pieniążek M., Kubasiak K. Comparing the effectiveness of mobilization techniques with movement and myofascial techniques in patients following distal radius fractures treated conservatively. Med Rehabil 2017; 21(4): 31-37. DOI: 10.5604/01.3001.0012.0895

Wersja internetowa (pierwotna) / internet version (original): www.rehmed.pl
INTRODUCTION
Fractures of the distal radial bone are one of the most common types of upper limb injuries. In recent years, the number of patients with this type of fracture reporting to ERs has been systematically increasing. Distal radial bone fractures usually occur as a result of falls onto the extended upper limb. Due to the large number of these fractures, physicians and physiotherapists strive to develop appropriate treatment protocols aimed at minimizing the risk of complications and optimizing the time needed for recovery. Fractures of the distal radial bone are traumatic injuries difficult to treat mainly because of the complex structure and biomechanics of the wrist area and the large variety of these fractures. In many distal radius bone fractures, surgical provision is necessary, mainly in unstable or osteoporotic fractures in the elderly. The main complications regarding these fractures are lesions and dysfunctions of the soft tissues. Rare complications include carpal tunnel syndrome and damage to tendons.

The rehabilitation of patients after fractures of the distal radial bone is based on many different methods and procedures. There are reports in which the authors use physical methods, e.g. EMS, TENS, laser therapy, ultrasounds and cryotherapy. In many reports, the results of using appropriate movement exercises and functional therapy are presented. In a large number of works, the authors show the results of therapy using various manual methods and physical methods used. Group A (n = 10) comprised patients who were mobilized with movement using the Mulligan concept and motor exercises (peg-board system exercises, Flextend, visual biofeedback, home programmes) were applied, and they differed in the manual methods used. Group B (n = 10) consisted of patients who were subjected to myofascial techniques – myo-

• Which methods of patient rehabilitation following distal radius fractures leads to better final results?

STUDY AIM
The aim of the present study was to compare the effectiveness of rehabilitation methods with movement according to the Mulligan concept and myofascial techniques in patients following distal radial bone fractures, including answering the following questions:

• Does the proposed programme of rehabilitation for patients after fractures of the distal radius bone result in improved hand function?

Table 1

| Characteristics of the studied groups | Group A | Group B | \( p \) |
|--------------------------------------|---------|---------|------|
| No. of subjects | 10      | 10      |      |
| No. of females | 9       | 9       |      |
| No. of males | 1       | 1       |      |
| Average age of subjects (years) | 54.4 ± 9.5 | 50.3 ± 13.5 | 0.22 |
| Average duration of rehabilitation (weeks) | 6.4 ± 2.2 | 6.2 ± 2.1 | 0.45 |
| Average time from injury to beginning rehabilitation (weeks) | 9.4 ± 1.6 | 9.8 ± 4 | 0.42 |
| Side of fracture occurrence | Dominant | 6       | 5   |
| Non-dominant | 4       | 5       |      |
| Type of performed work | Physical | 2       | 1   |
| Intellectual | 8       | 9       |      |
fascial loosening, the Fascial Distortion Model, muscle energizing techniques\textsuperscript{25–27}. Detailed characteristics of the subjects are presented in Table 1.

The tests were carried out twice – before and after rehabilitation. Based on the accepted standards, the range of active movements of the fingers and wrist were tested goniometrically; forearm rotation; global hand grip force was examined dynamometrically at the second (G2) and fourth (G4) width levels using a Jamar dynamometer; and superficial feeling was evaluated using Two-Point Discrimination. The measurements were performed by an experienced therapist who did not conduct the therapy or know to which group the subjects belonged. Based on the obtained results, functional loss was calculated according to the Swanson concept, Total Active Motion (TAM) and the sensory index in line with the methodology by Szczechowicz\textsuperscript{28–30}. The results of research were statistically analysed and presented using Excel 10. Descriptive characteristics of the studied groups were created and the significance of differences was calculated using the Student’s \( t \)-test (\( p < 0.05 \)).

**RESULTS**

In both groups, there was statistically significant improvement in the TAM index of the fingers, calculated on the basis of joint movement ranges (Table 2). The results did not differ significantly between the studied groups.

There was significant improvement in wrist and forearm movement in both groups (Table 3). Greater improvement was obtained in group B and these results were significantly differed between the groups.

The results of the percentage loss of thumb function, calculated according to the Swanson concept, showed statistically significant improvement in the range of the analysed parameters for both groups (Table 4). The differences between the groups turned out to be statistically significant only in the case of examination 2 in the following: CMCP joints (Lat.: carpmetacarpa-

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**Table 2**

| Results of Total Active Motion index (TAM) [°] | I finger | II finger | III finger | IV finger | V finger |
|---------------------------------------------|---------|----------|------------|-----------|----------|
| Group A Examination 1                      | 75.4    | 235.2    | 238.8      | 240.2     | 229.7    |
| Examination 2                              | 103.6   | 260.9    | 264.7      | 261.9     | 256.0    |
| Difference                                  | 28.2*   | 25.7*    | 25.9*      | 21.7*     | 26.3*    |
| Group B Examination 1                      | 92.0    | 208.2    | 219.5      | 217.6     | 212.4    |
| Examination 2                              | 122.0   | 258.3    | 265.2      | 264.6     | 259.8    |
| Difference                                  | 30.0*   | 50.1*    | 45.7*      | 47.0*     | 47.4*    |
| Significance of differences (\( \rho \)) between groups | Examination 1 | 0.14 | 0.09 | 0.16 | 0.1 | 0.18 |
| Examination 2                              | 0.01*   | 0.32     | 0.45       | 0.29      | 0.29     |
| Difference                                  | 0.43    | 0.08     | 0.12       | 0.05      | 0.09     |

*statistically significant differences (\( \rho < 0.05 \))

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**Table 3**

| Results of wrist and forearm range of movement evaluation [°] | Wrist | Forearm |
|-------------------------------------------------------------|-------|---------|
|                                                             | Extension | Flexion | Radial deviation | Ulnar deviation | Pronation | Supination |
| Group A Examination 1                                      | 32.6    | 36.7    | 10.6           | 16.4           | 66.2      | 46.0       |
| Examination 2                                              | 47.7    | 55.5    | 16.5           | 23.5           | 76.2      | 62.7       |
| Difference                                                 | 15.1*   | 18.8*   | 5.9*           | 7.1*           | 10.0*     | 16.7*      |
| Group B Examination 1                                      | 29.8    | 37.6    | 10.4           | 13.4           | 58.0      | 40.4       |
| Examination 2                                              | 57.7    | 65.3    | 21.2           | 25.1           | 79.9      | 77.7       |
| Difference                                                 | 27.9*   | 27.8*   | 10.8*          | 11.7*          | 21.9*     | 37.2*      |
| Significance of differences (\( \rho \)) between groups   | Examination 1 | 0.24 | 0.42 | 0.48 | 0.25 | 0.32 | 0.15 |
| Examination 2                                              | 0.01*   | 0.02*   | 0.03*          | 0.04*          | 0.02*     | 0.03*      |
| Difference                                                 | 0.01*   | 0.03*   | 0.02*          | 0.03*          | 0.01*     | 0.03*      |

* statistically significant differences (\( \rho < 0.05 \))
| Table 4                                                                 |
|------------------------------------------------------------------------|
| Results of percentage loss in thumb function according to Swanson's    |
| method [%]                                                             |
| CMCP                      Adduction   Opposition MCP IP Thumb totalled |
| Group A                  |
| Examination1             38.8         17.8      21.1      19.3   12.8    23.0  |
| Examination2             25.2         11.0      14.2      9.5    9.6     14.5  |
| Difference               13.6*        6.8*      6.9*      9.8*   3.2*    8.5*  |
| Group B                  |
| Examination1             40.3         19.3      21.0      18.9   9.3     22.1  |
| Examination2             16.0         9.0       7.0       7.4    5.1     8.5   |
| Difference               24.3*        10.3*     14.0*     11.4*  4.2*    13.6* |

Significance of differences (p) between groups:

- Examination1: 0.88, 0.81, 0.98, 0.96, 0.24, 0.85
- Examination2: 0.03*, 0.20, 0.01*, 0.33, 0.01*, 0.01*
- Difference: 0.14, 0.28, 0.07, 0.37, 0.27, 0.13

* statistically significant differences (p<0.05); CMCP – the thumb carpometacarpal joint (Lat. carpometacarpalis pollicis); MCP – metacarpophalangeal joint (Lat. metacarpophalangeae); IP – Interphalangeal joint (Lat. interphalangeae)

| Table 5                                                                 |
|------------------------------------------------------------------------|
| Results of percentage loss in wrist and arm function according to      |
| Swanson's method [%]                                                   |
| Extension Flexion Radial deviation Ulnar deviation Wrist totalled      |
| Hand totalled                                                          |
| Group A                  |
| Examination1             11.0         9.3       9.4       13.6    21.1    13.5  |
| Examination2             5.0          3.0       3.7       6.5     8.7     7.1   |
| Difference               6.0*         6.3*      5.7*      7.1*    12.5*   6.4*  |
| Group B                  |
| Examination1             12.2         9.0       9.7       16.6    22.8    14.6  |
| Examination2             1.6          0.4       1.6       4.9     3.3     4.4   |
| Difference               10.7*        8.6*      8.1*      11.7*   19.4*   10.2* |

Significance of differences (p) between groups:

- Examination1: 0.44, 0.86, 0.93, 0.08, 0.57, 0.76
- Examination2: 0.01*, 0.01*, 0.11, 0.03*, 0.01*, 0.04*
- Difference: 0.00*, 0.09, 0.13, 0.03*, 0.01*, 0.02*

* statistically significant differences (p<0.05)

| Table 6                                                                 |
|------------------------------------------------------------------------|
| Results of global hand grip strength [kg]                              |
| G2                       G4                                        |
| Group A                  |
| Examination 1            10.1          5.7*       12.4    |
| Examination 2            17.7         18.1       |
| Difference               7.6*         5.7*       |
| Group B                  |
| Examination 1            11.5          10.0      |
| Examination 2            22.6         20.0      |
| Difference               11.1*        10.0*     |

Significance of differences (p) between groups:

- Examination 1: 0.34, 0.27
- Examination 2: 0.07, 0.29
- Difference: 0.19, 0.13

* statistically significant differences (p<0.05)
lis pollicis), IP (Lat.: interphalangeae) and the whole thumb.
Significant improvement in hand function was achieved in both groups (Table 5). Significantly greater improvement was obtained in group B. Also, in the entire wrist area as well as in individual movements, there was statistically significant improvement in both groups regard the percentage loss of function (Table 5). Differences between groups turned out to be statistically significant, in favour of group B.

Statistically significant improvement in global gripping force was achieved at the second (G2) and fourth (G4) grip width levels in the studied groups, but the results did not significantly differ between the groups (Table 6).

Improvement in sensory index was also obtained in both groups (Table 7). For the ulnar nerve, this improvement was statistically significant. The results did not differ significantly between the groups.

DISCUSSION
Distal radius fractures are one of the most frequent types of upper limb fracture, and those especially at risk (mainly women) are in the 60-70 age group19–31. In our research, the mean age of patients was 52.3 (54.4 – group A and 50.3 – group B), and women accounted for 90% of the subjects. The evaluated group began rehabilitation relatively late after the fracture. In our case, the average time that passed from injury to the beginning of rehabilitation was 9 weeks. Assuming that immobilization time after fractures is usually 4 to 6 weeks, rehabilitation should start as soon as it is removed.

Despite such a high frequency of fractures, there is no single, universal method for treatment. Many studies and authors indicate the effectiveness of various methods of conservative and postoperative procedures. The goals of rehabilitation, which include, among others, maintaining and increasing the range of motion in joints not directly affected by damage, increasing the range of movement of the affected joint, reducing pain and edema, improving soft tissue mobility, increasing limb activity during everyday activities, increasing hand strength, returning to earlier functional level, are implemented in various ways, using all available therapeutic means. While rehabilitating patients, attention is paid to the effectiveness of exercises in the field of kinesiotherapy, therapeutic methods (e.g. PNF), occupational therapy, functional muscle stimulation, static progressive and dynamic bracing (orthosis), early controlled movement, isometric massage, manual therapy or physical agents treatments. Many authors focus on the importance of patient education and home programmes16–23,32. The results of the various forms of therapy, often used in different combinations, on the one hand, demonstrate efficacy and often very good final and long-term results of fracture treatment, but on the other, they also indicate a large percentage of complications and problems for the patients. The most frequent and the most troublesome for patients include soft tissue defects and dysfunctions, Sudeck’s syndrome, irritation of the median or radial nerves, sensory disturbances, stiffness of the wrist and finger joints, pain during axial limb loading, reduction of hand strength or limitation of everyday functioning8–15,32.

Patients being rehabilitated at our Centre undergo routine examinations concerning range of motion, muscle strength and sensation during the first visit. On their basis, in conjunction with the previous interview and functional expectations of patients, the rehabilitation programme is individually determined. Cyclic repeatability of measurements allows to modify and intensify the therapeutic programme on an ongoing basis, adapting it to current needs and possibilities. In the case of patients from the studied groups, the applied programme practically did not differ in the scope of its basis. It mainly involved exercises using the peg-board system, enabling resistance exercises in practically all muscle groups within the wrist and hand. At the subse-

| Group A | Median nerve (norm – 28 pts.) | Ulnar nerve (norm – 12 pts.) |
|---------|-------------------------------|-------------------------------|
| Examination 1 | 26.7 | 10.3 |
| Examination 2 | 27.9 | 11.6 |
| Difference | 1.2 | 1.3* |

| Group B | Median nerve (norm – 28 pts.) | Ulnar nerve (norm – 12 pts.) |
|---------|-------------------------------|-------------------------------|
| Examination 1 | 27.0 | 11.2 |
| Examination 2 | 27.9 | 11.9 |
| Difference | 0.9 | 0.7* |

| Significance of differences (p) between groups | Median nerve (norm – 28 pts.) | Ulnar nerve (norm – 12 pts.) |
|-----------------------------------------------|-------------------------------|-------------------------------|
| Examination 1 | 0.36 | 0.07 |
| Examination 2 | 0.5 | 0.18 |
| Difference | 0.41 | 0.2 |

* statistically significant differences (p<0.05)
quent stage of rehabilitation, in order to increase the range of motion and strengthen the muscles, exercises at higher intensity levels and those more functional were used. The programme included exercises via the Flexextend system as well as elements of visual biofeedback using Hercules and Biometrics sets. In the field of physical therapy, magnetic fields, laser therapy, fluid therapy and functional muscle stimulation were used. A very important element of therapy was the home-based programme, which was tailored to each patient and regularly updated. An important difference in rehabilitation regarded the various manners of applying manual work. In some patients (group A), mobilization with movement using the Mulligan concept was used, while in the second case (group B), myofascial techniques (muscular fascia loosening, Fascial Distortion Model and muscle energizing techniques) were performed. Despite the random selection of patients, there were no statistically significant differences between the study groups. Both the average age and duration of rehabilitation were similar, as well as the period from injury to beginning rehabilitation.

The obtained results indicated effectiveness of both therapeutic programmes. In both groups, statistically significant improvement was achieved in virtually all of the analysed parameters. Significant improvement was observed both in relation to the TAM index, the percentage of hand function deficiency computed according to the Swanson methodology, and in terms of the global grip force.

In the group using myofascial techniques, almost two times greater improvement in the TAM index for the 2nd and 5th fingers was obtained. This, however, did not affect achieving better final results of rehabilitation, which were very similar in both groups. The difference was due to the fact that patients from this group achieved worse initial results. Analysis of the TAM index for the thumb shows slightly worse results in group A, both in the first and second examinations, although the obtained difference (between exam 1 and exam 2) is practically the same in both groups. In general, there were no statistically significant differences between the analysed groups.

Analysing the results of the percentage decrease in function of particular wrist and thumb joints and the entire hand calculated according to the Swanson methodology, it can be seen that in examination 1, they are similar to each other. In examination 2, smaller functional defects were noted in group B for all the analysed parameters, although not in all cases were there statistically significant differences between the obtained final results and both groups.

Analysis of wrist and forearm movement showed slightly smaller values of movement ranges for examination 1 in group B in the case of extension, ulnar deviation, pronation and supination. Examination 2 found larger ranges of all assessed movements, and differences between groups were statistically significant. Filipova et al. presents the results of patients treated conservatively. He compares two groups - one only subjected to physiotherapy (PT) and the other, in which, apart from physiotherapy, occupational therapy (PT + FOT) was used. The total range of movement obtained at the end of treatment was -116 (PT) and 112 (PT + FOT) degrees in the sagittal plane of the wrist; and 161 (PT) and 156 (PT + FOT) degrees in rotation range of the forearm. In our research, this was 103 (group A) and 123 (group B) degrees for the wrist and 139 (group A) and 156 (group B) degrees for the forearm, respectively. It should be noted, however, that the patients studied by Filipova et al. started rehabilitation right after immobilization was removed, i.e. 4-8 weeks after the fracture, when in our group of subjects, it was as much as 9 weeks after the fracture. In turn, in our study, the rehabilitation time was, 6 weeks on average, and in the cited studies, 3 weeks.

The assessment of global hand grip strength in examination 1 demonstrated slightly higher strength assessed at the second level of grip width and smaller at the fourth in group B. This group also achieved greater improvement in strength and higher values at the end of rehabilitation. However, the differences between the groups were not statistically significant. In their study, Filipova et al. also analysed changes in global hand grip strength, presenting them as percentages equated to the norms of Mathiowetz et al., according to the standards taking age, gender and dominant limb proposed by Bohannon et al. into account. The values obtained in the final examination amounted to 44% (PT) and 56% (PT + FOT). By making analogous comparisons in our group of respondents, 63% (group A) and 81% (group B) of maximum strength values were obtained, respectively. It seems, however, that a more appropriate reference for strength is to compare it to that of the opposite limb, which takes individual factors (other than age, sex or dominating side, such as structure, hand and forearm shape index, performed occupation or other non-professional or sports-related activities) affecting its value into account.

Analysing the results of sensation showed statistically insignificant improvement in the indicators of median and ulnar nerve sensation. In both exams and groups, this parameter was at a similar level (slightly lower values were noted in group A in exam 1). Many other authors present the results of their research demonstrating and comparing different methods of conservative procedures, but unfortunately based only on the DASH questionnaire, which is difficult to compare with the results of our research.

The small number of groups and the lack of unambiguous, statistically significant differences between them in the final results does not allow to draw conclusions supporting the effectiveness of one of the therapeutic methods. However, the visible variation in results indicates the need to individualize rehabilitation programmes, depending on the needs of specific patients and based on the results of physiotherapeutic evaluation. Similar conclusions are presented by Filipova et al. comparing conservatively treated patients follow-
ing distal radial bone fractures, analysing the results of rehabilitation using physiotherapy as well as physiotherapy and occupational therapy. They point to the desirability of including functional therapy for individuals with significant strength loss in the programme of functional therapy. The often emphasized therapeutic approach is also of importance, which Professor Dega already spoke of many years ago in the Polish rehabilitation model. One cannot insist on the effectiveness of one, chosen or preferred therapeutic method, ignoring the significance of others.

CONCLUSIONS

1. The applied programme for rehabilitating patients following fractures of the distal radial bone is characterized by statistically significant improvement in hand function.

2. The use of soft tissue techniques is a more effective method of hand function restitution than the method of mobilization with movement.

Conflict of interest: none

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