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Effectiveness on the use of the GripAble platform in distal radius fracture: case study

Abstract

Distal radius fracture is characterized by loss of bone continuity and is often caused due to falls on the hands. It can occur at any age and can cause changes in customers' activities of daily living. The aim of this case study is to analyze the efficacy of conventional occupational therapy treatment, associated with the use of the GripAble platform in a person diagnosed with distal radius fracture. We intended to conduct a prospective observational study with descriptive basis, with a 62-year-old female subject with distal radius fracture treated conservatively. The patient was followed by Occupational Therapy on a south hospital in Portugal. Occupational Therapy using virtual rehabilitation through GripAble allowed to achieve significant improvements in pain, joint range of motion and grip strength of the case under study. Virtual rehabilitation through GripAble, associated with conservative treatment, was effective in the rehabilitation process of a case of distal radius fracture.

Keywords: distal radius fracture, gripable, occupational therapy, rehabilitation, hand

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Introduction

Distal radius fracture is the most frequent of the upper limb, reaching up to 75% of forearm fractures.[1] They are defined as those that occur up to three centimeters from the radiocarpal joint.[2] "Complex lesions and variable prognosis are considered, which depends on the degree of impairment and the type of treatment instituted".[3] They are found in populations of all age groups, despite the higher prevalence in children and the elderly.[4] In addition to age, gender is also considered as a risk factor, since men are more likely to suffer this type of fracture.[4] Some authors indicate that the incidence of this type of fracture tends to increase over time, since annually there has been an increase in population aging, an increase in the rates of childhood obesity and an increase in the participation of children and young people in sport activities.[5] These fractures cause physical, functional, and emotional limitations. Pain decreased joint amplitudes and muscle strength are complications resulting from the bone consolidation process, soft tissue injury and associated complications that may arise during treatments.[2] This type of fracture can cause limitations in the performance of activities of daily living (ADL's), work and leisure if these complications persist after treatment.[6] Patients may also develop stress/anxiety if the rehabilitation process is slow, or the pain remains for long periods of time. In addition, the time to return to normal function after proper treatment may be prolonged and, in some cases, never return to normal.[5]

Conservative treatment is indicated for more stable and non-displaced distal radius fractures of or for fractures that may be unstable in elderly patients who are debilitated or have decreased cognitive abilities.[7] In these cases, closed reduction and immobilization with plastered splint or orthosis are generally chosen.[8] This type of treatment considers the taking of analgesics and anti-inflammatory drugs, being associated with a continuous and individualized rehabilitation program, which includes cryotherapy (for the control of edema and pain), techniques for gaining joint range of motion and muscle strength, such as joint mobilization, neuromuscular rebalancing, strengthening exercises, electrotherapy, among others.[9] Conservative treatment shows better results in terms of functionality than surgical treatment[1].[10] In this study, the grip strength remained practically unchanged in the cases treated conservatively while in the cases treated surgically there was a significant decrease in strength. The authors advocate conservative treatment or other less aggressive surgical techniques.[10]

Occupational Therapy (OT) in hand reeducation after traumatic injury aims at the recovery of lost physical functions, such as muscle strength, sensitivity, range of motion and reintegration of the patient in the family, professional and social context.[11] Occupational therapists use the activity to rehabilitate. These activities can be, for example, games.[12] Through virtual rehabilitation, it is possible to stimulate multiple motor and sensory skills, allowing the patient interaction and offering the therapist the possibility of creating an individualized rehabilitation program, according to their needs.[12] This technique proved to be an effective way to promote fun and motivation, being a facilitator of the rehabilitation process. In addition, virtual reality benefits from increased balance, endurance, dexterity, speed, and range of motion.[12] The games used for fracture rehabilitation promote the increase of the joint amplitudes of the elbow, forearm, wrist and fingers.[13]

Virtual rehabilitation offers many benefits compared to traditional treatment methods, as it makes the rehabilitation process fun and stimulating; it allows the processing of data in a "transparent" way, being possible to store it in the device that performs the simulation; data can be made available on the Internet; virtual therapy can be performed at home and adapted and monitored remotely.[14]

There are several games, such as ReValidate! and Leap Motion that were developed to increase the range of motion of the elbow, forearm, wrist, and fingers joints, in addition to allowing the continuation of treatment at home. ReValidate! was constructed with the objective of working the isolated movements of the wrist (flexion, extension, deviations, and prono-supination) in a controlled manner.[15] The Leap Motion is a small device with sensors capable of capturing the movements of the player's hands.[9] The Nintendo Wii™ which, although not built for the specific purpose of rehabilitation, includes several games that allow not only to increase ranges of motion, but also simulate the ADL´s, promoting the increase of functionality.[9]

The GripAble platform aims to optimize the performance of the person, as well as promote the increase of range of motion and grip strength decreased due to the clinical condition. This platform is "a multifunctional portable device that incorporates force and motion sensors, being able to monitor interaction and wirelessly connect to electronic devices, allowing the user to perform objective assessments of grip strength and range of motion of the wrist, monitor the assessment in accordance with standard protocols and monitor the progress of the individual." [16]

In addition, this platform offers fun and engaging skill training activities that adapt to users' interests, while working on hand and arm movements and grip strength, providing real-time feedback on activity levels.

The choice of this platform was due to the advantages presented over the other equipment: its approximation with the movements performed in real context; the added value of enabling the evaluation of ranges of motion and grip strength; the fact that it allows the realization of grip force associated with the various movements of the wrist; the diversity of games available. Another reason for choosing GripAble was because there is a good correlation with Jamar (a dynamometer most used as an instrument for assessing grip strength)

Purpose of the study

The aim of this case study is to analyze the efficacy of conventional treatment of OT, associated with the use of the GripAble platform, in a person diagnosed with distal radius fracture, in a late stage of evolution.

Material and methods

The present single case study is an observational and prospective one, under a descriptive basis and mixed data processing. Regarding the treatment of data, this study is considered quantitative.[17] The choice of case acquires a very particular meaning, is always intentional and is based on pragmatic criteria.[18]

Data collection as well as the study were carried out during two months on a south hospital in Portugal. The research was approved by the Ethics Committee and the patient informed of all procedures to which it was going to be subject, having signed the free and informed consent.[19] This study was conducted with a 62-year-old female with a clinical (chronic) diagnosis of distal radius fracture of the left hand treated conservatively due to a fall on the hand. The patient works as a secretary on a hospital. The patient was referred for treatment in OT to improve occupational performance in performing ADL's and instrumental activities of daily living (IADL's) identified by her. She was submitted to OT treatment in the hospital for 15 sessions, three sessions were performed per week, lasting 60 minutes each.[20]

The initial evaluation was carried out on April 11 and the reassessment on May 6, 2022, after the 15 treatment sessions. Through the semi-structured interview, the client identified the sweeping of the house, picking up coins, cutting food, holding the papers with the clips and washing the dishes, as doing the activities with greater difficulties in performing. These difficulties are due to the deficit in the joint amplitudes of the wrist (flexion/extension, prono-supination, and radial deviation) and fingers, the positioning of the hand in marked cubital deviation, the deficit in muscle strength (namely grip strength), the deficit of fine motricity, motor coordination and, consequently, manual dexterity.[21]

The GripAble platform was used to evaluate grip strength and wrist ranges of motion, specifically flexion, extension, prono-supination, and radial and cubital deviations. For the evaluation of these parameters, the procedure recommended by the GripAble platform was considered. The result of the initial evaluation is shown in Figure 1. The Visual Numerical Pain Scale was used as a way of evaluating pain complaints. The client reported that she presented a pain 8, very close to the maximum score (10 points maximum).[22]

Figure 1 Initial evaluation data.

As specific objectives, we defined pain control, correcting the marked cubital deviation, decrease in joint stiffness, increase in strength and in range of movement, in addition to promoting functional performance.

To achieve these objectives, the following treatment was carried out:

Massage: Massage involves manipulating body tissues to relieve tension and pain and promote relaxation. In addition, therapeutic massage also includes the maintenance of positions, which extend to soft tissues and apply pressure to the body. This improves flexibility and reduces muscle tension.[20]

Mobilization: At the beginning of all sessions, before performing any activity, the client should benefit from preparatory methods, such as passive mobilization. Joint mobilization is a technique that involves slow and passive movements of the articular surfaces. It is used for several purposes, such as increased range of motion, repositioning and realignment of the joint, reduction of pain and redefinition of the distribution of forces uniformly around the joint.[21]

Proprioceptive neuromuscular facilitation (P.N.F.): Technic that uses manual resistance for facilitation purposes. The techniques are defined as specific stimulus placement methods, through the proprioceptors, to obtain desired answers and, thus, accelerate the neuromuscular mechanism. The most used techniques were approximation, traction and contract-relax to increase wrist range of motion and increase muscle strength (always respecting pain limit).[22]

GRIPABLE: through this platform were held several games that promote the realization of several movements like those performed in The ADL's and IADL's, facilitating the rehabilitation of motor skills.[9]

The set of games recruited for this study was:

Ballon buddies: Aims at the controlled movement of tightening and dropping. Through this, it is allowed to control the movements of the bird up and down the screen, trying to collect the stars (Figure 2).

Concierge: allows you to use extension and flexion of the hand to make deliveries on the floors of the hotel. Through the extension of the hand the lift rises, through the flexion the elevator descends. This activity aims to encourage a strong grip, while allowing the stabilization of the wrist.

Windowsill: Through the pronation and supination this game allows you to create and cultivate a miniature garden, working on control and stability at specific points (Figure 3).

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Pigeon hunter: Through repeated hold and controlled release, the game allows you to shoot arrows at flying pigeons (Figure 4).

Pufferfish: Through the radial and cubital deviation it is possible to control the fish to collect the bubbles, while swimming through a sea of dangers that become more dangerous over time (Figure 5).

Figure 2 Patient performing the game Ballon Buddies.

Figure 3 Patient performing windowsill game.

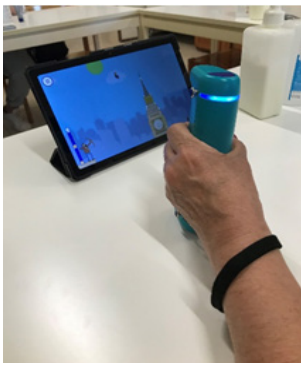

Figure 4 Patient performing pigeon hunter game.

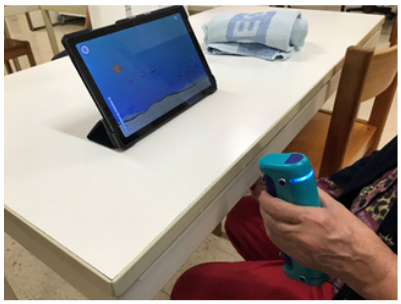

Figure 5 Patient performing the game Pufferfish.

Results

After the 15 sessions of treatment, there was a good evolution of the patient's functionality. Mobilization, massage and PNF allowed improvement in pain. There was also improvement in the range of motion of flexion and extension of the wrist, pronation, supination, and cubital and radial deviations. This progress allowed the client to carry out the significant activities identified at the beginning of the therapeutic process, namely in sweeping the house, washing the dishes, and cutting the food.[23]

Through the analysis of the data presented in Figure 6, it is possible to verify improvements in the level of joint amplitudes and grip strength. Despite these improvements, the client maintains a deficit in joint amplitudes. However, it is verified that the data of the articular amplitudes of pronation and supination are altered, not seeming to correspond to reality. These results may be due to the patient's difficulties in maintaining concentration in the proposed activity, in the difficulty in understanding the requested movements, or in performing compensatory movements (Figure 6).

Figure 6 Final evaluation data.

With the comparison of the data obtained in Figures 1&6, it is also possible to verify an increase in the overall grip strength.[24] Regarding pain, it decreased with the treatments performed from an 8 to a 4. With the treatment it was possible to correct the alignment of the structures, recovering part of the flexion and corrected the cubital deviation initially presented. Through GripAble, the functionality was enhanced, being visible greater use of the hand by the patient. The patient was motivated throughout the sessions by the dynamism of the activities developed. The various levels of difficulty of the games were a form of motivation and desire to continue to attend therapy. The patient's involvement with the treatments was a positive factor for their improvement, since when she could not perform a certain movement or achieve a certain score in the games, she transformed it into an incentive to improve her performance in the next session.[25]

Discussion

The literature shows that the commonly used procedures are not well documented and tested, hindering the practice based on evidence by health professionals in the treatment of this type of fracture.[23] According to the study developed by the authors mentioned above, there is no specific rehabilitation protocol for this type of diagnosis.

It is possible to verify an increase in the use of virtual reality as a form of clinical rehabilitation and the use of games in a home context. However, there are still few studies indicating the effectiveness of these platforms[24].

Studies developed[15] indicate that the games show advantages in health education, motivation, and potential, increasing the support of patients to the treatment of distal radius fractures. Both the patient and therapists consider the game a valuable support tool for rehabilitation,

providing a fun and challenging experience as a method of performing exercises for the wrist.[15]

Compared to ReValidate! which allows only isolated movements of the hand, GripAble also allows a global grip associated with these movements. Here, it also uses the grip force simulating some tasks of ADL's and IADL's, such as grabbing a kettle, ironing, among others. Leap Motion, in turn, can capture movements of the fingers, performing them in the air. This does not simulate in such a real way the realization of the movements necessary to carry out the day-to-day tasks, such as GripAble.

For Nintendo Wii™ it has the advantage over GripAble because it includes IADL's simulation games, such as a food preparation activity titled Food Network: Cook or Be Cooked™. However, the movements requested during the activities do not simulate the resistance of the hand of objects in real context and are not always realistic, since those who play must make a constant push on a button.

It is concluded that GripAble is the only one of these devices that allows an approximation to functional movement. In view of the results obtained in the various studies consulted, there are significant improvements compared to conventional therapy.[9] These results can be explained by the motivational factor. There are some possibilities regarding motivational aspects in the use of virtual reality, such as the possibility of the customer/player being able to overcome challenges and have control over various parameters that it does not have in real life, which can have a cathartic effect. Another of the possibilities is the question of competition and overcoming, how to be the best, win the game, among others.[25] The patient showed motivation to overcome and improve her performance, longing for the next therapeutic sessions.As with the above-mentioned studies,[9,15] the present study also verifies improvements in the level of joint amplitudes, grip strength and pain, using virtual reality. During the project there were some limitations, namely the fact that there is no scientific evidence in the use of GripAble as a form of therapeutic intervention, since there are only studies that report the reliability of the device as an instrument for assessing grip strength.

Conclusion

With the present study, it was possible to verify that virtual rehabilitation, through GripAble, associated with conservative treatment was effective in the rehabilitation process of a case of distal radius fracture, allowing to achieve significant improvements in pain, joint amplitudes, and grip strength.

It was found that the patient improved significantly with the use of virtual reality in 15 sessions. The authors propose to carry out new studies that allow the collection of data with GripAble in order to create scientific evidence regarding the intervention process through the games of this equipment; studies that assess the reliability of this device for the evaluation of range of motion; studies that use the performance of exercise programs at home, as a complement to treatments in the therapeutic context and also to conduct studies that scientifically support the potential of GripAble in the evaluation of the functions related to ADL's and IADL's.

It is suggested the development of games that simulate the ADL's and IADL's, since existing ones can be considered childish by certain clients. Include greater variability of games, allows to meet various interests and, consequently, motivate more customers.

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Conflicts of interest

The authors report no conflicts of interest in this work.

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