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Efekt terapeutyczny działania krioterapii miejscowej na staw kolanowy, uzależniony od rozpoznania choroby zwyrodnieniowej

Profil chorych kierowanych do leczenia w zakresie rehabilitacji ogólnoustrojowej

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Ocena postępów leczenia usprawniającego w reumatoidalnym zapaleniu stawów za pomocą biomechanicznej analizy czynności stawu łokciowego

Assessment of the effects of rehabilitation interventions for patients with rhematoid arthritis using biomechanical analysis of elbow function

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Streszczenie:

Wstęp. Celem przedstawionej pracy jest weryfikacja metody oceny funkcji stawu łokciowego, metody, która u chorych z reumatoidalnym zapaleniem stawów pozwoliłaby na monitorowanie postępu choroby i ocenę efektywności usprawniania leczniczego i fizjoterapeutycznego.

Materiał i metody. Badaniami charakterystyk cyklicznych ruchów zginania i prostowania przedramienia w stawie łokciowym objęto grupę 82 osób. Stanowisko pomiarowe składało się z kontrolowanego komputerowo urządzenia do badania ruchów w stawie łokciowym (manipulandum). Urządzenie to pozwala na badanie stanu czynnościowego stawu łokciowego przy wykonywaniu cyklicznych izokinetycznych ruchów zgięcia i wyprostu. Ruch wykonywany był: 1. z minimalną szybkością, najwolniejszy jaki był możliwy do wykonania przez pacjenta, 2. z preferowaną szybkością – szybkość ruchu zależała od woli i nawyków badanego, 3. szybki – wykonywany z największą możliwą do wykonania szybkością. Badania przeprowadzono dwukrotnie – na początku i na zakończenie trzytygodniowego leczenia usprawniającego.

Wyniki. Otrzymane wyniki pokazują że leczenie usprawniające spowodowało poprawę kilku parametrów badanych ruchów. Zwiększeniu uległa amplituda (zakres) ruchu oraz prędkość kątowa w szczególności fazy prostowania, a także zmniejszyła się wartość współczynnik asymetrii. Nie stwierdzono natomiast wzrostu częstotliwości wykonywanych ruchów i istotnych zmian dotyczących okresu, zarówno szybkości preferowanej jak i maksymalnej.

Wnioski. Podsumowując uzyskane wyniki badań nad diagnostyczną przydatnością biomechanicznej analizy czynności stawu łokciowego przy użyciu aparatu typu manipulandum w RZS można stwierdzić że zastosowana metoda badania ruchów izokinetycznych pozwala na obiektywną ocenę patologicznych zmian w stawie oraz ocenę efektywności usprawniania leczniczego i fizjoterapeutycznego. Analiza zebranego materiału badawczego wykazała, że dla uzyskania wiarygodnych informacji o stanie funkcjonalnym pacjenta badanie powinno być wykonane w warunkach ruchów preferowanych i szybkich. Miałoby to dużą wartość zwłaszcza w doborze odpowiednich metod fizjoterapeutycznych.

Słowa kluczowe:

rehabilitacja, łokieć, biomechanika, reumatoidalne zapalenie stawów

Abstract

Background. *The aim of the investigations was to verify the effectiveness of a method of elbow function evaluation in patients with rhematoid arthritis. The method was expected to allow monitoring of disease progression and to help assess the effects of rehabilitation interventions.*

Material and Methods. Cyclic flexion-extension movements in the elbow joint were examined in 82 individuals. The measurements were carried out with a computer-controlled unit for studying elbow movements (manipulandum). The study participants performed movements 1) of minimum speed, ie., the slowest possible movement, 2) of preferred speed consistent with patient preferences and habits, and 3) of maximum speed. The measurements were carried out before and after a 3-week rehabilitation program.

Results. *The obtained results indicate that the rehabilitation intervention caused improvement in several parameters of the investigated movements. Movement amplitude (range of movement), angular velocity (especially angular velocity of elbow extension) increased, the symmetry index decreased while no changes were observed in movement cycle duration for preferred and maximum speed.*

Conclusions. *The results indicate that this method of isokinetic movement evaluation allows objective assessment of articular pathologies and rehabilitation/pharmacotherapy outcomes. Our investigations suggest that, in order to obtain reliable information on the patient's functional status, the measurements should be performed during preferred and maximum speed elbow movements. Information thereby obtained might be of considerable importance for selection of appropriate physiotherapy interventions.*

Key words:

rehabilitation, elbow, biomechanical, rheumatoid arthritis

Introduction

Changes within the elbow rarely occur during the initial stages of rheumatoid arthritis (RA); Elbow osteoarthritis typically affects middle-aged men who engage in strenuous manual activity [1]. Primary osteoarthritis of the elbow is an uncommon condition accounting for 2.1 to 3.0% of all cases of degenerative joint disease. After a few years, during the chronic stage of RA, pathologic changes within the elbow are diagnosed in as many as 41 to 68% of the patients [2]. Since the elbow is a joint which does not provide any support to body weight, rheumatoid lesions might initially remain asymptomatic. Usually both elbows are affected, but, interestingly enough, lesions tend to be more severe in the dominant hand.

Acute osteoarthritis of the elbow is associated with painful flexion contracture which interferes with the performance of several everyday routines including washing, hair combing and brushing and eating [3, 4]. Later stages involve severe damage to articular surfaces resulting in range of motion limitation and chronic contracture [5].

RA literature search has revealed a lack of research into the patient's condition and therapy outcomes based on objective assessment of the functional status and therapeutic strategies used. The majority of researchers studying the elbow during the acute stage of RA relied on subjective experience of their patients [6, 7, 8, 9]. Questionnaires and tests in hand and forearm pathologies often produce results that are far from homogenous; the majority of the findings are based onrespondents' self-assessment [10, 11]. Therefore it seems important to undertake investigations based on biomechanical analysis of elbow function. Such measurements are of particular importance in the acute stage of the disease. Objective data on the mobility of the affected articulation would facilitate the assessment of disease severity, selection of optimal physiotherapy interventions and effective pharmacotherapy [12].

Patients and methods

Study material

The study was approved by the Bioethics Committee for Scientific Research. All candidates were informed about the aim and character of the research and gave written consent to participate in the study. Eighty-two patients were recruited. The study group (Group S) comprised 42 patients of the Department for Rheumatic Diseases. There were 26 women and 16 men aged 35 to 75 years. All participants were diagnosed with rheumatoid lesions within the elbow. Disease severity was graded with the Steinbrocker Staging System; four patients were classified under Class II, 24 under Class III

and 14 under Class IV. Baseline evaluation also included the assessment of physical dysfunction the using the Mayo Elbow Performance Index . All patients scored below 60 points; 20 patients scored 55, 17 patients scored 35 and 5 patients scored 30 points.

In Group S, elbow function was examined twice, ie., at the baseline and at the end of hospital treatment (prior to and after the therapy). In order to eliminate the influence of the circadian rhythm [13], all examinations were performed at a fixed time, ie., after morning gymnastics.

During a 3-week stay in hospital all study participants also received pharmacotherapy. Thirty-three patients were treated with encorton- POLFA SA. Pabianice, Poland synthetic anti-inflammatory glucocorticoid and methotrexate EBEWE Holzkirchen, Germany – an immunosuppressive drug with therapeutic effects usually observed over 6 weeks. Seven patients were also given methotrexate, but, instead of encorton, used betamethasone sodium phosphate (Diprophos) MSD. Warszawa, Poland or methylprednisolone sodium acetate (Solu-medrol) Pfizer, Kent, United Kindom. Two patients with lumbar discopathy were given myolastan – a skeletal muscle relaxant. The majority of patients also received medication to treat other ailments (effox, cardonit, enarenal, asotopirin). Along with pharmacotherapy, each patient underwent a series of physiotherapy interventions. Thirty-six patients received liquid nitrogen cryotherapy in the area of the knee (20 sessions), elbow (10 sessions), ankle (5 sessions), shoulder (2 sessions), wrist (6 sessions) hands (10 sessions) and feet (3 sessions). Fifteen patients underwent diadynamic therapy, especially in the area of the knee (5 sessions), shoulder (3 sessions), elbow and cevical spine (2 sessions each), ankle, hips and hand joint (1 session each). Fourteen patients received ultrasound treatment in the area of the ankle (8 sessions), knee (3 sessions), feet (2 sessions), lumbar spine and hand joints (1 session each). Twelve patients underwent low frequency magnetic field therapy, and 10 underwent massage to facilitate tissue relaxation and improve blood supply. All participants took part in individual gymnastic sessions:

• decompression exercises with resistance (30 patients): gluteal muscle, quadriceps femoris, flexors and extensors of the elbow;
• self-assisted exercises (12 patients): shoulder girdle muscles;
• hand exercises to improve strength and range of motion (40 patients).

The control group (Group C) consisted of 40 participants including 25 women and 15 men aged 40 to 80 years. Osteoarticular diseases were ruled out by clinical history and physical examination. The control participants underwent one examination only.

Measuring station

The measuring station consisted of a computer-controlled apparatus for studying elbow movements (manipulandum) developed in the Motor Behavior Laboratory , University of Wisconsin-Madison, USA. The device allows the examination of elbow function during isokinetic flexion and extension. The manipulandum used in our investigations consists of a mechanical part, a movable arm fixed to a stationary base of support. Such a design allows easy (resistance-free) rotational movement of the manipulandum arm in relation to the base of support. A multi-rotation type linear potentiometer, with stabilized voltage supply, is attached to the axis of manipulandum rotation. Changes in mandibulandum arm position during the patient's forearm flexion and extension cause changes in the voltage signal. The signal of angular changes was sampled using a sampling frequency of 1000 Hz and stored on computer disk using the Axotape (Axon Instruments Inc., USA). After the experimental session, kinetic parameters of the movement were calculated with a specially designed computer software.

Study procedure

Each participant placed their right forearm on the manibulandum so that the elbow's axis ran parallel to to the axis of manipulandum rotation. The forearm position was secured with a forearm and hand positioning device and hand grip. In order to eliminate the effect of gravitation on elbow movements, the upper limb was positioned horizontally. As a result, the plane of elbow movements ran vertically to gravitational forces. Gravitation effect was fully eliminated due to the properties of the measurement station allowing support to each of the three segments of the upper limb. Body position was also stable.

During the testing procedure, our study participants performed cyclic forearm extension and flexion movements with different angular velocities. The following movement speeds were studied:

• Slow movement – the slowest movement possible for each particular patient,

• Preferred speed movement – movement speed was consistent with patient preferences and habits,

• Maximum speed movement – performed at the fastest possible speed.

Each measurement session comprised three tests (each at a different velocity) repeated three times. The interval between each test lasted 1 minute. The duration of a single session did not exceed 20 minutes.

Movement parameters

Based on the registered signals movement parameters were calculated for the study and control groups. Linear and angular parameters of each movement were analysed using descriptive statistics. The following movement parameters were calculated and analyzed:

1. Amplitude (range of elbow movements) [rad]
3. Movement frequency [Hz]
4. Duration of movement [s]
5. Angular velocity of elbow extension [rad/s]
6. Angular velocity of elbow flexion [rad/s]
7. Symmetry index within a movement cycle defined as the duration of flexion to extension components within one movement cycle.

Biomechanical assessment comprised of spatiotemporal properties of cyclic movements. Spatial analysis of movement included the determination of movement direction (flexion, extension) and amplitude whereas the temporal analysis included the duration of particular movement phases as well as time-frequency analysis of a movement cycle.

Statistical analysis

Descriptive statistics was calculated for research data including the means, standard deviations, the ranges of particular parameters in the study and control groups as well as for each movement speed.

In the study group, the above mentioned parameters were calculated both before and after rehabilitation interventions. The results were hypothesized to have normal distribution; the hypothesis was assessed using the Shapiro-Wilk test. If the significance value of the Shapiro-Wilk Test is greater than 0.05, the data is normal. If it is below 0.05, the data significantly deviate from a normal distribution.

Nonparametric tests were used to analyse the significance of differences between the examined parameters in the study group (before and after rehabilitation) and the control, separately for each type of movement. Intergroup comparisons were performed with the Mann–Whitney U test. The Mann-Whitney U test is considered the nonparametric alternative to the independent t-test. The level of significance was set at $p<0.05$.

Results

Based on the obtained data, we evaluated the characteristics of cyclic flexion-extension movements in the elbow joint under three experimental conditions:

1. slow movement
2. preferred speed movement
3. maximum speed movement.

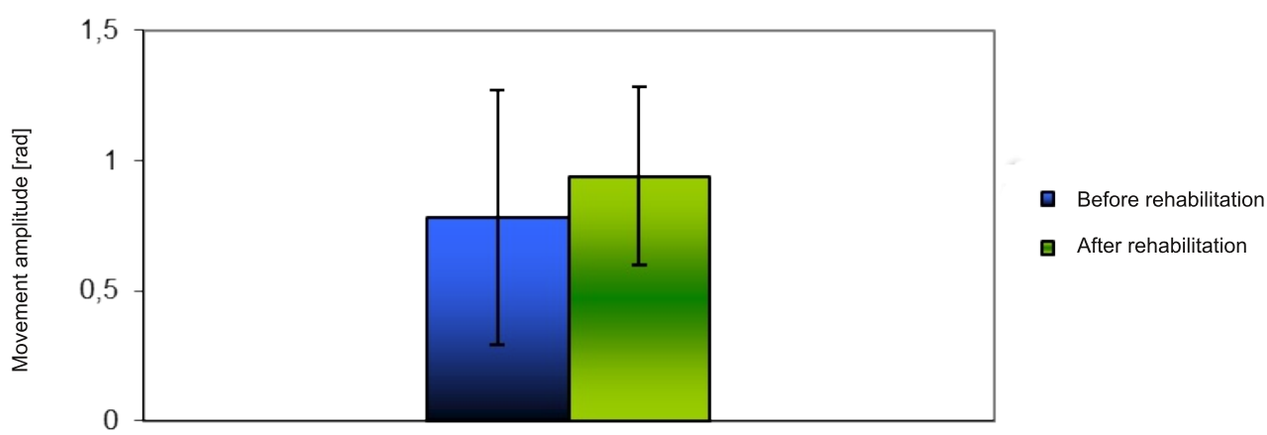
The preliminary analysis of the research findings revealed that RA patients experienced considerable difficulties when performing slow cyclic movements at a constant speed. Thus, slow movement did not satisfy any of the four requirements to perform a one-way ANOVA test:

1. Normal distribution.
2. Adequate sample size, ie., n>100.
3. Variance stability.
4. Linear effect of several factors (age, pharmacotherapy, rehabilitation).

Statistical analysis was performed to compare pre- and post-rehabilitation parameters of cyclic movements in the elbow joint. Preferred movement frequency did not change as a result of rehabilitation interventions; the mean value of this parameter before and after rehabilitation was 0.33 (SD 0.11) Hz (range 0.15-0.62 Hz) and 0.31 (SD 0.18) Hz (range 0.17-0.52 Hz), respectively. The Wilcoxon test confirmed the lack of significant improvement in preferred movement frequency ($z=0.78$, $p<0.43$). Statistical analysis of preferred movement's cycle duration also did not demonstrate any significant effect of rehabilitation ($z=0.08$; $p<0.93$). Mean values of this parameter were comparable before and after rehabilitation and amounted to 1.97 (SD 0.91) vs. 1.95 (SD 0.95) s, respectively.

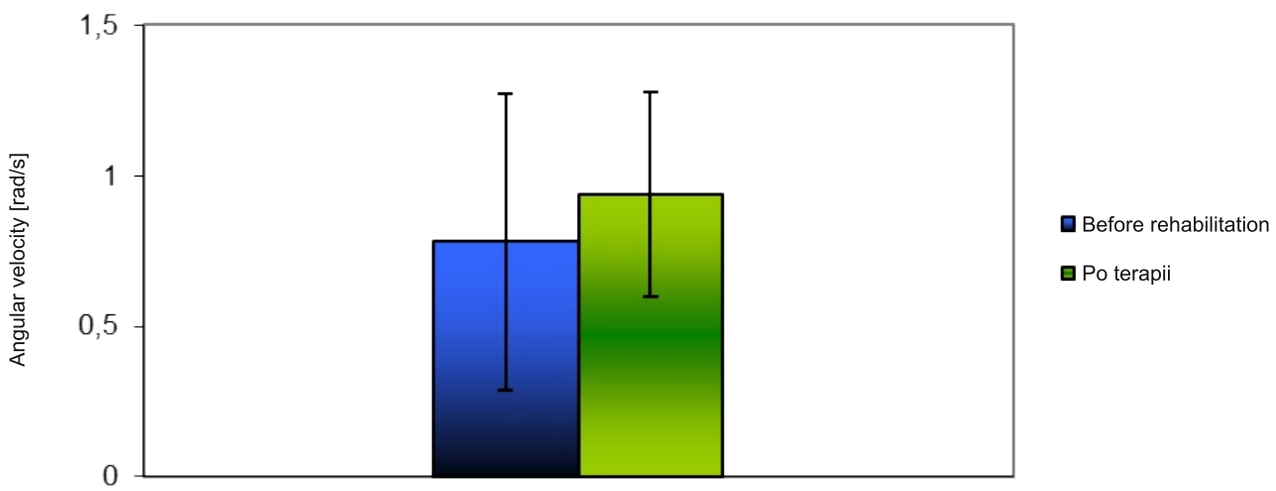
Amplitude (range of movement) is another important characteristics of cyclic movement. A comparison of pre- and post-rehabilitation movement amplitudes revealed an increase in preferred speed movement amplitude from 1.3 (SD 0.66) rad to 1.55 (SD 0.39) rad. The Wilcoxon test for paired samples revealed that mean amplitude change was statistically significant ($z = 2.17$, $p<0.03$).
An increase in preferred speed movement amplitude was seen in 28 patients (66.67% of the study population) [Fig 1].

Fig. 1. RA patients - mean amplitudes of preferred speed movement before and after rehabilitation intervention



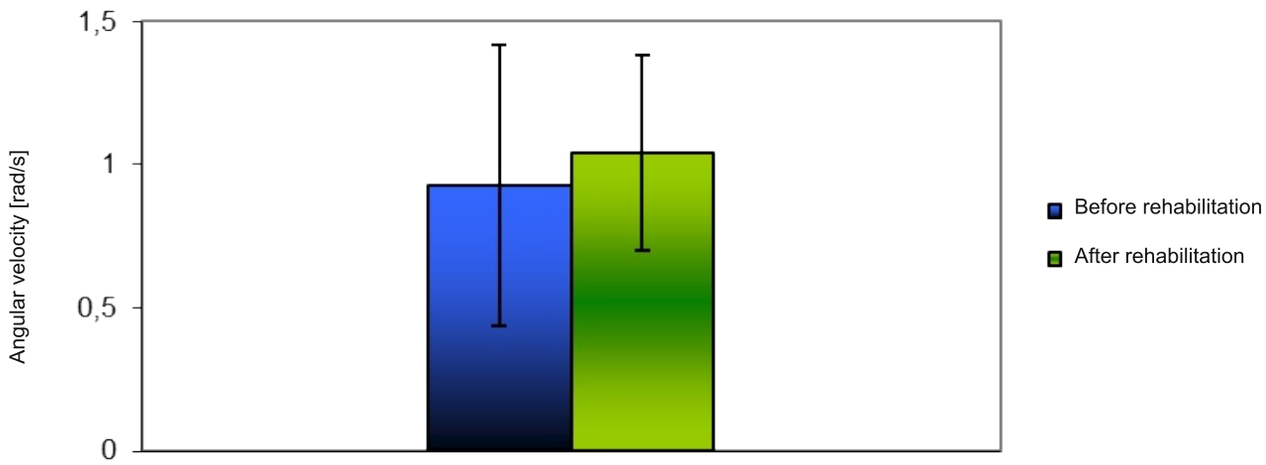
Although the mean frequency of preferred speed movement did not change, positive changes were found regarding the pattern of movement cycle.
Elbow extension angular velocity increased significantly after rehabilitation intervention. Figure presents a graphical representation of mean values and standard deviations. Baseline and post-intervention extension angular velocities were 0.78 (SD 0.49) rad/s and 0.94 (SD 0.34) rad/s, respectively. The Wilcoxon test revealed that the difference was statistically significant at $z = 1.96$, $p<0.05$. An increase in angular velocity of elbow extension during preferred speed movement was observed in 31 patients (71.43 % of the study population) [Fig. 2].

Fig. 2. RA patients - mean (± SD) values of elbow extension angular velocity during preferred speed movement before and after rehabilitation intervention



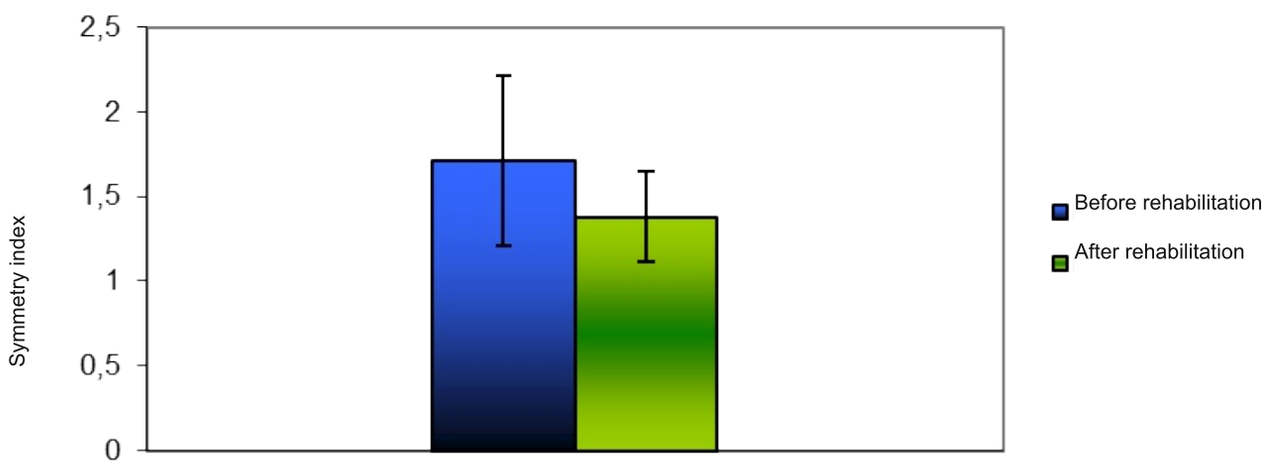
Angular velocity of elbow flexion also increased significantly after rehabilitation intervention; the increase exceeded 10%. Pre- and post-intervention flexion angular velocities were 0.93 (SD 0.5) rad/s and 1.04 (SD 0.35) rad/s, respectively. The Wilcoxon test confirmed the statistical significance of this change ($z =2.03$, $p< 0.04$). Post-rehabilitation increase in elbow flexion angular velocity during maximum speed movement was noted in 26 patients (61.90 % of the study population) [Fig.3].
RA patients exhibited considerable asymmetry of cyclic flexions and extensions of the elbow joint. Despite the post-rehabilitation angular velocity increase, the single-cycle flexion – extension was characterized by statistically

Fig.3. RA patients - mean (± SD) values of elbow flexion angular velocity during preferred speed movement before and after rehabilitation intervention



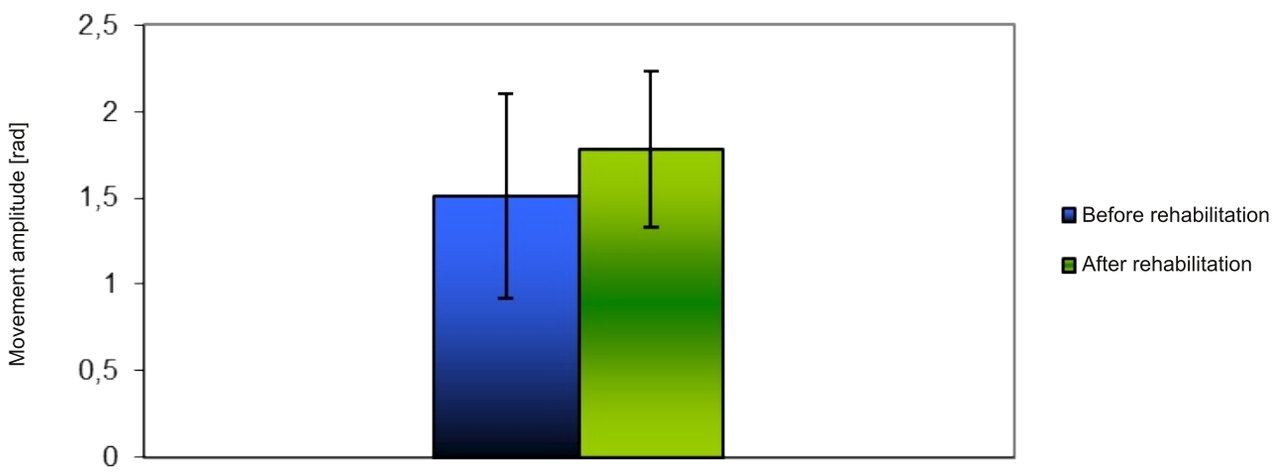
significant asymmetry (z = 4.097, p < 0.00042). The pre-rehabilitation flexion-extension symmetry index for preferred speed movement was high (preRSI = 1.71 (SD 1.01). Post-rehabilitation measurements revealed a marked improvement in flexion-extension symmetry which was evidenced by a decrease in the symmetry index (postRSI = 1.38 (SD 0.54). Statistical analysis confirmed that rehabilitation interventions produced statistically significant improvement in movement symmetry (z = 1.97, p<0.05). However, the symmetry of movements performed by RA patients still differed from that of our control participants. The Mann-Whitney test revealed that the significance of the pre- and post-rehabilitation intergroup difference was at the level of p<0.01 and p< 0.05, respectively [Fig. 4].

Fig. 4. RA patients – symmetry index before and after rehabilitation intervention



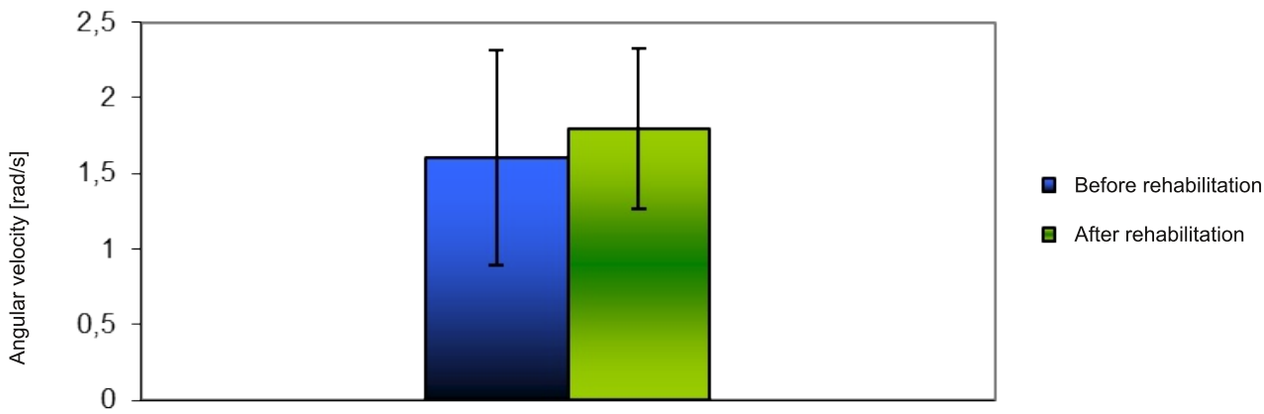
Some improvements in movement amplitude and angular velocity of elbow extension were observed during maximum speed cyclic movements performed after rehabilitation intervention. Movement frequency ($z=1.26$; $p<0.21$) and mean duration of a movement cycle ($z=0.69$; $p<0.49$) did not change. Post-therapy range of elbow motion was markedly improved in 26 patients (61.90% of the study population). Mean amplitude of maximum speed movements increased from 1.5 (SD 0.59) rad to 1.78 (SD 0.45) rad. The Wilcoxon test confirmed a significant effect of the therapy on the range of maximum speed movements at $z = 2.15$; $p<0.03$ [Fig. 5].

Fig. 5. RA patients - mean amplitudes of maximum speed movement before and after rehabilitation intervention



Another parameter which improved significantly following rehabilitation was angular velocity of elbow extension. The mean pre- and post-rehabilitation values were 1.6 (SD 0.71) rad/s and 1.8 (SD 0.53) rad/s, respectively. Nonparametric Wilcoxon test confirmed a significant effect of the therapy on elbow extension angular velocity at $z = 2.15$; $p<0.03$. Post-therapy improvement in elbow extension angular velocity was seen in 26 patients (66.67% of the study population). Angular velocity of elbow flexion did not show significant improvement ($z = 0.795$; $p= 0.43$) [Fig. 6].

Fig. 6. RA patients - mean (± SD) values of elbow extension angular velocity during maximum speed movement before and after rehabilitation intervention.



Discussion

Rheumatoid arthritis is a systemic inflammatory dis order, the most common form of inflammatory arthritis characterized by several symptoms including fatigue, swelling, pain, stiffness, limited range of motion and muscle weakness [14, 15, 16]. A combination of these symptoms along with reduced physical and mental capacity have negative impact on quality of life of RA patients.

Joint and muscle stiffness commonly described as morning stiffness in and around joints lasting at least 1 hour is among the revised diagnostic criteria for rheumatoid arthritis [17]. RA-related stiffness can be of non-muscular origin; it may result from compensatory strategies aimed at prevention of joint deformity and pain. Damage to joint surfaces results in increased friction between bones which are now devoid of articular cartilage. Since articular cartilage is not innervated [18], early injuries can progress to degeneration even before evident clinical symptoms emerge. Pain usually develops when the synovial membrane and bone tissues become affected and increased intra-articular friction causes nerve ending irritation. Such painful experience compromises movement fluency in patients with rheumatoid arthritis of the knee. [19] Valle et al. (2006) used the pendulum test of [20] Wartenberg (1951) to measure the effect of pathological changes in the knee on movement characteristics. Nine women with rheumatoid arthritis were compared to age-matched healthy controls. The subjects were half-lying; the relaxed knee was dropped from near-full-extension. The kinematics of leg oscillations was recorded using ultrasonic markers (Zebris CMS HS10). This noninvasive method revealed significant differences between passive knee motion in the study and control groups; the amplitude of the first swing as well as oscillation damping were different than in healthy individuals. Multivariate regression analysis demonstrated that increasing stiffness was the main factor to reduce knee flexion and extension. The authors consider the Wartenberg test a practical tool of biomechanical analysis of

the knee; they also believe the test could be used to follow up the effects of pharmacological and rehabilitation intervensions in rheumatoid arthritis. Nevertheless, the Wartenberg test is not useful for the examination of upper limb joints since it is difficult for the patient to assume a position in which to perform free oscillatory movements in the gravitational field. Therefore we focused on active cyclic movements. The working hypothesis was that increased stiffness of the kinematic chain was the main cause responsible of slower motion and decreased movement amplitude. The manipulandum was to help determine whether an analysis of active cyclic movement would facilitate assessment of rehabilitation interventions outcome.
The aim of the present study was to compare pre- and post-rehabilitation results of biochemical measurements. The maximum speed increased significantly which might evidence considerable improvement in joint function. Greater amplitude of movement proved an increase in range of motion. Joint flexion and extension became markedly faster during preferred speed movement indicating a significant improvement of range of motion. Our results suggest that not all movements performed by the patients might be used as outcome measures for rehabilitation programs. Several parameters of maximum and preferred speed movements did not seem to have been significantly influenced by therapeutic elbow joint interventions. Only movement amplitude changes clearly demonstrated the beneficial effect of rehabilitation.

Pre-rehabilitation parameters of the patients' maximum and preferred speed movement were significantly different compared to the control participants. Movement speed and frequency were lower and joint range of motion below normal. Thus, the patients' quality of life and functional status were substantially compromised compared to the control. In-hospital rehabilitation interventions resulted in a slight, although statistically significant, improvement in movement parameters. Amplitude increased and the symmetry of cyclic forearm motion, i.e., extension/flexion movements around the elbow joint, improved. The biomechanical assessment of the elbow joint used in this study facilitates quantification of movement dysfunction in RA patients and helps assess the results of rehabilitation interventions.

Results

The results of our investigations into diagnostic usefulness of manipulandum-based biomechanical analysis of elbow function in patients with rheumatoid arthritis indicate that this method of isokinetic movement evaluation increases the chance for objective assessment of articular pathologies and rehabilitation/pharmacotherapy outcomes. Our investigations suggest that, in order to obtain reliable information on the patient's functional status, the measurements should be

performed during preferred and maximum speed elbow movements. Such information would be of considerable importance for selection of appropriate physiotherapy interventions.

Kinesitherapy presently used for elbow osteoarthritis relies on passive exercises, where the exercising patient decides on movement speed and range of motion [21, 22, 23, 24]. The results of our investigations seem to emphasize a need for developing some other rehabilitation strategies. Interventions should still be based on passive movements, which, however, should be performed at the highest possible speed. Under such conditions, the patient is forced to concentrate on task performance and not pain-avoidance behaviour. Repeated flexion and extension exercises, especially with the elbow moving through a full range of motion, help alleviate the pain. It has been well established that RA patients usually report the greatest pain following a period of inactivity, eg., just after getting up in the morning.

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Piśmiennictwo/ References

1. Gramstad GD, Galatz LM. Management of elbow osteoarthritis. J. Bone Joint Surg 2006: 88: 421-30.
2. Gaździk T. Choroby stawu łokciowego. PZWL Warszawa; 2000.
3. Pomianowski S, Sawicki G, Grys G. Przykurcz stawu łokciowego- przyczyny, sposoby leczenia. Chir.Narz. Ruchu 1999; 64(1): 11-17.
4. Wójcik K. Uszkodzenie stawu łokciowego u dorosłych, Choroby stawu łokciowego. PZWL 2000; 146-153.
5. Morrey BF. The posttraumatic stiff elbow. Clin-Orthop-Res. 2005 Feb, 431: 26-35.
6. O`Connor D, Kortman B, Smith A. Correlation between objective and subjective measures of hand function in patients with rheumatoid arthritis. J. Hand Ther. 1999; 12: 323-329.
7. Kubiak J., Niemierzycka A., Skojarzona terapia fizykalna w leczeniu entezopoatii stawu łokciowego. Post. Rehab. 2002, 16(1): 5-13.
8. Maciak W., Łyp M., Ogonowski A., Targosiński P.: Epikondylopatia- zastosowanie fonoforezy z ketoprofenu w terapii. Med. Sport. 2002, 18(12): 507-512.
9. Smidt N., Assendelft W.J., Arola H.: Effectiveness of physiotherapy for lateral epicondylitis: a systematic review. Ann.Med. 2003, 35(1): 51-62.
10. Trudel D, Duley J, Zastrow I, Kerr EW, Davidson R, MacDermid JC. Rehabilitation for patients with lateral epicondylitis: a systematic review. J. Hand Ther. 2004; 17(2): 243-266
11.] Mika A, Mika P, Janusz M. Porównanie efektywności mobilizacji i klasycznego modelu rehabilitacji w leczeniu ograniczeń ruchomości stawów typu odwracalnego. Fizjoterapia 2001; 9(1): 5-9.
12. Lehman JF. Rehabilitation medicine: past, present and future. Arch. Phys.Med. Rehab. 1982; 63(7): 291-297.
13. Gauthier A, Davenne D, Van Hoecke J. Time of day effects on isometric and isokinetic torque developed during elbow flexion in humans. Eur. J. Appl. Physiol. 2001; 84: 249-252
14. Lee DM, Weinblatt ME (2001) Rheumatoid arthritis. The Lancet 358: 903-911
15. [14] Majewska K, Majewski D. Wpływ zmian zachodzących w stawach w przebiegu reumatoidalnego zapalenia stawów na jakość życia chorych. Nowiny Lek. 2003; 72: 444-447.
16. Rindfleisch JA, Muller D. Diagnosis and Management of Rheumatoid Arthritis. American Family Physician 2005; 72(6): 1037-1047.
17.] Arnett FC, Edworthy SM, Bloch DA, McShane DJ, Fries JF, Cooper NS. et al. The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. Arthritis Rheum. 1988; 31:315-24.
18. O'Driscoll SW. The healing and regeneration of articular cartilage. J. Bone Joint Surg 1998; 80-A(12):1795-1812.
19. Valle MS, Casabona A, Sgarlata R, Garozzo R, Vinci M, Cioni M. The pendulum test as a tool to evaluate passive knee stiffness and viscosity of patients with rheumatoid arthritis. Musculoskelet Disord. 2006; 7: 89.
20. Watenberg R. Pendulousness of the legs as a diagnostic test. Neurology 1951; 1:8-24.
21. Dega W. Ortopedia i rehabilitacja. PZWL Warszawa, 1983; 54-58.
22. Chinchalkar SJ, Szekeres M. Rehabilitation of elbow trauma. Hand-Clin. 2004; 20(4): 363-374.
23. Clelnd JA, Whitman JM, Fritz JM. Effectiveness of manual physical therapy to the cervical spine in the management of lateral epicondylalgia: a retrospective analysis. J. Orthop. Sports. Phys. Ther. 2004; 34(11): 713-722.
24. Kiwerska-Jagodzińska K, Mikuła W. Postępowanie leczniczo usprawniające w zwichnięciu stawu łokciowego. Post. Rehab. 1998; 12(1):143-151.