Analysis of the effects of the upper limb improvement programme in patients after ischemic stroke treated with botulinum toxin

Analiza efektów programu usprawniającego kończynę górną pacjentów po przebytym niedokrwiennym udarze mózgu leczonych toksyną botulinową

Elżbieta Mirek 1 (A,B,C,D,E), Kinga Opoka 3 (B,C,D,E,F), Krzysztof Kozioł 3 (A,B,C,D), Magdalena Filip 1 (A,C,D,E), Szymon Pasiut 1 (A,C,D), Jagoda Szymura 1 (A,C,D), Agnieszka Legwant 3 (A,C), Anna Wasielewska 2 (B,C), Michał Michalski 2 (B,C), Tomasz Tomszewski 2 (B,C)

1 Department of Clinical Rehabilitation, Section of Rehabilitation in Neurology and Psychiatry, University of Physical Education in Krakow
2 Department of Neurology with Stroke Unit and Neurological Rehabilitation Unit, Krakow
3 Doctoral studies (Ph.D). at the Department of Physical Education, University of Physical Education in Krakow, Poland

Key words
stroke, spasticity, botulinum toxin, neurorehabilitation

Abstract
Introduction: Stroke is not only a medical problem, but also – due to the permanent disability of the injured person – a significant social problem. A significant number of patients after a neurological event develop increased muscle tone. Upper motoneuron damage syndrome promotes pain, stiffness, muscle contracture and weakness, which can potentially delay or prevent success in the rehabilitation process. In the upper limb, the spastic pattern is most often expressed through adduction and internal rotation of the glenohumeral joint, combined with flexion in the elbow, radiocarpal joint and interphalangeal joints. The specificity of spasticity-type increased tension makes rehabilitation of patients suffering from this disorder one of the most difficult tasks of neurological rehabilitation.

Aim: The aim of the study was to assess muscle tone and range of motion of the inferior limb in patients after ischemic stroke subjected to 4 cycles of intramuscular injections of a botulinum toxin preparation and subjected to motor rehabilitation.

Research Project: Pilot experimental study.

Methodology: The study was carried out in the Neurological Unit with Stroke Sub-unit and Sub-Department of Neurological Rehabilitation at John Paul II Specialist Hospital in Krakow in the period from September 2014 to November 2015. The study group consisted of 20 patients after ischemic stroke (13 men, 7 women), age 30 to 72. All patients completed a 4-cycle study, which included injections of the botulinum toxin preparation, combined with a 15-day cycle of individual rehabilitation exercises. Each training session lasted 90 minutes. In order to verify the therapeutic process, active and passive mobility was measured according to the SFTR method and the assessment of muscle tone level was done using the Modified Ashworth Scale.

Results: The taken therapeutic actions caused a positive increase in mobility, mostly passive, in the glenohumeral-scapular, elbow and forearm as well as the radiocarpal joints. There was also a slight increase in active mobility of the upper limb joints. In the course of obtaining results, it was shown that the use of botulinum toxin, combined with the rehabilitation exercise programme, significantly reduced pathological muscle tone both within the elbow, radiocarpal joint, and the interphalangeal joints of the hands.

Conclusions: The presented results showed that the use of the botulinum toxin combined with medical rehabilitation allows local treatment of spasticity without exposing patients to adverse systemic reactions associated with oral medication. In addition, it has a positive effect on the increase in passive and – to a lesser extent – active range of motion in the joints of the inferior limb.

The individual division of this paper was as follows: a – research work project; B – data collection; C – statistical analysis; D – data interpretation; E – manuscript compilation; F – publication search

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INTRODUCTION

Stroke is not only a medical problem, but also because of the permanent disability of its victims, it is also a significant social problem. Critical brain ischemia is also one of the most common causes of long-term disability in adults, which generates significant costs associated with early hospitalization of patients, long-term care, rehabilitation and numerous adversities in the life of a patient. Increased spasticity-type tension, according to Lance’s definition, is a motor disorder characterized by an increase in tonic reflexes to stretching, depending on stretching pace, which is the result of displacement of the stretch reflex as a component of motoneuron damage at a higher level. Upper motoneuron damage syndrome promotes pain, stiffness, muscle contracture and muscle weakness, which can potentially delay or prevent success in the rehabilitation process. It can be noticed that spasticity occurs most frequently within the elbow (79%), wrist (66%) and ankle joint (66%). In the upper limbs, the spastic pattern is most often expressed through adduction and internal rotation of the glenohumeral joint, combined with flexion in the elbow joint, and the radiocarpal joint and the interphalangeal joints of the hands. The shoulder complex is lowered, its mobility is reduced limited. The specificity of increased spasticity-type tension makes rehabilitation of patients suffering from this disorder one of the most difficult tasks of neurological rehabilitation. Numerous unfavourable symptoms and complications associated with spasticity affect the significant reduction of quality of life in patients.

STUDY AIM

The aim of the study was to evaluate the benefits of treatment of stroke patients with type A botulinum toxin and motor rehabilitation.

The presented clinical experiment sought answers to the following questions:

1. Does botulinum toxin treatment combined with motor rehabilitation influence the range of active and passive mobility in the upper limb joints in patients after ischemic stroke?

2. Do intramuscular injections of botulinum toxin type A reduce the muscle tone in patients after ischemic stroke?

MATERIAL AND METHODS

The study was carried out at the Neurological Department with Stroke Sub-unit and the Neurological Rehabilitation Sub-unit at John Paul II Specialist Hospital in Krakow in the period from September 2014 to November 2015. The permission of the bioethical commission with the signature 99/KBL/OIL/2016 was obtained for conducting this experiment.
Qualification for testing was done by neurology specialist. The basic criterion for inclusion of patients in the research programme was a history of ischemic stroke. Other criteria for participation in the program were:
- age of at least 18 years,
- documented hospitalization for ischemic stroke,
- post-stroke spasticity of the upper limb (MAS≥2) in at least one muscle group,
- established date of medical rehabilitation no later than 3 weeks after administration of the drug.

The study program excluded patients:
- with severe swallowing or breathing disturbances,
- pregnant or breastfeeding,
- with myasthenic syndrome,
- taking drugs that inhibit neuromuscular transmission (e.g. aminoglycosides),
- with symptoms of general infection,
- with the presence of inflammation within the planned injection site,
- with dementia (MMSE test ≤18 points) – not applicable to patients with aphasia, alexia or agraphy who take acenocoumarol or warfarin and on the day of drug administration, had INR value exceeding 2.5,
- with persistent upper limb contracture or muscle atrophy in the affected limb,
- with hypersensitivity to the neurotoxin complex or any of botulinum type A (BOTOX A) components that have severe side effects after drug administration,
- having a baclofen pump,
- resistant to the drug.

### Research methods

The measurements conducted in the experiment included the evaluation of active and passive mobility of the occupied and indirectly occupied upper limb in the glenohumeral-scapular, elbow, antebrachial and the radiocarpal joint in accordance with the SFTR method using a goniometer. Patient positioning and alignment of the goniometer axis were made in accordance with the applicable standards. The measurement of the range of motion in the joints of the indirectly occupied upper limb did not deviate from the norm. The goniometric examination included analysis of passive and active mobility successively in the joints of the limb affected by paresis:

1. The glenohumeral-scapular joint – movements in the sagittal, transverse, frontal and rotational planes.
2. The elbow joint – movements in the sagittal plane.
3. The antebrachial joint – movement in the rotational plane.
4. The carpal joint – movements in the sagittal and frontal plane.

Another measurement was conducted to assess the spasticity level of muscle groups in the upper limb using The Modified Ashworth Scale – MAS. The research considered muscles including the elbow joint, the radiocarpal joint and the interphalangeal joints of the hands. The measurements were made in accordance with the applicable standards by a qualified physician and physiotherapist. The therapists conducting rehabilitation exercises were excluded from the process of clinical evaluation of patients.

### Treatment procedure

The treatment procedure was conducted by a multidisciplinary team consisting of physicians and physiotherapists. Treatment included multifactorial procedures described below as “combination therapy”. Combination therapy consisted of the following interactions:

1. Injection of botulinum toxin type A;
2. Movement therapy.

Patients were injected with BOTOX (Botulinum Toxin Type A) using sterile 25, 27 or 30 G needles in the superficial and long muscles in the deep muscles. In controlled clinical trials, doses of 100 units of BOTOX A were administered to patients. They were divided between occupied muscle groups and administered during one procedure under the control of an ultrasound machine. The patients were given the following muscle injections: deep flexor of the fingers (15-50 units), superficial flexor of the fingers (15-50 units), flexor carpi radialis (15-60 units), flexor carpi ulnaris muscle (10-50 units), thumb flexor (20 units) and the biceps brachii flexor (50-100 units). Injections were performed by a neurology specialist.

The patients qualified for the research programme were subjected to 4 cycles of intramuscular injections of the botulinum toxin. Subsequent applications of Botox were performed every 12 weeks. Each time, 3 weeks after the injection, the patients took part in a 3-week programme of individual therapeutic exercises. Participants were subjected to clinical evaluation at the time they were qualified for each of the 4 stages of the study programme, as well as upon completion of each study programme. During the improvement training, they were required to go to therapy 5 days a week. Each session lasted 90 minutes. During the programme, specialized exercises were carried out to improve functioning of the upper limb and improve the overall fitness of the patients.

Patients participated in individual rehabilitation sessions at a gym. Each time, motor training was preceded by 30-minute muscle elongation with increased tension using a pneumatic cuff (Photos 1 and 2). Then, they took part in the 60-minute improvement programme which consisted of a warm-up lasting 10 minutes, including mobilization of joint, nerve,
muscular and fascial structures, and education of how to shift body weight to the directly occupied side (Photos 3 and 4). The introductory part was followed by the 40-minute main part, which included activities, i.e. active muscle exercises of the indirectly occupied limb with simultaneous support on the paretic limb injected with Botox A, active and supported exercises of the inferior limb muscles in closed kinematic chains, shaping a correct movement pattern and inhibition of associated reactions, exercises to effectively and efficiently interact with a changing environment using utensils (i.e. water bottles, cup, towel, clothes), manipulative exercises of the paretic upper limb (Photos 5, 6 and 7). The therapy was completed with 10-minute calming exercises.

Methods of statistical analysis

The obtained results were subjected to statistical analysis using the Statistica 9.1 programme. A significance level of 0.05 was assumed for all tests. For the analysis of changes in active and passive mobility of the upper limb joints in patients after ischemic stroke, after four cycles of botulinum toxin type A injection, the Student’s t-test for dependent samples was used. To determine the effect of type A botulinum toxin on the muscular tone of patients after ischemic stroke, after four cycles of botulinum toxin injection type A the Student’s t-test for dependent samples was used.

RESULTS

The data obtained during the measurements of active and passive mobility of the upper limb in the glenohumeral-scapular, elbow and antebrachial and radial-carpal joints revealed significant statistical improvement in passive mobility: in the glenohumeral-scapular, the passive extension movement increased on average by 23.25° ($p = 0.000$) (Table 2), horizontal flexion – on average by 10.9° ($p = 0.0054$) (Table 2), internal rotation 17.25° ($p = 0.0029$) (Table 2), abduction – on average by 28.75° ($p = 0.0001$) (Table 2) and adduction – on average by 3.4° ($p = 0.0398$) (Table 2); in the ulnar and antebrachial joints, there was an increase in the range of passive flexion – on average by 11.5° ($p = 0.0161$) (Table 3) and supination – on average by 21.25° ($p = 0.0028$) (Table 3). During the analyses, a significant increase in the active extension in the glenohumeral joint was demonstrated – on average by 13.5° ($p = 0.008$) (Table 2) and radial deflection in the carpal-radial joint, by an average 2.5° ($p = 0.0289$) (Table 4). The remaining measurements did not reveal the occurrence of statistical significance, however, there was a growing trend in the range of active mobility in all upper limb joints.

In the group of 20 patients qualified for the botulinum toxin type A programme, a statistically significant pathological decrease was noted in increased spastic muscle tone. The biggest difference from the initial tension was noted in the muscle group within the carpal joint, successively in the muscle group including the interphalangeal joints and the ulnar joint. Following rehabilitation, the muscle tension within the elbow was reduced by an average of 1.58 MAS
ment was obtained using 1,000 units of the preparation (Dysport). At the higher dose of 1,500 units, excessive weakness of the injected muscles was observed. The lack of changes in the active mobility of the limb injected with the botulinum toxin may result from the inhomogeneous clinical condition presented by people qualified to participate in the study, which influenced the differentiation of rehabilitation activities. Not without significance were also some perceptual impairments that patients had to deal with as a result of a neurological event or in the course of dementia syndrome. The reasons for the lack of improvement in terms of active mobility and functioning of the upper limb may be a consequence of too low sensitivity of the clinical trials. Based on my own observations, as well as other authors, it should be assumed that an unfavourable role in the analysed research programme could also be played by the time factor from the onset of ischemic stroke to the time of qualifying patients for the study. In my own research, it was on average 33 months. In the research by Simpson et al., it was 37 months, Bakheit et al., also 37, and Brashear – 52 months.

DISCUSSION

All patients participating in the experiment reported an increase in the passive range of motion, but it was not possible to prove that the therapy with the use of botulinum toxin injections combined with motor rehabilitation, cause a statistically significant increase in active mobility of most joints within the inferior upper limb. However, there was a growing tendency for the range of active movement along with subsequent stages of therapy.

The results of the conducted studies are in line with the results presented by the team of the II Neurological Clinic at the Institute of Psychiatry and Neurology in Warsaw. These authors conducted a joint review of clinical trials on the treatment of post-stroke spasticity using botulinum toxin type A. They analysed 10 experiments, and their assessment showed a significant reduction in pathological muscle tone and an increase in passive motion in the upper limbs in all the analysed works. The results of their observations proved that in the majority of patients, there was no increase in the range of active mobility or it was insignificant. Both the amount of improvement and the time of maintaining the effects of therapy were only partially dependent on the dose and place of administration of the drug. Slawek and Bogucki evaluated the results of work on the use of type A botulinum toxin in the treatment of post-stroke spasticity occurring over the years. The authors analysed a number of studies confirming the effectiveness of therapy with the use of toxins in reducing muscle tone, increasing the range of motion to relieve pain and improve self-care activities related to personal hygiene and dressing. However, they noted a lack of studies with control or placebo groups, clearly confirming the effectiveness of the botulinum toxin preparation in increasing the active mobility of the inferior limb. In these observations, they emphasize the importance of choosing the proper dose of the drug allowing to reduce the tension while maintaining muscle function. The authors cite the results of research in which the most important functional improvement was obtained using 1,000 units of the preparation (Dysport). At the higher dose of 1,500 units, excessive weakness of the injected muscles was observed. The lack of changes in the active mobility of the limb injected with the botulinum toxin may result from the inhomogeneous clinical condition presented by people qualified to participate in the study, which influenced the differentiation of rehabilitation activities. Not without significance were also some perceptual impairments that patients had to deal with as a result of a neurological event or in the course of dementia syndrome. The reasons for the lack of improvement in terms of active mobility and functioning of the upper limb may be a consequence of too low sensitivity of the clinical trials.

Also, statistical scales used to assess the effects of Botox A may also be too sensitive to detect changes. Based on my own observations, as well as other authors, it should be assumed that an unfavourable role in the analysed research programme could also be played by the time factor from the onset of ischemic stroke to the time of qualifying patients for the study. In my own research, it was on average 33 months. In the research by Simpson et al., it was 37 months, Bakheit et al., also 37, and Brashear – 52 months. The analysis of my research also shows that ther-
### Table 2
Changes in range of motion – ROM in the glenohumoral-scapular joint

| Glenohumeral-scapular joint | Passive movement | Active movement | Difference 8-1 | p  |
|------------------------------|------------------|----------------|----------------|----|
|                              | Test 1 | SD1 | Test 8 | SD8 | Test 1 | SD1 | Test 8 | SD8 | Difference 8-1 | p  |
| Sagittal plane               |        |     |        |     |        |     |        |     |               |    |
| Flexion                      | 115.5  | 33.79 | 124.75 | 22.39 | 9.25 | 0.1516 | 45.25 | 54.47 | 55.25 | 54.76 | 10 | 0.0705 |
| Extension                    | 45.75  | 18.73 | 69 | 17.06 | 23.25 | 0 | 21.75 | 20.02 | 35.25 | 22.03 | 13.5 | 0.008 |
| Horizontal plane             |        |     |        |     |        |     |        |     |               |    |
| Horizontal flexion           | 76.75  | 17.39 | 86.5 | 12.49 | 10.9 | 0.0054 | 76.75 | 41.62 | 86.5 | 39.71 | 9.75 | 0.2801 |
| Horizontal extension         | 18.25  | 21.23 | 23 | 17.58 | 4.75 | 0.1892 | 8.75 | 10.37 | 10.25 | 11.53 | 1.5 | 0.4449 |
| Rotational plane             |        |     |        |     |        |     |        |     |               |    |
| External rotation            | 66.25  | 27.71 | 70.75 | 26.32 | 4.5 | 0.2733 | 18.5 | 31.79 | 25.25 | 30.8 | 6.75 | 0.1287 |
| Internal rotation            | 62.5   | 22.39 | 79.75 | 16.34 | 17.25 | 0.0029 | 18.25 | 25.51 | 27.75 | 31.56 | 9.5 | 0.3175 |
| Frontal plane                |        |     |        |     |        |     |        |     |               |    |
| Abduction                    | 108 | 25.05 | 136.75 | 34.79 | 28.75 | 0.0001 | 54.25 | 50.06 | 77.25 | 59.06 | 23 | 0.051 |
| Adduction                    | 10.25  | 10.82 | 13.75 | 11.91 | 3.5 | 0.0398 | 3 | 5.94 | 5.5 | 7.49 | 2.5 | 0.1799 |

### Table 3
Changes in range of motion – ROM in the ulnar and antebrachial joints

| Ulnar joint | Passive movement | Active movement | Difference 8-1 | p  |
|-------------|------------------|----------------|----------------|----|
|             | Test 1 | SD1 | Test 8 | SD8 | Test 1 | SD1 | Test 8 | SD8 | Difference 8-1 | p  |
| Sagittal plane |        |     |        |     |        |     |        |     |               |    |
| Flexion     | 131 | 21.31 | 142.5 | 9.25 | 11.5 | 0.0161 | 65.75 | 58.63 | 80.25 | 58.52 | 14.5 | 0.1478 |
| Extension   | 6 | 14.92 | 3.25 | 7.99 | -2.75 | 0.1716 | 17.25 | 25.26 | 11.75 | 14.35 | -5.5 | 0.157 |
| Antebrachial joint |        |     |        |     |        |     |        |     |               |    |
| Rotational plane |        |     |        |     |        |     |        |     |               |    |
| Supination   | 58 | 28.99 | 79.25 | 15.07 | 21.25 | 0.0028 | 8.5 | 21.65 | 14 | 25.47 | 5.5 | 0.1589 |
| Pronation    | 89.75 | 14.53 | 89.5 | 2.24 | 2.75 | 0.417 | 21.75 | 35.29 | 22.75 | 37.15 | 1 | 0.8848 |

### Table 4
Changes in range of motion – ROM in the radiocarpal joint

| Radiocarpal joint | Passive movement | Active movement | Difference 8-1 | p  |
|-------------------|------------------|----------------|----------------|----|
|                   | Test 1 | SD1 | Test 8 | SD8 | Test 1 | SD1 | Test 8 | SD8 | Difference 8-1 | p  |
| Sagittal plane    |        |     |        |     |        |     |        |     |               |    |
| Flexion           | 74.25 | 14.53 | 78.75 | 13.94 | 4.5 | 0.1543 | 11 | 19.37 | 14.5 | 21.64 | 3.5 | 0.2699 |
| Extension         | 48.1 | 22.22 | 76 | 13.04 | 27.9 | 0.0001 | 5.75 | 19.21 | 10 | 19.53 | 4.25 | 0.3247 |
| Frontal plane     |        |     |        |     |        |     |        |     |               |    |
| Abseil deflection | 26.5 | 12.15 | 27.25 | 9.93 | 0.75 | 0.7715 | 1.25 | 4.55 | 2 | 5.48 | 0.75 | 0.3299 |
| Radial deflection | 24.25 | 10.79 | 25 | 8.58 | 0.75 | 0.6855 | 1.75 | 4.38 | 4.25 | 7.99 | 2.5 | 0.0289 |
apy with the use of botulinum toxin significantly influenced the increase in the range of passive motion in the joints of the inferior upper limb, and to a lesser extent also affected the improvement of the range of active mobility. The basic level of spasticity and functioning of the limb presented by patients at the time of qualifying for the experiment was of great importance in increasing the scope of active mobility. In those who were diagnosed with slight active mobility in the limb joints prior to the project, there was significant improvement in its scope. An important aspect of the therapy was the joint implementation of individually selected therapeutic goals. Based on numerous publications referring to this issue, it can be assumed that pathologically increased tension is not always the primary problem deciding on the lack of active mobility of the limb occupied by the disease process. Thus, therapy based only on its reduction may prove ineffective. It should also be concluded that the lack of improvement in the functional activity of the limb is related to pathophysiology of spasticity, weakness of the inferior limb and other adverse symptoms associated with damage to the central motor neuron22,19. Many authors suggest that combating only muscle hyperactivity does not directly translate into improvement of their active work20.

Many experimental studies, including the results obtained in my own studies, confirm the effectiveness of botulinum toxin therapy to reduce abnormal muscle tone. In numerous clinical trials with different doses and toxin preparations, there was a significant reduction in the level of spasticity measured using the MAS scale compared to the control group, where placebos19,20,21 were used. Kwolek and Myjkowska22, among others, undertook the same subject of research22. In the conducted experiment, they assessed a group of 44 patients injected with the toxin and subjected to rehabilitation. These authors showed a reduction in spasticity within the area of the upper limb and hand, where the mean value for the entire limb was reduced by 0.9 points on the MAS scale, while for the hand by 1 point on the same scale. After further analysis, they obtained results approximate to those presented in my work, namely 12 weeks after the first test, the mean spastic tension reduction for the upper limb was only 0.8 points, and for the hand 0.9 points on the MAS scale. Characteristic fluctuations in the tension level before consecutive cycles of application can result from the temporary therapeutic effect of botulinum toxin, which after about 12 weeks is gradually removed from the body. It can be concluded that the positive changes in muscle tone and the longer duration of the drug’s action on the muscles are not only the result of the botulinum preparation, but also the systematically conducted, purposeful, rehabilitation combined with re-education of muscle tone.

Maintaining proper patient behaviours at their home environment and during daily activities is needed to extend the duration of positive results of therapy in the field of muscle tone22,23,24. However, there was no significant improvement in the functioning of the upper limb as measured by clinical tests25,26. This allows to conclude that the reduction of pathological muscle tone does not correlate directly with restoring the active activity of the ineffective limb27,28.

In this context, a reasonable recommendation seems to be that future experimental protocols should be conducted using a variety of different interactions (combination therapy). An important factor that increases the effectiveness of therapy in patients after ischemic stroke may also be the prolongation of treatment time. In addition, in order to obtain reliable results showing improvement in active mobility of the upper limb, it may be necessary to exclude patients from participation in the experiment with upper limb affected paralysis and those in which cognitive deficits prevent full, active involvement in the therapy carried out in a functional way. More importantly, planned therapeutic interventions should be precisely designed and in accordance with current training protocols based on reliable physiological premises, their aim should be to determine the most effective way of treatment for patients after ischemic stroke. Summing up the results of the conducted study, it can be assumed that the treatment of patients after ischemic stroke with the use of botulinum toxin combined with motor improvement, effectively leads to increased passive mobility of the upper limb, as well as re-education in pathological muscle tone. Most of the patients did not manage to achieve an increase in active mobility in the joints of the upper limb.

Today, we know with certainty that the use of botulinum toxin should not be the only method of therapeutic treatment in patients after ischemic stroke, and the best results can be obtained using pharmacotherapy.
combined with systematic motor rehabilitation. My research, as well as reports from other authors, prove that the use of botulinum toxin in the analysed group of patients is a safe method, devoid of significant adverse effects or dangerous local and systemic complications. The use of botulinum toxin allows the treatment of local spasticity without exposing patients to unwanted systemic reactions associated with oral medication. In addition, the preparation is selectively injected within the affected muscles, without affecting the muscles in their surroundings.

Toxin type A in the treatment of upper limb spasticity following ischemic stroke and modulated placebo-controlled study of the effects on quality of life and other person-centred outcomes. J Rehabil Med 2009; 41: 536-544.

Kwolek A, Mykiowska E, Pop T. Nowe metody w leczeniu spastyczności kośći górnej u osób po udarze mózgu. [New methods in the treatment for upper limb spasticity in post-stroke patients] Post Psychiatr Neurol 2004; 2(18): 53-57. [In Polish]

Levacik W.M., Taylor K., Siegler R.J., Dean S.G., McPherson K.M., Weatherall M. Is goal planning in rehabilitation effective? A systematic review. Clin Rehabil 2006; 20(9): 739-755.

Nannenga C.S., Postema K., Schönberger M.C., van Twillert S., Lettinga A. Combined Clinical and Home Rehabilitation: Case Report of an Integrated Knowledge-to-Action Study in a Dutch, Rehabilitation Stroke Unit. Phys Ther 2015; 95(4): 558-567.

Kawasaki K., Kollen B.J., Wagenaar R.C. Therapeutic Impact on Functional Recovery in Stroke Rehabilitation: A critical review of the literature. Physiotherapy 1999; 85(7): 377-391.

Shean E.L. Botulinum treatment of spasticity - why is it so difficult to show a functional benefit? Curr Opin Neurol 2001; 14(6): 771-776.

Carr J., Kline A.T., Melo A. Does botulinum toxin improve the function of patient with spasticity after stroke? Arq Neuropsiquiatr 2007; 65(3): 592-595.

Knecht S., Hessle S., Oster P. Rehabilitation after stroke. Dtsch Arztebl Int 2011; 108(36): 600-606.

Korr R., Dodd K.J., Shields N., Bruder A. Therapeutic exercise in physiotherapy practice is beneficial: a summary of systematic reviews 2002-2005. J Physiother 2007; 53(1): 7-16.

Barnes M. Postspasticity in spastic patients. Farmakoter Psychiatr Neurol 2005; 3: 241-248.

Oczakrzi S., Sivirugthuk Boxtulinum toxin in Post-stroke Spasticity. Clin Med 2007; 5(9): 132-138.

Address for correspondence
Elzbieta Mirek PhD
e-mail: mirek.ela@wp.pl

CONCLUSIONS

The obtained results allowed to formulate the following conclusions:

Application of botulinum toxin type A in patients after ischemic stroke combined with individualized motor rehabilitation increases the range of active and passive motion of the upper limbs, thus favourably affecting their functional efficiency.

The local application of botulinum toxin type A in patients after ischemic stroke results in the reduction of muscle tone.

Conflict of interest: none

References

1. Strejkowska A., Buciński A. Udar mózgu – czynniki ryzyka i profilaktyka. [Cerebral stroke – risk factors and prophylaxis]. Post Farmakoter 2009; 65(1): 46-50. [In Polish]

2. European Stroke Organisation (ESO) Executive Committee; ESO Writing Committee. Guidelines for management of ischaemic stroke and transient ischaemic attack 2008. Cerebrovasc Dis 2008; 25(5): 457-507.

3. Feigin V.L., Lawers C.M., Bennett D.A., Barker-Collo S.L., Parag V. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review. Lancet Neurol 2009; 8: 355-369.

4. Brola W., Fudała M., Przybylski W., Czernicki J. Profilaktyka późnych powikłań udaru mózgu. [Prophylaxis against late complications of stroke]. Stud Med 2008; 9: 21-26. [In Polish]

5. Urban P.P., Wolf T., Uebele M., Manx J.J., Vogt T., Stoeter P. et al. Occurrence and Clinical Predictors of spasticity following ischemic stroke. Stroke 2010; 41(9): 2016-2020.

6. Scrivener K. Don’t underestimate the power of one arm. Living independently after stroke. Phys J 2016; 62(4): 234.

7. Zembaty A. Szczegółowa metodika badania i normy wybranych zakresów ruchów stawów obrażeń kraniozgólnych. [In Polish] A. Zembaty A. (ed.): Kineziterapia. Część I. Wyd. Kasper. Kraków 2002: 214-215. [In Polish]

8. Scrivener K. Interater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther 1987; 67(2): 206-207.

9. Gailes M.P. Introducing CliniSim. Austral. J Physiol 2009; 51: 139-140.

10. Boyd R., Ada L. Physiotherapy management of spasticity. [In]: Barnes M.P., Johnson G.R. (eds.). Upper Limb Function in Neurological Syndromes and Spasticity. Cambridge University Press. New York 2008. 79-98.

11. Charakterystyka skali G [Available from: http://www.lines.com.pl/index.php/inne-je-je-wkly/je/je]. [In Polish] Accessed: 12.2017

12. Zubirowski J., Wicha W. Leczenie spastyczności poudarowej z zastosowaniem toksyny botulinowej typu A. Przegląd badań klinicznych. [Treatment of post-stroke spasticity with botulinum toxin type A. A review of clinical trials]. Post Psychiatr Neurol 2004; 2(18): 79-83. [In Polish]

13. Slawek J., Bogucki A. Toksyna botulinowa typu A w leczeniu spastyczności kończyny górnej u chorych po udarze mózgu. [Botulinum toxin type A in the treatment of upper limb spasticity following cerebral stroke] Post Psychiatr Neurol 2004; 2(18): 1-5. [In Polish]

14. Fleuren J.F.M., Voerman G.E., Eren-Wolters C.V., Snekki G.J., Rietman J.S., Hermens H.J., et al. Stop using the Ashworth Scale for the assessment of spasticity. J Neurol Neurosurg Psychiatry 2010; 81: 46-52.

15. Pandyan A.D., Johnson G.R., Price C.I., Curless R.H., Barnes M.P., Rodgers H. A review of the properties and limitations of the Ashworth and modified Ashworth Scales as measures of spasticity. Clin Rehabil 1999; 13: 373-383.

16. Gajdosik R.L., Bohannon R.W. Clinical measurement of range of motion review of goniometry emphasizing reliability and validity. Phys Ther 1987; 67(12): 1867-1872.

17. Simpson D.M., Alexander D.N., O’Brien C.F., Tagliati M., Awad A.S., Leon J.M., et al. Botulinum toxin type A in the treatment of upper extremity spasticity: a randomized, double-blind, placebo-controlled trial. Neurology 1996; 46(5): 1306-1310.

18. Bakheit A.M., Thilmann A.F., Ward A.B., Poe W., Wissel J., Muller J., et al. A randomized, double-blind, placebo-controlled, dose-ran- ging study to compare the efficacy and safety of three doses of botulinum toxin type A (Dysport) with placebo in upper limb spasticity after stroke. Stroke 2000; 31(10): 2402-2406.

19. Brashear A., Gordon M.F., Eloiciv E., Kassischev V.D., Marconiak C., Do M., et al. Intramuscular injection of botulinum toxin for the treatment of wrist and finger spasticity after a stroke. N Engl J Med 2002; 347(6): 395-400.

20. Thibaut A., Chatelle C., Ziegler E., Bruno M., Laureys S., Gossieres O. Spasticity after stroke: Physiology, assessment and treatment. Brain Inj 2013; 27(10): 1-13.

21. McCrory P., Turner-Stokes L., Baguley I.J., De Graaff S., Katkar P., Sandanam J., et al. Botulinum toxin A for treatment of upper limb spasticity following stroke: a randomized, double-blind, placebo-controlled study of the effects on quality of life and other person-centred outcomes. J Rehabil Med 2009; 41: 536-544.

22. Bruneau A., Buciński A., Udzina M., Mirek E., e-mail: mirek.ela@wp.pl
