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A study regarding the results of a rehabilitation program in patients with traumatic lesions of the hand after surgery
Studiu privind rezultatele programului de recuperare la pacienții cu leziuni traumatice operate ale mâinii

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Abstract

Background. Work-related accidents or domestic traumas of upper extremities have become more frequent in the modern industrial and technological society. Major traumatic lesions need surgery and unfortunately, the recovery period is a very long and strenuous process which can last years, with multiple re-interventions for adhesions, nerve and tendon surgical approaches and rehabilitation programs before and after surgeries.

Aims. To demonstrate with objective tools of assessment and statistics the benefits of the rehabilitation program on the clinical, neurological, functional, socio-professional and psychological status of patients after hand surgery.

Methods. The authors elaborated and followed a prospective study based on 54 cases with surgery for traumatic hand lesions, who followed three series of medical rehabilitation programs consisting of three weeks of daily PRM therapeutic protocol in the Clinic of the National Institute of Physical and Rehabilitation Medicine, between Jan 2011- Aug 2012.

Results. The results confirmed the international epidemiologic data, with a statistically significant improvement of all the local post-surgical conditions, better QoL and FIM scores.

Conclusions. A rehabilitation program proved to be an essential sequence after or between surgeries for traumatic hands, with benefits for the functional independence of patients.

Key words: traumatic lesions, rehabilitation program, hand surgery.

Rezumat

Premize. Accidentele de muncă sau casnice cu afectarea extremității superioare au devenit din ce în ce mai frecvente în era modernizării și tehnologizării industriale. Marea majoritate a acestor leziuni traumatice sunt majore și necesită intervenție chirurgicală și din nefericire, perioada de recuperare care urmează este un proces lung și obositor, care poate dura ani de zile, cu re-intervenții chirurgicale pentru aderențe sau plastii de nervi sau tendoane, cu programe de reabilitare medicală înainte și după operații.

Obiective. Demonstrarea, folosind mijloace obiective de măsurare și interpretare statistică, a rezultatelor benefice ale programului de Recuperare Medicală asupra statusului neurologic, clinic, funcțional, socio-profesional și psihologic la pacienții cu intervenții chirurgicale la nivelul mâinii.

Metode. Autorii au elaborat și urmărit un număr de 54 de cazuri cu leziuni traumatice operate ale mâinii în cadrul unui studiu prospectiv desfășurat între ianuarie 2011 și august 2012, când aceștia au fost integrați în cadrul unor serii de trei săptămâni de recuperare în cadrul INRMFB.

Rezultate. Rezultatele studiului sunt concludente, asigurate statistic, corepunând datelor epidemiologice din literatura de specialitate și confirmă îmbunătățirea semnificativă a condițiilor locale post-operatorii, creșterea calității vieții și o mai bună funcționalitate a mâinii operate la pacienții care au urmat programul de recuperare medicală.

Concluzii. Acest studiu demonstrează, pe baza elementelor de medicină bazată pe dovezi, eficiența semnificativă a programului de Recuperare Medicală, ca secvență terapeutică esențială în patologia post-traumatică operată a mâinii.

Cuvinte cheie: patologie traumatică a mâinii, chirurgia mâinii, program de recuperare medicală.

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Introduction

Post-traumatic and post-surgical hand pathology represents a special chapter of Physical and Rehabilitation Medicine, due to the great number of patients with this kind of pathology who present to our services and also, due to the major functional implications upon their lives, with economic implications on health and social insurance policies (Dias & Garcia, 2006).

The idea of a study on traumatic lesions of the hand after surgery was based on the many and complex traumatic cases and also, on the positive feedback from patients (who were capable to use the injured hand for daily usual activities after rehabilitation programs) and from surgeons (who observed more rapid and better improvements for patients who were integrated in rehab sessions).

The novelties brought by this study are:

- Standardization and quantification of multiple possibilities of sequelae at anatomical, clinical, functional and psychological level. This is why we created a unitary test-sheet with subjective evaluation (by the patient) and objective evaluation (by the therapist), which can be repeated through the study (Brailescu et al., 2011a). This unitary test-sheet is a very useful tool for all the specialists involved in hand pathology therapy, because it is based on complex clinical evaluation (sensory and motor neurological testing, muscular and joint assessment, soft tissue appreciation, etc.), paraclinical testing (EMG, X-rays, thermography, etc.), functional evaluation (FIM score, Michigan score, etc.) and psychological impact (depression/anxiety standard scales), which is non-invasive, easy to do, based on usual kit equipment (goniometry, dynamometry, Semmes-Weinstein kit, neurological reflex hammer) and is reproducible at the beginning, at the end and during the rehabilitation program.

- Holistic approach of the patient - quantification and monitoring of the physical, psychological, functional status of the patient, but also of the impact of the disease on the social, economic and professional life of the patient (activities of daily living, self-care, supervision or dependence on other persons for grooming/eating/etc., social relationships, transportation, communication possibilities, work-related aspects, financial aspects) and also, on society (insurances, social support, public sanitary policy). It is a mixture of the protocol schemes recommended by surgeons for each type of lesion (O'Brien, 2009), with the rehabilitation protocol for each post-surgical condition (Cooper, 2006).

- Global therapeutic approach – all the patients of the study received all the procedures recommended in the protocols (Sidenco, 2005) consisting of electrotherapy, thermotherapy, kinetotherapy and ergotherapy, adapted to the individual particularities of each patient and modified during the recovery process (Brailescu et al., 2009). There were daily sessions, 3-4 hours per day, 10-15 days, 3-4 sessions per year.

- Inter- and multi- disciplinary approach – a complex evaluation and treatment team, as in international Hand Centers (King et al., 2005): plastic surgeon (long-term management, multiple surgical interventions), physical and rehabilitation specialist (for assessment and program

strategy), physiatrist assistant and kinethotherapist (for assisting the patients during the daily rehabilitation programs), ergotherapist (specialized in upper limb activities), neurologist (for clinical and EMG monitoring), orthetist (individualized elaboration and training of orthoses/prostheses/assisting devices), orthopedist (fracture healing evaluation, metal implant removal), psychologist or psychiatrist (anxiety/depression treatment), social assistant (economic and social reintegration).

- Precise evaluation of clinical and functional parameters, for a better evidence-based medicine approach – we used not only the standard clinical musculo-skeletal assessment (joint angle measurement by goniometres, muscle strength measurement by dynamometers, prehension measurement by clinical scales), but also a modern device called Pablo *Tyromotion* (1). It offers the possibility for the accurate evaluation of ten types of prehension (grips and pinches) and the measurement of angles of movement for the shoulder, elbow, wrist and fingers, with the computerized determination of the values and storage in a database which allows for the precise measurement and statistical processing of the values during the recovery process (Brailescu et al., 2011b). This device has a therapeutic software with many games adapted to the clinical status, which gives the opportunity to continue traditional ergotherapy with virtual reality-based therapy (Burdea & Coiffet, 2003). There was a group of patients that after the general classic program also worked with Pablo for half an hour daily and we analyzed separately their progress.

- There are a lot of international studies (Morgan, 1997; Helbok et al., 2010; Hartwig, 2011; Stein et al., 2011) regarding the efficiency of using Pablo in neurological upper limb pathology in adults and children (stroke, Parkinson's disease, cerebral palsy), but none regarding the post-traumatic surgical hand, so this is another challenge.

- Other studies from the literature in the field of hand rehabilitation (Sidenco, 2005) were based on statistics using clinical assessments with quite subjective measurements (made by comparison with the valid hand) or using classical evaluation (goniometry or dynamometry) with mechanical devices, not as accurate as a computerized device such as Pablo. The precise assessment gives accurate values and the statistical analyses of these data are more trustable and evidence-based medicine oriented (Baicus, 2007).

- Clinical approach of the statistical analysis – we used not only mathematical analysis (comparison of scores and parameters as absolute values or percentage differences between evaluations), but also a very useful approach for the clinician (evaluation by dysfunction categories; for instance, the fact that a percentage of the patients with the greatest dysfunctionality reaches a medium-dysfunctionality category during the therapeutic program has a major medical and prognostic value, meaning that the injury was not total and there is still a recovery potential).

Hypothesis

To demonstrate with objective tools of assessment and statistics the benefits of the rehabilitation program for the clinical, neurological, functional, socio-professional and psychological status of the patients after hand surgery.

The researchers were oriented on the efficiency of the rehabilitation program in which the patients were integrated after a traumatic injury of the hand which needed surgery, upon the following major therapeutic goals:

- Reduction of pain and edema
- Improvement of local vascular and trophic conditions for a good quality healing
- Mobility improvement, especially the recovery of functional angles
- Muscular strength improvement, especially for grasp efficiency
- Functional independence improvement, especially for basic ADLs
- Motor and sensory re-education
- Domestic and social reintegration and progressive professional re-adaptation
- Better quality of life

Material and methods

The research protocol was structured as a prospective study.

a) Period and place of the study: 20 months between January 2011-August 2012 for patients with traumatic injuries of the hand who needed surgery and who followed a rehabilitation program in the National Institute for Rehabilitation, Physical Medicine and Balneology in Bucharest.

b) Subjects and groups under study: There were 54 cases (53 patients, because one of the patients had both hands affected at different time moments and each trauma was considered a case by itself) of different severe traumas of the hand who needed one or multiple surgical interventions on bones/muscles/tendons/nerves/vascular structures and who presented to the Clinic for post-surgical rehabilitation. All the patients who met the inclusion criteria were integrated in the classical medical rehabilitation program. There was a subgroup of 15 patients who worked during an additional 30 minute daily session using the Pablo Tyromotion device, the rest of the program being the same.

- Inclusion criteria: traumatic etiology of the injury at wrist-hand-finger level, after surgical intervention (in Plastic Surgery or Orthopedics), with painful and dysfunctional sequelae.

- Exclusion criteria: immediate local complications after surgery (incomplete cicatrization, infections, hemorrhages, suppurations) which were treated and after a short delay, were also included in the study.

c) Tests applied: All the patients who met the inclusion criteria were evaluated during the study, during each session of treatment, using a unitary evaluation-chart proposed by the authors (Brailescu et al., 2011a), based on subjective evaluation (by the patient) and objective tests (by the therapist) for a complex assessment regarding:

- local conditions (edema, vasculotrophic status, scar process);
- pain (McGill score, VAS score);
- psychological and post-traumatic status (PTS score);
- disability (DASH – Disabilities of the Arm, Shoulder and Hand score and formula);
- functional scores (FIM – functional independence measurement; Michigan score and formula);

- neurological tests for each of the three major hand nerves (median, ulnar and radial) with sensitivity tests (tactile/discriminative/thermal and pain assessment) and motor deficit assessment (three clinical degrees);

- mobility assessment – upper extremity joint range of motion assessment (shoulder, elbow, wrist and fingers) using classical goniometry and the Pablo device;

- strength assessment – arm, forearm, hand global muscular strength assessment using classical dynamometry and the five-degree clinical scale;

- prehension assessment – 10 types of grips and pinches using the Pablo device (grip strength flexion, pinch grip thumb-index, pinch grip thumb-medius, pinch grip thumb-4th finger, pinch grip thumb-5th finger, lateral grip thumb-index, interdigital grip index-medius, interdigital grip medius-4th finger, interdigital grip 4th finger-5th finger, tridigital pinch grip) using the Pablo device (1);

- quality of life measurement – QoL score

d) Therapeutic methodology: We used a complex therapeutic strategy, according to the protocols, adapted and optimized for each patient, so we created a therapeutic formula based on general principles, which could be individually adapted, very useful and time-saving for clinicians (Brailescu et al., 2012), consisting of:

- Medication: local agents (antiinflammatory, analgetic, pro-healing products) and oral drugs (neurotrophic vitamins and amino acids, antiinflammatory agents, painkillers, anxiolytics, muscular relaxants).

- Electrotherapy: galvanic currents, low and medium frequency currents – analgetic effects, electrostimulation, vascular gymnastics.

- Thermotherapy: high frequency ultrasound, continuous or pulsed short waves – trophic and healing effects, antiinflammatory, analgetic, anabolic effects.

- Physical procedures with cellular and metabolic biotrophic effects, neuro-vegetative optimization – low frequency LASER and magnetic field therapy.

- Kinetotherapy based on posturing, stretching, passive/passive-active/active mobilizations, free or weight-resistive movements, mechanotherapy, coordination exercises, all types of grasps/grips/pinches exercises.

- Ergotherapy: classical occupational therapy for upper limb training based on usual activities and gestures, training for using orthoses/prostheses/assisting devices; a number of 15 patients also trained with Pablo, with adapted games based on virtual reality (Brailescu et al., 2011b).

e) The statistical analysis of the results from the evaluation charts was based on basic statistical principles (Isaic-Maniu et al., 2004; Boboc, 2007) and was performed using Microsoft Excel and Kynos Modalisa and consisted of:

Descriptive statistics

- Arithmetic means, means without extreme values and standard deviations for quantitative variables, expressed as mean [\pm standard deviation]

- Frequencies and percentages for qualitative variables. Dynamic analysis included 54 cases (first and second evaluation) and 39 cases (third evaluation).

Significance tests

For evolution between the three determinations, for identifying those parameters which improved during the

study, but also to identify the differences between groups which could determine the categories with better results:

- Statistical comparison of sample means with the pair t-Student tests (2 means). This analysis can identify the possible significant evolution of numerical parameters and it was made on the patients that presented for successive evaluation.

- Statistical comparison of percentages using the square Chi test, for identifying the possible significant evolution between different groups of patients defined by sex (male, female), environment of origin (urban, rural), Pablo therapy (yes, no), additional surgeries during the study (yes, no).

- Statistical comparison of numerical variables with ANOVA analysis for identifying possible significant differences between the previously defined patients.

- The statistical estimation of the results was done for a minimum significance threshold accepted in biology ($p=0.05$) and for a statistical precision of 95%, using statistical test decision criteria.

Results and discussions

Using the anamnestic data and the parameters and values from the evaluation charts of the 54 cases during the rehabilitation program followed in our Clinic, after the previously described statistical processing, the results were as follows:

The statistical epidemiological results obtained in the studied patients correspond to the general epidemiological data from the international literature: the profile of the patient with the maximum risk of traumatic injury at wrist-hand level is male (77%), young and professionally active (38.9 years-mean age), most of the accidents are at home (80%) and only 20% are work-related for some professions at risk ("blue-collars are more risky than white-collars"). The most frequent mechanism of injury was cutting (33 cases of all 54 cases), mainly affecting the left hand (62%) and the non-dominant hand (66%), in the volar part of the wrist/hand/fingers (83%) and the most injured anatomical parts were the 3rd (33%) and 4th fingers (41%).

We noticed that our results were in accordance with the distribution of injuries in anatomical structures as described in the literature: the tendons were the most frequently affected structures in traumas of the wrist/hand (94% of cases), neurological injuries were observed in 74% of cases, 54% had vascular injuries, muscle and bone traumas were in almost equal percentages (around 45%) and 11% of the patients presented traumatic injuries in several anatomical segments, not only in the hand (multiple traumatic pathology).

The inclusion criteria for the study was the history of traumas which needed surgery for wrist/hand/fingers; the most frequent surgical intervention was tendon suture (81%), nerve suture (70%), vascular microsurgery (43%), metal implant for fracture consolidation (44%) and skin/nerve/tendon grafting was needed in 39% of patients. Six patients underwent replantation after amputations: four - in the thumb, one - at radiocarpal joint level, one - at distal forearm level.

The great number of surgical interventions (57% of the patients required two or three interventions, 15% needed

four or five, and 9% needed six or more surgeries) shows the complexity and the severity of the pathology and is one more reason for rehabilitation program series before, after and between multiple interventions, for the maximum benefit of the patient's recovery process.

The beginning of a therapeutic rehabilitation program was after 5.2 months (average period after excluding extreme values), but we noticed that more than half of the patients started specialized therapy within 3 months post-surgery and one third of the cases in the first year after surgery.

Paraclinical investigations for such patients are relatively cheap, consisting of X-rays and soft tissue ultrasound (for 61% of the patients) and EMG monitoring for nerve injuries - only 24% of the cases underwent this examination, even if it was indicated for more cases, which is why we suggest that an electromyograph and a neurologist should be available in a Hand Center (Slutsky, 2005; Strommen et al., 2005).

This kind of pathology needs only little medication and the costs with the recommended drugs are low (antiinflammatory drugs, analgetics, neurotrophics, anxiolytics); the real costs are with the rehabilitation programs and the socio-economic implications (long medical holidays and early retirement).

The basis of the rehabilitation program is the kinetic program - kinetotherapy and occupational therapy, and all the studied patients benefited from them (there are no contraindications for therapeutic exercise after proper healing following surgery). For 28% of the patients, we added ergotherapy using Pablo during half an hour daily sessions. Among physical procedures, the Curapuls (pulsed short waves) was applied to all the patients because it has the widest indication list for biotrophic and anabolic effects and it also works on metal implants. The rest of the procedures were applied in 85-87% of cases for analgesic/antiinflammatory/vasculotrophic effects (low and medium frequency electrotherapy, galvanization, laser and ultrasound therapy) and neuromuscular electrostimulation (depending on the denervation level) with parameters (type, dosage, intensity, treatment time) adjusted for each patient and at each evaluation. Because the treatment was well chosen and monitored during treatment sessions, there were no adverse reactions to these specific procedures and their contribution to pain/local conditions/neurological problems/mobility/functionality was major and was demonstrated by the statistical improvement of all analyzed parameters and scores (as follows).

There was a significant decrease of the pain (both during rest and during movement) proved by an amelioration of 59% between the beginning and the end of the study. Also, the average post-traumatic stress score improved by 56% between the first and the last evaluation.

As a result of the combined physical therapy applied, we noticed a significant improvement of all parameters measuring the local post-surgical conditions: edema (decreasing by 78% of the average score), cicatrization (improvement by 68% of the average score), vasculotrophic conditions (improvement by 56% of the average score). These improvements of vascular and soft tissue conditions help the patient better cooperate and respond to kinetics

and also, contribute to interrupting the pathophysiological chains of chronic pain and CRPS (Complex Regional Pain Syndrome).

The dynamic statistical analysis of the average DASH score (simple and formula-calculated) demonstrated that the patients of the studied group had a significant decrease of the disability in the entire upper limb (by 36%, 52%, respectively, overall at the end of the study). Also, there was a greater satisfaction after surgery - proved by a 33% improvement of the total Michigan score at the end of the treatment.

The functional independence of the patients significantly increased after therapy, with a 57% improvement of the average FIM score and it was related to a better quality of life, with a 30% increase of the average QoL score (Tulski & Chiaravallotti, 2005) at the end of the study, meaning that rehabilitation helped the patients use their hands in more activities during usual activities and made them feel better and more confident in their prognosis.

A synthesis of the favorable evolution of symptoms and functionality is shown in Figure 1.

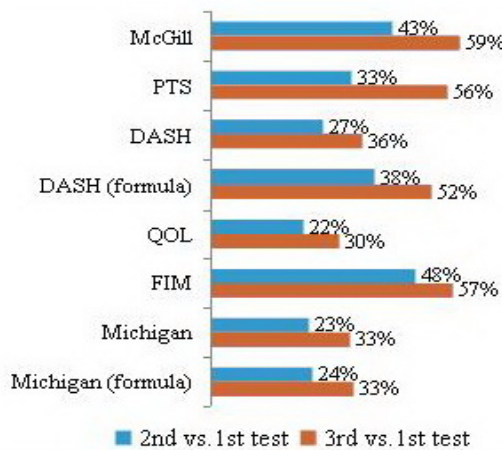


Fig. 1 – Average of the functional score evolution during treatment.

The sensitivity perturbations significantly improved after complex sensory re-education sessions: for each affected nerve (ulnar/median/radial), for each type of tested sensitivity (tactile/discriminative/protection/thermal) and for each category of severity (small/medium/severe deficits), representing an efficient monitoring of post-surgical neuro-recovery (Hansson & Cassale, 2010). The evolution of each nerve showed an improvement: the tactile sensitivity scores at the third evaluation were better for all the three major tested nerves - 31% for the median nerve, 28% for the ulnar nerve and 17% for the radial nerve. A significant improvement in discriminative tactile sensitivity scores was also seen: 46% for the median nerve, 48% for the ulnar nerve and 19% for the radial nerve at the last evaluation compared to the first. The median and ulnar nerves had a better and more rapid recovery of the sensitivity problems compared to the radial nerve and this is in accordance with the neurological literature and with the clinics - the flexion of the wrist and fingers recovered before extension. The thermal protection sensitivity, used by neurologists as a monitoring criterion for post-surgical

recovery (Rosen & Lundborg, 2003; Carlsson et al, 2008; Klein-Weigel et al., 2007), proved to improve by 32% at the end of the study, meaning that the patients could better support the cold environment during domestic, recreational or professional activities, with the widening of the area of activities for the patients.

A new and clinically significant element in this study was the analysis of the categories with total clinical neurological deficit (zero score) at the beginning of the study. Even if the differences were relatively small, the fact that these patients with no detectable clinical movement advanced to a superior deficit category (more than 1 point) was of great importance for the prognosis based on reinnervation potential, especially for the median nerve (15%) and the ulnar nerve (14%).

Extremely significant was the evolution of mobility parameters in the shoulder, forearm, wrist, thumb and fingers evaluated using the Pablo device and quantified according to a 5-level scale, the score being determined by percentage (objectively measured using Pablo) compared to the healthy part (1). All the motor parameters had a positive evolution, but with different percentages: 64% for finger mobility, 39% for thumb mobility, 32% for wrist flexion/extension, 25% for wrist cubital/radial movement, 25% for pronation/supination, 5% for shoulder mobility. The small difference for shoulder and elbow mobility improvement was based on a relatively good mobility at the beginning of the study, those two joints being only indirectly traumatized, without undergoing surgery. Very important for the patients was the improvement of joint mobility for the wrist, thumb, fingers due to kine- and ergotherapy. A synthesis of ascending evolutions for all categories of sensitivity, mobility and local conditions for the post-surgical traumatic cases of our study is illustrated in Figure 2.

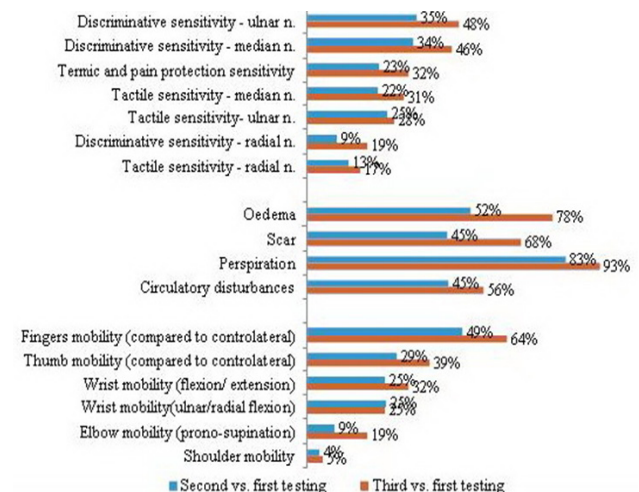


Fig. 2 – Synthesis of the evolution of sensitivity, mobility and local conditions scores.

The evolution of prehension strength in the studied patients showed a significant improvement for all the 10 types of grips/pinches evaluated with the Pablo device as averages, but in variable percentages. The best evolution was found for grip strength (117%), followed by the thumb-medius pinch grip (106%) and thumb-ring finger (101%).

Very important for the clinician was the synthesis of the evolution of the severity categories: 6 patients advanced from the most affected category (with zero grip strength) to the category with pinch grip between the thumb and the 3rd - the 5th finger detection possible; also, 4 of the 7 patients who were not able to perform the tridigital pinch grip at the beginning of the study became testable at the end of the study. Even if statistical values may seem of low significance, their meaning is very important for the therapist - the switching from zero strength to a superior category even if with low strength and non-functionality proves there was a good prognostic factor for long-term rehabilitation and reinnervation potential.

The statistical analysis on splits (subgroups) of patients was based on two methods (previously described), both of them aiming to identify possible significant differences between different categories of patients defined depending on sex (male/female), environment (urban/rural), additional surgeries during the study (yes/no). The conclusion was that there were no significant differences between the subgroups of patients (except for some grip/pinch types which were predictable depending on the surgery type), meaning that the evolution percentages of sensitive nervous disturbances and of joint mobility parameters were favorable for all categories of patients. Translated in clinical reality, these results mean that all the subgroups of patients, regardless of gender or environment of origin, have similar chances for recovery - the most important are their integration in proper rehabilitation programs and their adherence to treatment.

The evaluation of the subgroup of 15 patients who followed the classical program (physical procedures and kinetics), but were also integrated in a 30 minute daily session of working with the Pablo Tyromotion device (Brăilescu et al., 2011b; Nica et al., 2013).

The influence of Pablo therapy on sensitive re-education: The fact that some of the patients worked additionally for half an hour daily with the Pablo device could be seen as additional sensitive training (shape, texture, weight recognition) and as an audio-visual feedback integration during movement performance (specific sounds and acoustic intensities for reaching the established kinetic aims). Unfortunately, we did not have the technical possibilities for objective measurements by performing functional MRI or neuro-physiological studies; also, the neurological lesions were combined (median plus radial nerve injuries, etc.) and the number of patients was not sufficient for a pertinent statistic. The possible relationship between the sensitive input by Pablo ergotherapy and the favorable evolution of sensitive disturbances in patients with neurological sequelae after surgical traumatic hand injuries has only been clinically noticed and will be studied in the future.

The influence of Pablo therapy on functional re-education: The comparison of the subgroups with/without Pablo was made similarly to that of other categories of patients, using the χ^2 test and ANOVA analysis. Based on the t-Student test for paired groups, there were significant differences between the mean values ($p < 0.01$) calculated using both formulas for the second versus the first evaluation and for the third versus the first evaluation.

The use of game modules adapted to individual deficit allowed the patients who additionally worked with Pablo to have a better evolution of the disability DASH score. The same greater improvements in the Pablo group were obtained for the simple Michigan score (15.1 points in the Pablo group versus 14.1 points in the non-Pablo group) and for the Michigan score formula (377.9 points in the Pablo group versus 355.1 points in the non-Pablo group). The differences between DASH, QoL and FIM at the second determination were constantly significant ($p < 0.04$). The patients who worked 30 minutes with Pablo in addition to the classical rehabilitation program experienced better functional scores, meaning a better improvement for performing usual activities at home. An increase by 4.3 points of the FIM score at the end of the treatment for the Pablo group suggests a greater functional independence and better possibilities for familial and social reintegration.

The influence of Pablo therapy on motor re-education: the statistical analysis following the same principles as for the total group, based on averages of percentages representing differences between the first and the second, the first and the third evaluation, respectively, for each of the 10 types of grips/pinches tested with Pablo, showed that the Pablo group had a favorable evolution for all the studied parameters, but at a superior level compared to the general group. The grip strength had the best percentage increase – by 144% at the second evaluation and by 249% at the third evaluation compared to the beginning, a favorable trend being also found in the general group, but at lower values (70% and 117%, respectively). The thumb-fingers grips had the same good evolution: thumb-medius and thumb-4th finger grips had a remarkable increase in the Pablo group (146% and 114% at the second evaluation, 236% and 187% at the third evaluation). A smaller increase was found for the thumb-5th finger grip at the second determination - compared to the general group (57%), but with a better increase at the end of the study (141% in the Pablo group versus 82% in the general group). The final percentage difference for the thumb-index pinch grip was 187% with Pablo versus 97% without Pablo, the lateral thumb-index mobility was 137% in the Pablo group versus 76% in the general group, interdigital index-medius pinch increased by 89% in the Pablo group compared to 61% in the general group, and the tri-digital pinch had the lowest percentage increase in all the patients, but it was higher in the Pablo group (116% versus 52%). The interdigital 4th finger-5th finger was the only one with an inferior percentage growth compared to the general group at all evaluations (35% in the Pablo group versus 60% in the general group for the second determination; 73% in the Pablo group versus 112% in the general group at the third evaluation). These results suggest that working with the Pablo device for half an hour daily helps the force strength (the most useful kind of grasp for usual activities) and has a smaller effect on interdigital pinches. A synthesis of all the evolutions of the grips and pinches based on the comparison between the Pablo group versus the general group is shown in Figure 3.

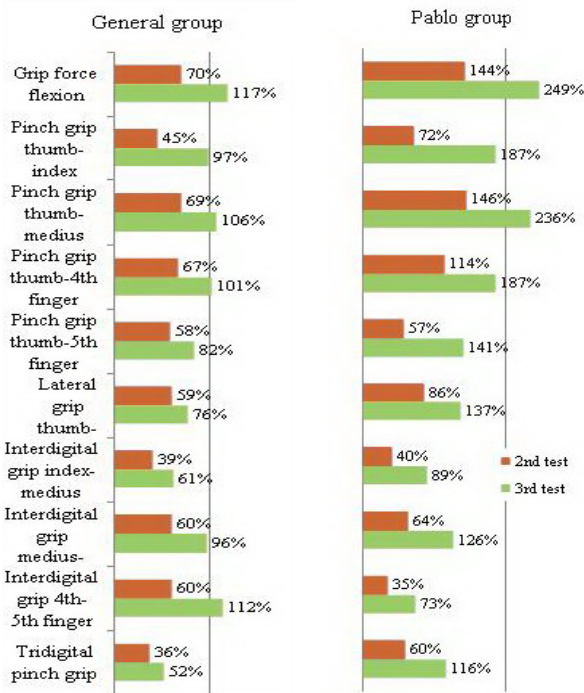


Fig. 3 – Evolution of grips/pinches based on the comparison between the Pablo group and the general group (averages).

Referring to the Pablo device, respecting the "evidence-based medicine" evaluation criteria and the correct statistical analysis, we can say that the Pablo device is an objective testing possibility for the range of motion and grasping strength that can be very useful in the clinical assessment and monitoring of patients with a post-traumatic hand. As a therapy, the results demonstrated that the Pablo game modules based on Virtual Reality concepts improved the motor and functional scores at a superior level compared to patients who did not work with Pablo, but this kind of ergotherapy must be seen as an adjuvant method to standard therapy and not as a substitute for it. Our personal conclusion based on the study results is that we can use Pablo as a complementary method of ergotherapy for the surgical hand (Nica et al, 2013).

Regarding social and professional re-adaptation: the patients of the study needed an average of 4.6 ± 3.9 months of medical leave, more than the European averages from other studies. In our study, 55% of the patients returned to their previous jobs, 18% needed to change their profession or to re-adapt to the working conditions according to their new status, but a percentage of 27% of the patients retired or became socially assisted. Given the average age of 38.3 years, 27% represents a great percentage for young and active people who cannot be professionally reintegrated. This has not only personal consequences, but also consequences at micro-economic level (family as a social cell) and at macro-economic level (society loses young adults who become socially assisted persons). It is a sign for the public health policy to improve the reintegration possibilities of these patients by including social assistants and ergotherapists in the medical team involved in hand pathology, for the maximization of the residual working capacities of each patient and a better adaptation at the work place.

Conclusions

1. The correct assessment of the post-traumatic and post-surgical hand is very important for the correct therapeutical management and for establishing the individualized rehabilitation treatment plan.

2. The evaluation protocol proposed by the authors had a holistic approach (clinical, paraclinical, functional, social and psychological) and the evaluation-chart is a complex and unitary method which is very useful for all the specialists involved in hand or traumatic pathology, offering an integrative image for all dysfunctional or disabling potential according to modern ICF concepts.

3. The physical procedures, medical kinetics and ergotherapy are the standard therapeutic rehabilitation protocol for the postsurgical hand, with the individualized and permanent monitoring of the clinical and functional status, and modern methods such as Virtual Reality concepts may be used as a supplement for a better optimization of classical therapy.

4. The results of the study proved that the rehabilitation program helps:

- maintain and improve the results of surgery, preparing the patients for possible future re-interventions
- prevent possible complications of immobilization/non-usage of the hand post-intervention
- improve vascular and trophic local conditions, allowing a better compliance for kinetotherapy
- increase joint mobility and the strength of grips/pinches with a better functionality and quality of life
- increase functional independence measurement, social reintegration and professional readaptation

5. Pablo game therapy sessions represent a continuation of the classical occupational therapy program that can also be performed by the patient himself, at home, and they give the opportunity to adapt the game parameters to the realistic functional status of the patient. The benefits are the improvement not only of locomotor values (ROM, strength, prehension), but also of attention, motivation, dexterity, based on audio-visual and haptic feedback that can help the patient in the early recovery process.

6. The results of the study are conclusive, reliable, statistically proving that the rehabilitation program has a significant therapeutic value as an essential sequence in a faster and better recovery from post-traumatic surgical hand pathologies.

Conflicts of interests

Nothing to declare.

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