Journal of Pharmaceutical Research International

33(60B): 1982-1988, 2021; Article no.JPRI.76439
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Impact of Artificial Intelligence in the Physiotherapy Rehabilitation of Distal Radial Fracture Patients: A Review

Tasneem Burhani [a*≡] and Waqar M. Naqvi [bφ]

[a] *Ravi Nair Physiotherapy College, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra, India.*
[b] *Community Health Physiotherapy, Ravi Nair Physiotherapy College, Wardha, Maharashtra, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both author made best contribution for the concept, assessment and evaluation, data acquisition and analysis and interpretation of the data. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i60B34889

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/76439

Review Article

Received 10 October 2021
Accepted 16 November 2021
Published 24 December 2021

ABSTRACT

Background: Physiotherapy is the desired therapeutic intervention for the recovery of fractures and discomfort associated with bones. In certain cases the patient may suffer from extreme pain because of sudden jerks or injuries. The goal of this review was to map out the available literature on virtual reality in distal radius fracture rehabilitation across physiotherapy disciplines.

Methods: An extensive and systematic search of the following databases was undertaken- Embase, Cochrane Library, PEDro, and CINAHL. The MeSH search items used were articles with "artificial intelligence, "machine learning" "virtual reality" "physiotherapy". Articles were identified if they described an intervention which is considered within the scope of a physiotherapist and targeted those with DRF.

Results: Total 35 were initially procured from which 26 articles were included, out of which 13 were observational, 6 Randomized Control Trials, 2 qualitative, 2 surveys and 3 systematic reviews. Only 9 studies focused explicitly on physiotherapy interventions.

≡ *Resident;*
φ *Professor and HOD;*
**Corresponding author: E-mail: tasneemburhani95@gmail.com, tapsburhani@gmail.com;*

Conclusion: The results of there view indicate that there is insufficient evidence to direct physical therapists in the treatment of individual with distal radius fracture using artificial intelligence.

Keywords: Artificial intelligence; distal radial fracture; physiotherapy; review.

1. INTRODUCATION

Artificial Intelligence is described as the creation of technology that is used to conduct technological operations requiring human intelligence involvement [1]. Artificial intelligence has played a significant role in developing technology. One of the main aspects of artificial intelligence is machine learning, which give us the opportunity to train our patients for both supervised and unsupervised learning. There are multiple features supported by machine learning that could be utilized for finer training. Artificial Intelligence (AI) can improve healthcare by enhancing the delivery of treatment, making decision and patient participation. AI has been the development of computer systems to solves human intelligence related problems.

AI is a field of mathematical innovation that has the potential to transform healthcare through innovative treatment delivery approaches, informed decision-making, and the facilitation of patient interaction. Machine Learning (ML) is a type of AI that can be applied to a variety of tasks to automate decision making and predict outcomes based upon patient data.The Artificial intelligence in health care is commonly used, for example, in applications that assist in quicker diagnosis and basic patient feedback [2].

It is noted that technology has proved to be very beneficial in the healthcare profession [3]. There are numerous applications being built that make life simple for doctors and patients. In clinical applications, technologies including artificial intelligence, machine learning and virtual reality are the most popular common. Health professionals are getting the resources they need to provide the kind of care and support needed by patients in need with the aid of apps such as these medical technologies. It also reduce sclinician’s workloads and offers the means to handle more clients than ever.

In recent decades, the need for physical therapy has grown with an improvement in injury care, physical strength, body functioning and overall body activity with participation of body movement research rather than drugs involvement and surgery. The need for physiotherapy has risen with the rise in physical activity, as well as the need for rehab facilities and the demand for physiotherapists. Technology in the medical sector now serves as a supportive workload device for physiotherapists.

1.1 Artificial Intelligence in Clinical Practice

A large amount of research within the field of digital rehabilitation has emerged. These experiments follow the concepts of Cognitive Infocommunication. These research reflect on the complexities of making knowledge sharing more normal for consumers. Virtual Reality's (VR) potential in rehabilitating people with cognitive difficulties has long been recognized by scholars and medical practitioners. There have been several trials showing the efficacy of VR for physical rehabilitation since the 1990s [4].However, whether therapies using VR have advantages over conventional physical therapy? Device assessment highlighted the value of VR: precision balances, strategic choices, and more specific adaptability. Researchers do not know enough about how a person learns a skill in VE, to what degree the skill in real life is enhanced by this environment [5].There is no compelling indication that enhancing efficiency can help. In this review, we discuss the state of the art of VR that have been introduced to promote personal health and physical activity, as well as the outcomes of clinical trials, to help in the treatment of patients with DRF. Jakub Olczak et al. did an assessment towards the use of AI to evaluate orthopedic fracture radiographs. This research encourages the use of AI for orthopedic radiographs, which can work at a human stage [6].

1.2 Virtual Reality in Healthcare

Virtual Reality (VR) is an immersive technology that enables for personalized intervention and can aid in the delivery of effective and person-centered therapeutic intervention [7]. Virtual reality refers to a computer environment or games that appear and feel real. Utilizing custom-made apps, people could interact with a simulated space [8]. Using VR-based games with hand-held controllers to turn tedious exercises into enjoyable and immersive experiences that patients look forward for doing. The simulated feature of VR shown to help decrease pain issues in patients with burns while changing dressings or receiving therapy [9]. Virtual reality is likely to be used to minimize and alleviate chronic pain in a number of ways. Disconnecting body activity from visual feedback has been found to minimize discomfort and enhance range of motion in research. In rehabilitation training, VR is an effective and precise analysis technique for joint (ROM), balance and function [10]. Personalizing treatment, encouraging patients, enhancing compliance, and monitoring their success will all be made better with it. This would reduce the amount of work that doctors have to do and it only includes limited supervision. Virtual rehabilitation has a range of advantages over conventional recovery approaches. It can be fun and motivates the patients. Virtual rehabilitation can be conducted at individual’s home. It reduces medication and service costs. Steven Phu et al. compared the results of VR training with the Balance Rehabilitation Unit (BRU) versus exercise with a modified Otago Exercise Programme on improving balance and physical performance in the Gait and Balance Gym's short-term restorative treatment environment [11]. The future use of VR as a realistic method to increase the results of balance training for reducing the likelihood of falls in elderly people is illustrated in this research.

In comparison, Yoon-Hee Choi performed research on a Smartphone game-based VR programme for stroke therapy in the upper limbs. The study's results revealed that the VR software focused on a mobile game successfully promotes upper extremity recovery in patients with stroke [12]. The meta analysis conducted by Han Suk Lee et al on the impact of VR training on function in chronic stroke survivors, According to the results, VR training was helpful in enhancing function in chronic stroke patients. Furthermore, VR training enhanced lower extremity function in the same manner as it improved upper extremity function [13].

1.3 Distal Radius Fracture Rehabilitation

Fractures of the upper limb are common, and are expected to increase with an elderly population [14]. Usually, young people experience these fractures from high-energy traumatic experiences such as collisions in motor vehicles, while elderly people with osteoporotic alterations sustain them from low-energy injuries such as a fall. Someone who has an upper extremity fracture will have trouble engaging in occupational, personal and sporting activities for up to 12 months after the fracture [15]. Many problems can be linked to the form or severity of the fracture, as well as complications including complex regional pain syndrome. Nevertheless, several other challenges might be based on the length and position of immobilization, surgical treatment or patient-related factors such as age, gender and fear-avoidance behavior. To solve these concerns and facilitate rehabilitation, individuals were mostly referred for physical therapy.

DRF is by far the most common fracture in musculo - skeletal unit, demonstrating approximately 15 percent -20 percent among all injuries handled in emergency services. Upper limb fractures are normal and can affect people of all ages. Over one's lifespan, the occurrence of DRF has a bimodal distribution. The prevalence is highest in adolescence, decreases in adult years from young to middle age, and then rises again sometime in the elderly [16]. Aged individuals over the age of 60 have a higher incidence, according to studies. It is the second most common form of fracture in this age group, after hip fractures with nearly four times more injuries in females as compared to males. Major sporting events and accidents are the most likely reasons of DRF in children and young adults [17]. Low-energy damage from a fall from a height, on the other hand, is perhaps the most leading cause of injury in the aged. The most common upper limb fractures–proximal humerus fractures and DRF–are predicted to rise by around 10% per five years until 2036. Physical rehabilitation is generally prescribed following an upper limb injury to help patients heal by reducing pain, increasing range of motion and strength, and improving function. Patients of distal radius fractures are typically treated conservatively with closed reduction and internal fixation [18]. Despite this, the treatment approach failed to maintain reduction, with more than half of the patients disclosing malformation and re-displacements. The most frequent cause of reduction failure and secondary fracture is ageing. Nevertheless, new literature shows that, regardless of residual deformity, older patients' function increases.

Distal radius fracture can lead both long and short -term disability such as lack of ROM, pain, muscle weakness and edema. It is likely that these disabilities will lead to a loss of everyday function. Post DRF, the physiotherapist's aim is to help the patient recover maximum joint strength and functional capacity. Physical therapy methods can be classified as active or passive in order to meet these aims. Exercise and counseling are examples of effective rehabilitation methods wherein the patient plays an active interest in their recovery. Passive treatments include methods including passive joint mobilization, wherein the patient plays a passive role in the treatment [19]. The rehabilitation plan involves therapists using their clinical reasoning abilities to develop a treatment regimen that is unique to them. To speed up recovery after DRF and increase functional status, the patients were either recommended for PT or assigned home-based conditioning programme. While the aims of physical therapy are simple, the procedures differ greatly. Treatment options include ultrasound, continuous passive motion, electrical stimulation, electro-myographic biofeedback, soft tissue mobilization, strength training and mobilizing exercises, use of dynamic splints and recommendation on education and rest. Even after an upper-extremity fracture, exercise is a successful intervention. For e.g. Michlovitz et al. discovered that at least 90% of patients attending rehab were advised to exercise after DRF [20].

A few patients develop wrist stiffness and grip weakness throughout the span of many months and undergo intensive physical therapy during their rehabilitation. PT is critical after the immobilization phase. Physical therapy is prescribed for managing pain, restoring range of movement, and improving muscle strength and function [21]. Active interventions are those that enable the patient to engage regularly in the recovery process, such as counseling, a Home Exercise Regime, or a supervised physical therapist programme. Massage, mobilizing joints, US, hot packs, and TENS are examples of passive interventions in which the patient is a passive participant during therapy. In this respect, the systematic study by Handoll et al. reported that evidence are insufficient to determine effectiveness of various interventions used for improved coping for adult rehabilitation with DRF [22]. The primary goal of this study is to analyze the efficacy of immersive virtual reality versus traditional physical therapy on pain and functional status in patients with DRF.

1.4 Incorporating Virtual Reality into Distal Radius Fracture Rehabilitation

Distal upper limb function is important for implementing Daily activities such as carrying items like cutlery, rotating a door handle or key in a lock, using a telephone or device, and writing, and is connected to QoL in DRF. VR-based rehab has shown to be successful in stroke survivors, and there are a range of VR-based rehab devices available, ranging from commercial video game equipment to robotics are recently being developed and used [23]. A considerable number of researches in stroke patients were already conducted in the context of upper extremity recovery, and a recent review discovered that VR-based rehabilitation is preferable to amount matched traditional therapy for enhancing upper extremity function. Nonetheless, many other VR-based upper limb recovery studies focused on the proximal upper extremity. Even though past researches found significant improvement with VR-based rehabilitation for the distal upper limbs, neither study had a control group. Using a VR device and various types of gloves, randomized control trials were conducted; nevertheless, due to the limited number of subjects, a conclusive conclusion about the treatment response could not be drawn.

As a consequence, innovative service distribution models and optimizing the usage of existing capital are important. Innovative recovery methods are being developed as a result of the advent of digital devices or "gamified" goods. Virtual Reality (VR) and video games are newer technologies that are gradually being used in recovery as they become more available and inexpensive and are widely have been used in therapy to enable patients to participate in repetitive training with complex activities. Exergames, also known as exergaming, are video games that are used to exercise. A variety of peer-reviewed articles and meta-analyses have looked at the use of virtual reality and video games for post-stroke recovery, with a specific emphasis on or inclusion of UE rehabilitation.

1.5 Gamification for Distal Radial Fracture Rehabilitation

Exercise is commonly prescribed to patients suffering from a number of wrist problems in order to restore impaired wrist and hand function [24]. Therapeutic interventions for regaining wrist motion are extremely unpredictable, and exercise procedure adherence is considered to be poor. Revalidate is a serious game. To inspire patients, standardized exercise regimens were developed. Patients have either been recommended for physical therapy or provided self-monitored home exercise plans to accelerate recovery and improve functional performance following distal radius fractures. Treatment guidelines for distal radius fractures state that this decision is given to the judgment of the surgeon and the patient, resulting in unreasonable recovery regimens that vary by area, region, hospital, and even individual surgeon. Besides that, just around 35% of patients are assumed to adopt their physiotherapy regimens to the core. Practical restrictions such as time, costs, and travel distances, as well as the complexity of recalling exercise guidelines, all play a part. Presently, this subject is underappreciated and badly studied. Serious games and wearable technologies may be considered exciting for home-exercise programs. Serious games are described as exciting and demanding software applications with the intention of imparting practical skills or information to their users. Their use in the treatment of chronic neurologic and musculoskeletal disorders has been thoroughly studied. Latest systematic studies suggest that serious games have the ability to enhance operation and track outcomes, considering the lack of high-quality validity studies. Furthermore, the use of newly introduced wearable motion sensors (wearable technology) in home-based recovery settings could increase real-time patient tracking. Despite this hypothesized impact of "wearable regulated" serious games, there have been few studies.

1.6 The Impact of Physiotherapy on the functional Outcome after Distal Radius Fractures

Patients are sometimes directed to physiotherapist after upper extremity trauma and particularly after DRF to manage pain, strengthen ROM, grip strength and recover full mobility [25]. It is well established that physical therapy is effective in returning functionality to affected extremities, but the effect of supervised physical therapy and successful wrist exercises after operatively treated DRF is still not completely explained in the literature. Several studies investigating additional supervised physiotherapy versus a prescribed home exercise programme showed no conclusive evidence that upper limb function really benefited with the supervised treatment compared to a sole home exercising programme. Krischak et al. and Souer et al.. even showed that the independent home exercises resulted in superior functional outcomes versus supervised physiotherapy [26].

2. CONCLUSION

Artificially intelligent technologies are creating improvements in the health-care sector that would have a huge influence on how health-care is provided in the twenty-first century [27]. Both healthcare professionals will be required to reevaluate their fit for function in an intelligence era characterized by smart computers, large data sets of immense size, and fundamentally different relationships with patients and algorithms [28]. We might certainly take seriously the suggestion that yesterday's health professions might – and maybe should – be substituted in part by more suitable alternatives, such as AI-based programmes and less costly options. Intelligent algorithms are already smarter than us within certain narrow domains and successful clinical practice in the future will require that we understand how to interpret the advice of machines, when to hand over control to them, and when to ignore them [29,30].

The Distal Radius (DRF) is among the most frequent fractures in the elderly, and the ulna is frequently affected too though. Most research comparing clinical outcomes following treatment have been completed. Despite the fact that these findings have contributed to our awareness, the appropriate treatment for distal radius and ulna fractures is either uncertain or debatable. The evidence supporting the use of virtual reality for DRF is limited. This study found that using the artificial intelligence system as a complement to out-patient therapy treatments for DRF patients with limited therapist guidance is safe and practical, and that it may enhance upper extremity use.

CONSENT

It’s not applicable.

ETHICAL APPROVAL

It’s not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tack C. Artificial intelligence and machine learning | applications in musculoskeletal physiotherapy. Musculoskelet Sci Pract. 2019;39:164–9.
2. Deep Learning for Sensor-Based Rehabilitation Exercise Recognition and Evaluation [Internet]; 2021. [cited 2021 May 22]. Available:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6412882/
3. Godse DSP, Singh S. Musculoskeletal physiotherapy using Artificial intelligence and machine Learning. 2019;4(11):7.
4. Full article: Artificial intelligence and physiotherapy – editorial [Internet]. [cited 2021 May 22]. Available from: https://www.tandfonline.com/doi/full/10.1080/21679169.2019.1569850
5. Rowe M. Artificial intelligence in clinical practice: Implications for physiotherapy education. 2018.
6. Olczak J, Fahlberg N, Maki A, Razavian A, Jilert A, Stark A, et al. Artificial intelligence for analyzing orthopedic trauma radiographs: Deep learning algorithms—are they on par with humans for diagnosing fractures? Acta Orthopaedica. 2017;88:1–6.
7. Kirsch B. Virtual Reality: The Next Big Thing for Libraries to Consider. 2019;2.
8. Bergmann J, Krewer C, Bauer P, Koenig A, Riener R, Müller F. Virtual reality to augment robot-assisted gait training in non-ambulatory patients with a subacute stroke: a pilot randomized controlled trial. Eur J Phys Rehabil Med. 2018;54(3):397–407.
9. Li A, Montaño Z, Chen VJ, Gold JI. Virtual reality and pain management: Current trends and future directions. Pain Manag. 2011;1(2):147–57.
10. Liao Y, Vakanski A, Xian M. A Deep Learning Framework for Assessing Physical Rehabilitation Exercises. IEEE Trans Neural Syst Rehabil Eng. 2020;28(2):468–77.
11. Phu S, Vogrin S, Al Saedi A, Duque G. Balance training using virtual reality improves balance and physical performance in older adults at high risk of falls. Clin Interv Aging. 2019;14:1567–77.
12. Mobile game-based virtual reality rehabilitation program for upper limb dysfunction after ischemic stroke - PubMed [Internet]; 2021. [cited 2021 May 22]. Available:https://pubmed.ncbi.nlm.nih.gov/27163250/
13. Lee H, Park Y, Park S. The effects of virtual reality training on function in chronic stroke patients: A systematic review and meta-analysis. BioMed Research International. 2019;2019:1–12.
14. Bruder AM, Shields N, Dodd KJ, Hau R, Taylor NF. A progressive exercise and structured advice program does not improve activity more than structured advice alone following a distal radial fracture: A multi-centre, randomised trial. J Physiother. 2016;62(3):145–52.
15. Brehmer JL, Husband JB. Accelerated rehabilitation compared with a standard protocol after distal radial fractures treated with volar open reduction and internal fixation: A prospective, randomized, controlled study. J Bone Joint Surg Am. 2014;96(19):1621–30.
16. Reid SA, Andersen JM, Vicenzino B. Adding mobilisation with movement to exercise and advice hastens the improvement in range, pain and function after non-operative cast immobilisation for distal radius fracture: A multicentre, randomised trial. J Physiother. 2020;66(2):105–12.
17. Applied Sciences | Free Full-Text | Home rehabilitation based on gamification and serious games for young people: A systematic mapping study | HTML [Internet]; 2021. [cited 2021 May 22]. Available:https://www.mdpi.com/2076-3417/10/24/8849/htm
18. The use of joint mobilization to improve clinical outcomes in hand therapy: A systematic review of the literature - PubMed [Internet]; 2021. [cited 2021 May 22]. Available:https://pubmed.ncbi.nlm.nih.gov/24044954/
19. Szekeres M, MacDermid JC, Birmingham T, Grewal R, Lalone E. The effect of therapeutic whirlpool and hot packs on hand volume during rehabilitation after distal radius fracture: A blinded randomized controlled trial. Hand (N Y). 2017;12(3):265–71.
20. (PDF) Exercise reduces impairment and improves activity in people after some upper limb fractures: A systematic review [Internet]; 2021. [cited 2021 May 22].
21. Available:https://www.researchgate.net/publication/51229970_Exercise_reduces_impairment_and_improves_activity_in_people

_after_some_upper_limb_fractures_A_systematic_review
22. Gutiérrez-Espinoza H, Rubio-Oyarzún D, Olguín-Huerta C, Gutiérrez-Monclus R, Pinto-Concha S, Gana-Hervias G. Supervised physical therapy vs home exercise program for patients with distal radius fracture: A single-blind randomized clinical study. J Hand Ther. 2017;30(3):242–52.
23. Rehabilitation for distal radial fractures in adults - Handoll, HHG - 2015 | Cochrane Library [Internet]; 2021. [cited 2021 May 22]. Available:https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD003324.pub3/references
24. Face Validity and Content Validity of a Game for Distal Radius Fracture Rehabilitation [Internet]; 2021. [cited 2021 May 22]. Available:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6773587/
25. Carneiro F, Tavares R, Rodrigues J, Abreu P, Restivo M. A gamified approach for hand rehabilitation device. International Journal of Online Engineering (IJOE). 2018;14:179.
26. Chung KC, Malay S, Shauver MJ, Wrist and radius injury surgical trial group. The relationship between hand therapy and long-term outcomes after distal radius fracture in older adults: Evidence from the randomized wrist and radius injury surgical trial. Plast Reconstr Surg. 2019;144(2):230e–7e.
27. Souer J, Buijze GA, Ring D. A prospective randomized controlled trial comparing occupational therapy with independent exercises after volar plate fixation of a fracture of the distal part of the radius. The Journal of Bone and Joint Surgery American Volume. 2011;93:1761–6.
28. Burns D, Leung N, Hardisty M, Whyne C, Henry P, McLachlin S. Shoulder physiotherapy exercise recognition: Machine learning the inertial signals from a smartwatch. Physiol Meas. 2018;39(7):075007.
29. Towards on-demand virtual physical therapist: Machine learning-based patient action understanding, assessment and task recommendation | IEEE Journals & Magazine | IEEE Xplore [Internet]; 2021. [cited 2021 May 22]. Available:https://ieeexplore.ieee.org/document/8792110
30. Applying machine learning to predict future adherence to physical activity programs | BMC Medical Informatics and Decision Making | Full Text [Internet]; 2021. [cited 2021 May 22]. Available:https://bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-019-0890-0

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/76439