

# Rehabilitation of patients after traumatic injuries to the hand and during the course of upper limb enthesopathic syndromes using personal electronic devices – a preliminary report

## Usprawnianie chorych po uszkodzeniach urazowych ręki oraz w przebiegu zespołów entezopatycznych kończyny górnej z wykorzystaniem osobistych urządzeń elektronicznych – doniesienie wstępne

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### Key words

physical therapy, hand rehabilitation, innovation in rehabilitation, smartphone, tablet

### Abstract

**Introduction:** Along with technological progress, various types of computerized testing systems, assessment and documentation of the course of treatment are used more and more often in upper limb rehabilitation after traumatic injuries. The necessity to individualize exercise programs is also emphasized. The large possibilities of adapting modern technological achievements used during treatment to achieve the expected and intended goals in the rehabilitation process are emphasized.

**Study aim:** The aim of the work is to present the possibility of using a tablet during rehabilitation of patients after selected traumatic upper limb injuries.

**Research material and methods:** This study material comprises patients rehabilitated due to various traumatic injuries and enthesopathic syndromes of the upper limb at the Specialist Centre of Hand Rehabilitation in Krakow. The presented exercises, which were part of a wider, comprehensive program to rehabilitate these patients, were also carried out at home. Particular attention was paid to the possibility of using a tablet and personal mobile phone (smartphones) in its course.

**Summary:** Professional literature on the issues of rehabilitation in patients after traumatic injuries to the hand, as well as in the course of enthesopathic syndromes, more and more frequently refers to the possibility of using modern programs and electronic devices in this process, including tablets and personal mobile phones. The use of these devices allows to conduct a rehabilitation program both in outpatient clinical conditions and home settings.

### Słowa kluczowe

fizjoterapia, rehabilitacja ręki, nowoczesność w rehabilitacji, smartfon, tablet

### Streszczenie

**Wstęp:** Wraz z postępowaniem technologicznym coraz częściej w usprawnianiu kończyny górnej po jej uszkodzeniach urazowych wykorzystuje się różnego rodzaju skomputeryzowane systemy badania, oceny i dokumentacji przebiegu leczenia. Podkreśla się także konieczność indywidualizacji programów ćwiczeń i wskazuje na duże możliwości adaptacji wykorzystywanych w trakcie leczenia nowoczesnych zdobyczy technologicznych dla osiągnięcia oczekiwanych i zamierzonych celów w procesie usprawniania.

**Cel badań:** Celem pracy jest prezentacja możliwości wykorzystania tabletu w czasie usprawniania chorych po wybranych uszkodzeniach urazowych kończyny górnej.

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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**Materiał i metoda badań:** Materiał pracy stanowią chorzy usprawniani z powodu różnego rodzaju uszkodzeń urazowych oraz zespołów entezopatycznych kończyny górnej w Specjalistycznym Ośrodku Rehabilitacji Ręki w Krakowie. Prezentowane ćwiczenia były częścią szerszego, kompleksowego programu usprawniania tych chorych, który był także realizowany w warunkach domowych. Szczególną uwagę zwrócono na możliwości wykorzystania w jego przebiegu tabletu i osobistych telefonów komórkowych (smartfonów).

**Podsumowanie:** Literatura fachowa dotycząca problematyki usprawniania chorych po uszkodzeniach urazowych ręki, a także w przebiegu zespołów entezopatycznych, coraz częściej odnosi się do możliwości wykorzystania w tym procesie nowoczesnych programów i urządzeń elektronicznych, w tym tabletów i osobistych telefonów komórkowych. Zastosowanie tych urządzeń pozwala na prowadzenie programu rehabilitacji zarówno w ambulatoryjnych warunkach klinicznych jak i domowych.

## INTRODUCTION

Along with technological progress, various computerized types of test systems, assessment and documentation of the treatment process are being increasingly used in upper limb rehabilitation. These are technologically complex and high-cost multi-functional systems, including BTE (Baltimore Therapeutic Equipment), E-Link (Biometrics Ltd.), Armeo®Boom, and RAPAE Smart Glove™. On the other hand, therapists often ask themselves the question – how can much cheaper devices that many patients have and use on a daily basis be used for therapeutic purposes<sup>1</sup>? Among others, Algar and Valdes<sup>2</sup> describe examples of the use of smartphones in the rehabilitation of patients suffering from trapezius-metacarpal joint degeneration and after fracture of the distal end of the radial bone. On the other hand, Levanon<sup>1</sup> indicates the possibility of using various types of modern technological achievements in the rehabilitation of those suffering traumatic injuries to the musculoskeletal system. In their opinion, they become especially useful in the process of reconstructing lost motor function of the hands, including conducting purposeful exercises requiring, inter alia, performing repetitive movements with the possibility of feedback as a form of additional stimulation and motivation. The necessity to individualize the exercise programmes proposed for these patients and to indicate the wide possibilities of adapting the devices used in this process is also emphasized. The assumption of such behaviour is to achieve the intended goals and expected effects of the rehabilitative treatment process<sup>1</sup>.

## AIM OF RESEARCH

The aim of the work is to present the possibility of using tablets and smartphones during the rehabilitation of patients after selected traumatic injuries to the upper limb and in the course of enthesopathic syndromes.

## RESEARCH MATERIAL AND METHODS

The study material consists of patients being rehabilitated due to various types of traumatic injuries and hand enthesopathic syndromes at the Specialist Centre of Hand Rehabilitation in Kraków. The presented exercises were part of a wider, comprehensive programme to rehabilitate these patients, which was also carried out at the patients' homes. Particular attention was paid to the possibilities of using tablets and smartphones in its course. The research methodology was based on the presentation of examples of the conducted rehabilitative treatment.

## USING A TABLET IN THE REHABILITATION OF PATIENTS FOLLOWING FRACTURES OF DISTAL RADIUS

The use of computer games included in personal mobile phones (smartphones), consisting among others in overcoming the maze of patient rehabilitation for distal radius fractures, was already described in 2014 by Algar and Valdes<sup>2</sup>. In our material, similar games were used in the rehabilitation programme for patients after each type of fracture of the distal radius, as well as after fractures in the vicinity of the elbow joint. The tab-

let used for this purpose had an additional grip, which allowed the use of different grip types – from placing the forearm in an intermediate position, to positioning it in pronation or supination. These exercises were carried out in various configurations, which allowed the implementation of the assumed goals and to obtain the expected results.

## Examples of rehabilitating patients after distal radius fractures

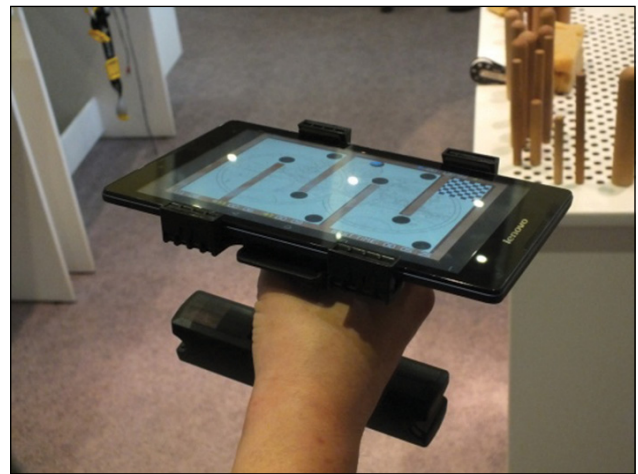
**Case 1** – 28-year-old female-patient, professional educator, she suffered a fracture to the distal ends of both radial bones of the right forearm due to intermediate mechanisms. The aim of the treatment was to increase the range of motion of the wrist and right forearm and to improve its stability and strength. The expected effect of this procedure was improvement in motor activity of the right upper limb and its functional efficiency. For this purpose, the rehabilitation programme used computer games logged on the tablet, including Labyrinth World and Labyrinth Lite, which were run in different positions of the right upper limb and using various movements.

Examples of recommended exercises:

1. Arm in adduction, elbow flexed at 90° angle, arm in intermediate position. Controlling the computer game consisted of performing supination and pronation movements of the forearm as well as the elbow and radial-wrist abduction (Photo 1a and b).
2. Adducted forearm, elbow flexed at 90° angle, forearm in pronation. Game control was based on performing supination and pronation movements with the forearm as well as flexing and extending the wrist.



a



b

**Photo 1**

**Example exercises using the "Labyrinth" game: A – initial position – lateral view, B – starting position – top view**

3. Adducted forearm, elbow flexed at 90° angle, forearm in intermediate position. Game control was based on the performance of supination and pronation movements of the forearm as well as flexing and extending the elbow.

**Case 2** – 63-year-old male patient, professional violinist, suffered a fracture of the distal part of the left-arm radial bone due to indirect mechanisms. Because of the persistent pain at the level of the *distal* radioulnar joint (DRUJ) and limited mobility of the wrist as well as supination of the forearm with pronounced progression in the morning, he was unable to work professionally. The aim of treatment was to increase supination of the left forearm, improve joint stabilization and to simulate playing a violin. Based on these premises, the "Maze" game was logged on the tablet (and a personal phone - as a home programme) and was used in the process of rehabilitation, which allowed, among others, to simulate playing a violin (Photo 2). Game control consisted of performing supination and pronation movements of the forearm and flexing and extending the left wrist.

**Examples of using a tablet in the rehabilitation of patients following traumatic injury to the fingers resulting in hyperalgesia of the fingertips**

**Case 1** – 36-year-old female patient, professional computer graphic designer, suffered traumatic injury to

the distal extensor tendon of the 3<sup>rd</sup> finger in the right hand due to intermediate mechanisms. The damage healed along with extension of this tendon resulted in dysfunction of the distal interphalangeal joint (DIP), and consequently, the necessity for its surgical reconstruction combined with temporary stabilization of the DIP joint with Kirschner wires. After removal and healing of the surgical wound, there was significant reduction in the functional efficiency of this finger in the pincer grip, painful scar tissue as a result of the surgery

and pronounced hyperalgesia of the pad, which definitely prevented the patient from fully performing professional work.

**Case 2** – 38-year-old female patient, professional translator, using a computer in her work, suffered traumatic damage to the deep flexor muscle tendon of the 3<sup>rd</sup> finger of the left hand due to immediate mechanisms. She was qualified for surgical fixation of the damaged tendon using the "end-to-end" method. The postoperative course complicated by neuroma in the scar after the surgical wound

**Photo 2**

**Example exercise using the "Labyrinth" game: initial position and grip simulating playing a violin – medial-lateral view**

resulting in a considerable degree of pain in the finger and the evident hyperalgesia of the fingertip making it difficult to work on a computer and to write.

In the rehabilitative treatment of both patients, the computer game “Piano Tiles” logged on the tablet or smartphone was used. It consists in touching the moving black blocks using the finger tips (Photo 3). This caused the reproduction of specific music. Erroneous hits result in the interruption of the game and the necessity to play again. These exercises were also performed by patients at home. Along with time, pain and paresthesia relief allowed to extend the duration of subsequent exercises and increase their frequency.

and gradual flexion of the arm resulted in an automatic increase of abduction to the elbow-wrist joint (Photo 4). The arm of the rehabilitated limb was adducted to the trunk, the elbow flexed to a 90° angle, and the forearm remained in an intermediate position. Game control consisted of performing supination and pronation movements of the forearm, as well as abduction to the elbow - and radial-wrist joint.

**Examples of using a tablet in the rehabilitation of patients surgically treated for scaphoid fracture**

Case 1 – 21-year-old male patient, footballer playing the position of goalkeeper, suffered fracture of the left scaphoid wrist bone from intermediate mechanism. He was qual-

ified for surgical treatment using the AO method. The postoperative course complicated by a significant degree of mobility limitation, weakness and pain of the left wrist. In order to improve the functional state of the left hand and wrist, including their strength, proprioception and stabilization, exercises were introduced using the “Labyrinth” game logged on the tablet.

The following exercises were used to rehabilitate this patient: left arm adducted, elbow flexed to a 90° angle, forearm in intermediate position. Game control consisted of performing supination and pronation movements of the forearm, as well as abduction to the elbow - and radial-wrist joint. An additional obsta-



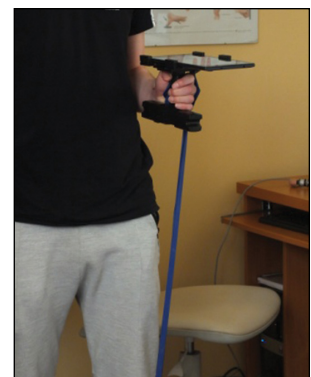
**Photo 3**  
Example exercises using the “Piano” game – top view



**Photo 4**  
Example exercise using the “Labyrinth” game – thumb flexion with abduction to elbow of the right wrist – medial view

**Examples of using a tablet in patients rehabilitated due to de Quervain syndrome**

Case 1 – 35-year-old male patient, professional computer scientist, suffering from de Quervain, manifested in pain complaints and limited supination and pronation movements of the right forearm, as well as abduction to the right elbow and radial-wrist joint. The “Labyrinth” game logged on the smartphone, placed in the additional holder, was used to treat this patient. Depending on the degree of experienced pain, the tablet grip method was modified. The thumb was set in an increasingly flexed position,



**Photo 5**  
Example exercise with the use of the “Labyrinth” game: A – resistance exercises for wrist extension muscles – frontal-lateral view, B – resistance exercises for wrist abduction muscles – frontal-medial view

cle was the Theraband tape placed on the metacarpus in order to resist movements of the wrist in different directions (Photo 5a and b).

## CONCLUSION

Professional literature on the issues of rehabilitation among patients, including those after traumatic hand injuries and in the course of enthesopathic syndromes of the upper limb, more and more often is beginning to refer to the possibility of using modern electronic programmes and devices in this process<sup>1,2,7-17</sup>. These are, among others, certainly tablets or personal mobile phones. The reports also postulate that these patients perform various everyday or periodic activities, including those related to work or recreation. They support not only the recovery of lost motor functions of the limb but are also an effective tool in the treatment of complications resulting from surgery. In this context, the importance of increased motivation of the rehabilitated patients in the implementation of rehabilitation plans is underlined. Those who are ill, see the effects of their work and have direct impact on it. They can independently choose the frequency and intensity of the per-

formed exercises, which also allows them to perform an established rehabilitation programme at home<sup>1-6</sup>.

**Conflict of interest:** None declared

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