International Journal of Science and Healthcare Research
Vol. 9; Issue: 4; October-December 2024
Website: ijshr.com
Review Article
ISSN: 2455-7587

The Rehabilitation of Texter's Thumb with Virtual Reality Headsets - A Systematic Review

Disha Bansal[1], Sandeep Saini[2], Osheen Bhandari[3], Ishnoor Singh[4]

[1]Intern, [2]Principal and Professor, [3]Assistant Professor, [4]Senior Demonstrator;
[1-4]College of Physiotherapy, Christian Medical College & Hospital, Ludhiana, Punjab, India.

Corresponding Author: Disha Bansal

DOI: https://doi.org/10.52403/ijshr.20240416

1. ABSTRACT

Rationale– In this day and age, it has become a troublesome task for one to resist video games or avoid texting on computers, tablets and cell phones. The continuous use of cell phones for texting and gaming leads to various injuries and one such injury is the Texter's thumb.
Aim- The aim of this systematic literature review was to determine the effectiveness of using virtual reality headsets for Texter's thumb rehabilitation.
Objective- To discuss the causes, symptoms, conventional treatment options and the latest alternatives provided by Artificial Intelligence (AI), i.e., virtual reality headsets, for the rehabilitation of Texter's thumb.
Methods- The present systematic literature review was conducted according to the PRISMA 2020 statement in Web of Science, Scopus, PubMed, ResearchGate and Google Scholar databases and was limited to the title and keywords. The initial electronic search yielded 105 articles and 41 articles were eventually included in the final review.
Results- The analysis of the reviewed articles revealed that patients used virtual reality headsets for the rehabilitation of Texter's thumb. Many subjects found these headsets easy to understand, easy to use, interesting, motivating, engaging, along with an improvement in hand and thumb function, a reduction in pain and an increase in the pinch and grip strength. A few of the users experienced other problems such as headache and visual disturbances.
Discussion- Evaluation of the articles included in the review showed that virtual reality headsets ultimately help to make thumb rehabilitation less painful. They follow the attention-distraction method as the patient gets distracted by the vastness of the virtual world and his attention is shifted from the discomfort caused by the injury to his surroundings in the virtual world. This makes VR, one of the simplest psychological therapies for the treatment of pain.
Conclusion- To conclude this systematic review, it can be stated that virtual reality headsets have indeed proved to be a boon for all the youngsters out there as the injury caused by strenuous texting can be rehabilitated through the use of AI. Nevertheless, it is still necessary to further enhance our knowledge and study in this field.

Keywords: artificial intelligence; virtual reality; texting injuries; Texter's thumb; hand rehabilitation

2. INTRODUCTION

In this day and age, when electronics, information technology, communication, gaming and digital media are advancing at a steady pace, it has become a troublesome task for all to resist video games or avoid texting on computers, tablets and cell phones.[1] Even after the augmentation of voice-activated technology, people are unable to keep their hands away from spending a significant amount of time on their phones and laptops as the constant urge to text or play keeps them busy.[2] Constant texting and gaming on cell phones can result in a number of injuries, including musculoskeletal disorders of the hand, wrist, forearm and neck[3].Repetitive, forceful, low-amplitude use of these hand-held devices has been linked to an increase in the incidence of these injuries. There has also been a mention of mental symptoms and sleep disturbances. One such injury is the Texter's thumb, which is also nicknamed as 'SMS thumb.[4]

Texter's thumb is an injury of the thumb that develops from repetitive or constant holding, scrolling and texting on cell phones as shown in *Figure 2.1. & 2.2.* Over time the sheath surrounding the tendon of the thumb becomes inflamed leading to swelling, pain and stiffness.[5]

Figure 2.1. – Scrolling[6]

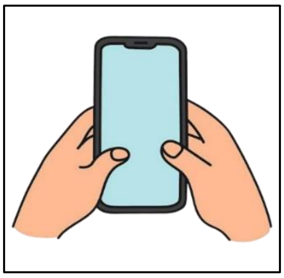


Figure 2.2. – Texting[7]

The patient experiences pain and tenderness running from the wrist to thumb as depicted in *Figure 2.3.*, swelling at the base to tip of the thumb, bruising and is unable to form a fist, turn the wrist, text, write or grab things.[5]

Figure 2.3. – Pain from wrist to thumb[8]

The effective management and prevention of Texter's thumb necessitates a brief understanding of the anatomy of the thumb in order to increase our knowledge regarding the text.

The upper limb distal portion is called the hand, which comes from the Latin word "Manus". It is a sophisticated and highly developed anatomical structure, that gives the brain its primary touch input and allows humans to perform a wide range of complex fine motor tasks including pinching, handling, power gripping and free movements. The index finger, thumb, ring finger, middle finger, and little finger are the five functional units that make up the hand.[9,10]The thumb, which comes from the Latin word 'pollex', is a unique and highly functional unit of the human hand. It constitutes the first digit and consists of several key anatomic features which include bones, joints, muscles, tendons and ligaments.[9]

The bones of the thumb include the Metacarpal bone, which forms the thumb base and connects to the wrist carpal bones; the proximal phalanx, which forms the first bone of the thumb that connects to the metacarpal bone and the distal phalanx which constitutes the tip of the thumb.[9]

The various joints in the thumb are the Carpometacarpal (CMC) joint, a saddle joint formed between the trapezium bone of the wrist and the base of the metacarpal bone, allowing movements of flexion-extension, abduction-adduction and opposition-reposition; Metacarpophalangeal (MCP) joint, a hinge joint between the metacarpal bone and proximal phalanx that allows for only flexion and extension and the Interphalangeal (IP) joint which is also another hinge joint allowing only for flexion and extension and is present between the proximal and distal phalanges of the thumb.*(Figure 2.4)*[9.10]

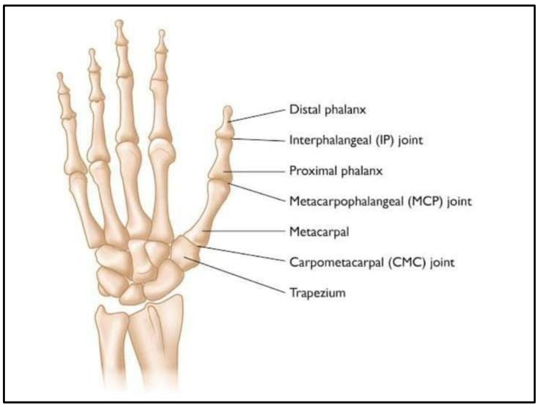


Figure 2.4.- Bones and joints of thumb[11]

The flexor pollicis brevis, flexor pollicis longus, and extensor pollicis longus and brevis, respectively, are the muscles that allow for flexion and extension at the thumb joints. Similarly, the abductor pollicis longus and the abductor pollicis brevis muscles provide abduction while the adductor pollicis muscle helps in the adduction of the thumb. Last but not the least the opponens pollicis muscle assists in the opposition of the thumb (Figure2.5).[12]

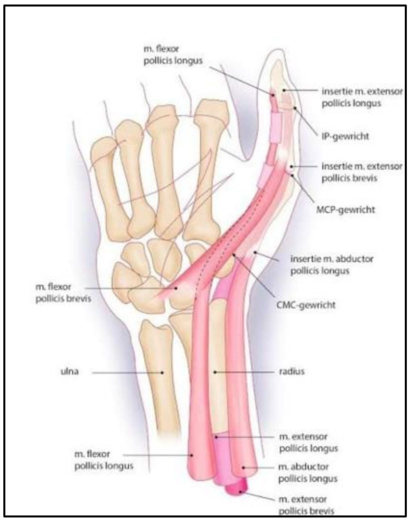


Figure 2.5 Muscles of thumb[12]

The thumb is further supported with flexor and extensor tendons of the respective muscles, collateral ligaments and volar plates which provide stability and prevent hyperextension of the thumb (*Figure 2.6 & Figure2.7).* The thumb receives a supply of blood from the radial artery through its branches, while the median and ulnar nerve' branches supply it. Hence, the thumb's unique anatomy allows for precision and power gripping along with different movements which are essential for many daily activities.[13]

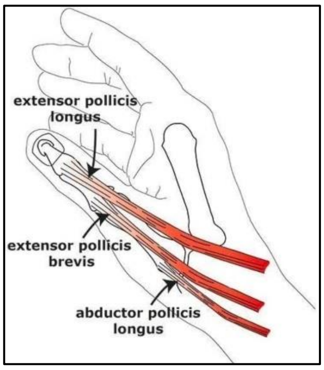


Figure 2.6 Tendons of thumb[14]

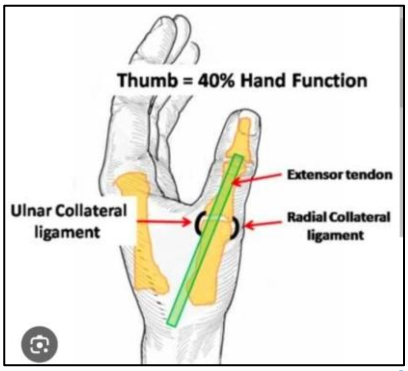


Figure 2.7 Ligaments of thumb[15]

Thus, Texter's thumb is a musculoskeletal condition that has gained attention recently as a result of the rise in mobile texting usage. The human body is well suited to repetitive motion, but when it is performed repeatedly over long periods of time, with significant force or with certain body parts in uncomfortable positions, it may become vulnerable. The thumbs on each hand are typically used to operate mobile phone keys, but they are not as well adapted to fine manipulation or dexterous tasks as fingers are. Both soft tissues and joints can be harmed by repetitive motion, such as texting on a mobile device. The high joint force has been associated with increased flexion at the MCP & IP joints, according to reports. Hence, the overuse and strain on the muscles, tendons, and joints of the thumb can trigger an inflammatory response leading to pain, swelling, and stiffness of the thumb due to which this condition is thereby termed as Texter's thumb.[16]

The various symptoms of Texter's thumb include: Pain (Discomfort or aching in the thumb joint or base of the thumb), Stiffness (Reduced flexibility in moving the thumb), Swelling (Noticeable swelling around the thumb joint or tendons), Tenderness (Sensitivity or pain when touching the affected area) Weakness (Reduced grip strength or difficulty performing tasks that involve the thumb) Numbness (Sensation of numbness or tinging in the thumb or the surrounding areas in extreme cases when the nerves get irritated)[17]

The term Texter's thumb, also known as 'Smart phone thumb' or texting thumb thereby describes discomfort or pain in the thumb due to excessive texting on smart phones. In addition, to the limitless texting, several other factors can lead to this condition such as:

Prolonged use of mobile devices- Extended periods of using smart phones or tablets can lead to strain of the thumb and the adjoining area.

Poor Ergonomics- Holding devices in abnormal positions or using them with poor posture can exacerbate the problem.

Repetitive Motions- Frequent and repetitive movements, such as typing or scrolling of these devices can strain the thumb muscles and tendons.

Overuse- Engaging in other repetitive activities involving the thumb, such as playing video games or using certain types of tools can contribute to further discomfort.

Lack of Proper Support- Not supporting the hand or wrist properly while using a device can lead to strain and pain in the thumb

This clearly indicates that incorporating adequate breaks and the adoption of ergonomic practices can help in preventing the disorder.[16,17]

Management of Texter's thumb can be effectively accomplished with guided physiotherapy measures. The general approach to be followed for the usage of conventional treatment is as follows:[18]

Rest and Activity Modification- Advise patients to reduce or modify activities that exacerbate symptoms.

Posture Correction- Address overall posture and ergonomics to minimize strain on the hands and wrists.

Ergonomic Education- Teach proper smartphone handling techniques and recommend using voice-to-text features or other hand free options.

Pain Management- Use ice packs and recommend over-the-count pain relievers if needed *(Figure 2.8.)*

Splinting- Use of thumb splint to provide rest and immobilize the affected joint for three consecutive weeks *(Figure 2.9.)*

Taping Techniques- Apply kinesiology tape to support the thumb and reduce the strain on the tendons and muscles.

Modalities- Utilize ultrasound therapy to reduce inflammation and promote healing. It is used at a frequency of 3 MHz and at an intensity of 0.5-0.7 w/cm for 3 to 5 minutes *(Figure 2.10.)*

Manual Therapy- Pain relief and improved function could be attained with methods such as joint mobilization or massage *(Figure 2.11.)*

Joint Mobilization- Methods for reducing stiffness and increasing joint mobility, especially at the thumb's carpometacarpal joint.

Functional Training- Include exercises that mimic daily activities to improve the functional strength and dexterity of the thumb.

Stretching and Strengthening Exercises- Implement exercise to improve flexibility and strengthen the muscles of the thumb and hand. Examples include thumb stretches and grip strengthening exercises.

Progressive Loading- Gradually increase the intensity of exercises to build endurance and strength in the thumb and hand.

Follow up- Regular visits and adjustment of the treatment plan based on progress and symptom changes are essential for effective management. It is imperative that the physiotherapist customise the treatment plan to address the unique needs and symptoms of each patient.[16-18]

Figure 2.8 – Icepacks[19]

Figure 2.9 – Splinting[20]

Figure 2.10 – Ultrasound Application[21]

Figure 2.11 – Massage[22]

Some of the routine exercises incorporated in the treatment plan for the management of Texter's thumb are:[16-18]

Stretching the thumb tendons - Using the other hand to gently pull the thumb toward the body while extending the arm as in a handshake. Hold each hand for thirty seconds *(Figure 2.12.)*

Curling the thumb - Putting it into the palm and pulling it out to create an open hand. Do it fifteen times *(Figure 2.13.)*

Extending an open hand – To use the thumb to make tiny circles. Do each direction fifteen times *(Figure 2.14.)*

Bending the thumb - Repeat it 15 times *(Figure 2.15.)*

Alternating between forming a fist and opening the hand - Repeat it 15 times *(Figure2.16)*

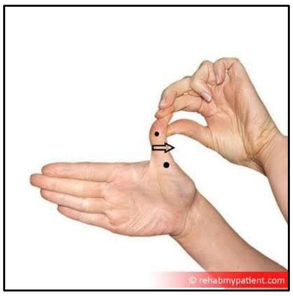


Figure 2.12 – Stretching of thumb[23]

Figure 2.13. – Curling of thumb into the palm[24]

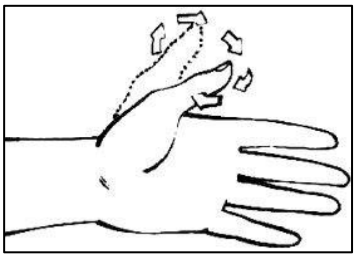


Figure 2.14– Making circles with the Thumb[25]

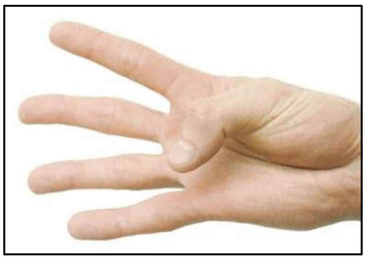


Figure 2.15 – Bending the thumb[26]

Figure 2.16 – Forming a fist and opening the hand[27]

The advancement of technology has provided alternatives to the conventional rehabilitative procedures in the form of virtual reality headsets which incorporate the usage of artificial intelligence. Thus, a thorough understanding of Artificial Intelligence, virtual reality and VR headsets is mandatory for the current literature review. Artificial Intelligence or AI is the technology that facilitates computers and machines in such a way that they can imitate human intelligence and other problem-solving tendencies. It can execute tasks that would otherwise require human intellect or intervention. Virtual assistants, autonomous vehicles and generative AI tools [like OpenAI's ChatGPT (*Figure 2.17.)*], Global Positioning System (GPS) guidance *(Figure 2.18.)* and other technologies (e.g. Virtual Reality, Robotics etc) are just some examples of AI.[28,29]

Figure 2.17 ChatGPT[30]

Figure 2.18 GPS[31]

AI in the form of robotics *(Figure 2.19.)* and virtual reality headsets *(Figure 2.20.)* has various applications in different industries across the world, such as healthcare, retail, finance, manufacturing, marketing, gaming, military etc.[29]

The usage of AI in healthcare has consistently resulted in the improvement of accuracy rates of medical diagnosis and has also ensured efficient management of sensitive healthcare data. In addition to its ability to automate digital patient experiences, it has facilitated drug research and development in the medical department. Medical robots, are a boon from AI itself as they provide assisted therapy or guide surgeons during surgical procedures.[32]

Figure 2.19 AI in Robotics[33]

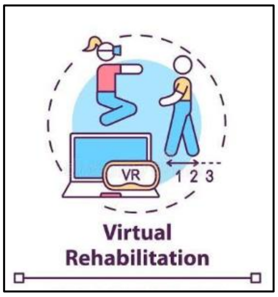


Figure 2.20 AI in VR Headsets[34]

The use of interactive simulations made with computer hardware and software to give users the chance to interact with environments that seem and feel like real-world objects and events is known as virtual reality or VR.[35] Through interaction and immersion, it enables the creation of virtual worlds where users can explore and interact in real-time, giving the experience a sense of reality. These virtual environments' content can be produced with particular uses in mind, like gaming or teaching. This method is currently extensively employed in telerehabilitation and clinics.[36]

The following are the three primary VR categories:[35]

Non-Immersive Virtual Reality**:** It has a computer-generated virtual world with the user still conscious of and in control of their real-world surroundings,[35,36] for instance video games *(Figure 2.21.)*

Semi-Immersive Virtual Reality**:** With graphical computing and large projector systems, like flight simulators for aspiring pilots *(Figure 2.22.)*, this kind of virtual reality (VR) makes sense for educational and training purposes. It provides an experience with some virtual environment- based elements.[35,36]

Fully Immersive Virtual Reality**:** It refers to the VR system that creates the most lifelike simulation experience, including sound, vision, and occasionally even smell. It makes use of a head-mounted display to give the user a multi-sensory experience,[35,36] such as car-racing games *(Figure 2.23.)*.

***Figure 2.21. – Video Games (Non-Immersive VR)**[37]*

***Figure 2.22. – Flight simulator (Semi-Immersive VR)**[38]*

***Figure 2.23. – VR Car Racing (Fully Immersive VR)**[39]*

The use of VR headsets *(Figure 2.24.)* as a treatment and rehabilitation modality has been increasing gradually. Its application is demonstrated by medical education, patient care, pain management, physical therapy, rehabilitation, and fitness.[40]

A device worn at eye level on the head is called a virtual reality headset. It has a tiny screen that lets the user get completely lost in the virtual environment. It also features a second earpiece that gives the user audio input.[40] The user of these headsets only sees the screen in front of his eyes, blocking out the outside world. Additionally, the virtual world experienced by the headset wearer moves in unison with their movements. These headgears are currently considered a novel approach to hand and thumb rehabilitation.[40] By making it easier for patients to complete their exercises, these headsets for physical rehabilitation of the thumb allow patients to recover from injuries faster *(Figure 2.25.)*. This is due to the fact that virtual reality diverts the patient's focus from their discomfort and presents an engaging alternate reality that both inspires and motivates them to finish the task.[35,36,40]

In light of the aforementioned, it is necessary to assess the effectiveness of virtual reality headsets for Texter's thumb rehabilitation.

Figure 2.24.- Virtual Reality Headsets[41]

Figure 2.25. – Virtual Reality Headsets in Rehabilitation[42]

3. METHODS

3.1. Research Guidelines-

The PRISMA 2020 statement[43], which is the Preferred Reporting Item for Systematic Reviews and Meta-Analysis, was followed in conducting the current systematic literature review. Its main purpose is to offer reporting guidelines for systematic reviews.

3.2. Research Question-

The following query was developed and used throughout the process of choosing the literature: "What are the effects of Virtual reality headsets in hand and thumb rehabilitation in patients with Texter's thumb?"

3.3. Search Strategy-

From March to May in 2024, a thorough electronic search was conducted across five databases. The search was limited to the title and keywords.

3.4. Information Sources-

The literature data bases used to search the field of publications were: Web of Science, Scopus, PubMed, ResearchGate and Google Scholar.

3.5. Keywords-

The database search employed the following terms as keywords: artificial intelligence; virtual reality; texting injuries; Texter's thumb; hand rehabilitation

3.6. Inclusion Criteria-

It consisted of articles:

published in the English language

about texting injuries related to cell phone usage

about musculoskeletal disorders of thumb, hand or upper extremity and their rehabilitation

with the subject 'virtual reality' or 'artificial intelligence.'

3.7. Exclusion Criteria-

Articles excluded were:

VR headsets not clinically tested on patients with hand or thumb injuries

Full-text was not available or accessible.

Not published in the English language.

3.8. Data Collection-

Using a laptop and printer, among other electronic devices, all of the articles were extracted. Each article was reviewed independently twice to eliminate bias.

3.9. Data Synthesis-

The extracted articles were grouped according to the injuries caused by texting or cell phone usage, their symptoms, conventional treatment options, artificial intelligence and its applications, virtual reality and use of VR headsets in the rehabilitation of texter's thumb.

MS Word was used to transcribe the literature review and generate tabulated diagrams and flowcharts.

3.10. Outcome-

The review's main goal was to see the impact of rehabilitation of Texter's thumb by VR headsets on the range of motion of the thumb, degree of pain and the pinch and grip strength of the thumb. The secondary outcome included an evaluation of the patient's motivation to complete the exercises in a fun and engaging way, as well as the effectiveness with which the functional tasks were carried out.

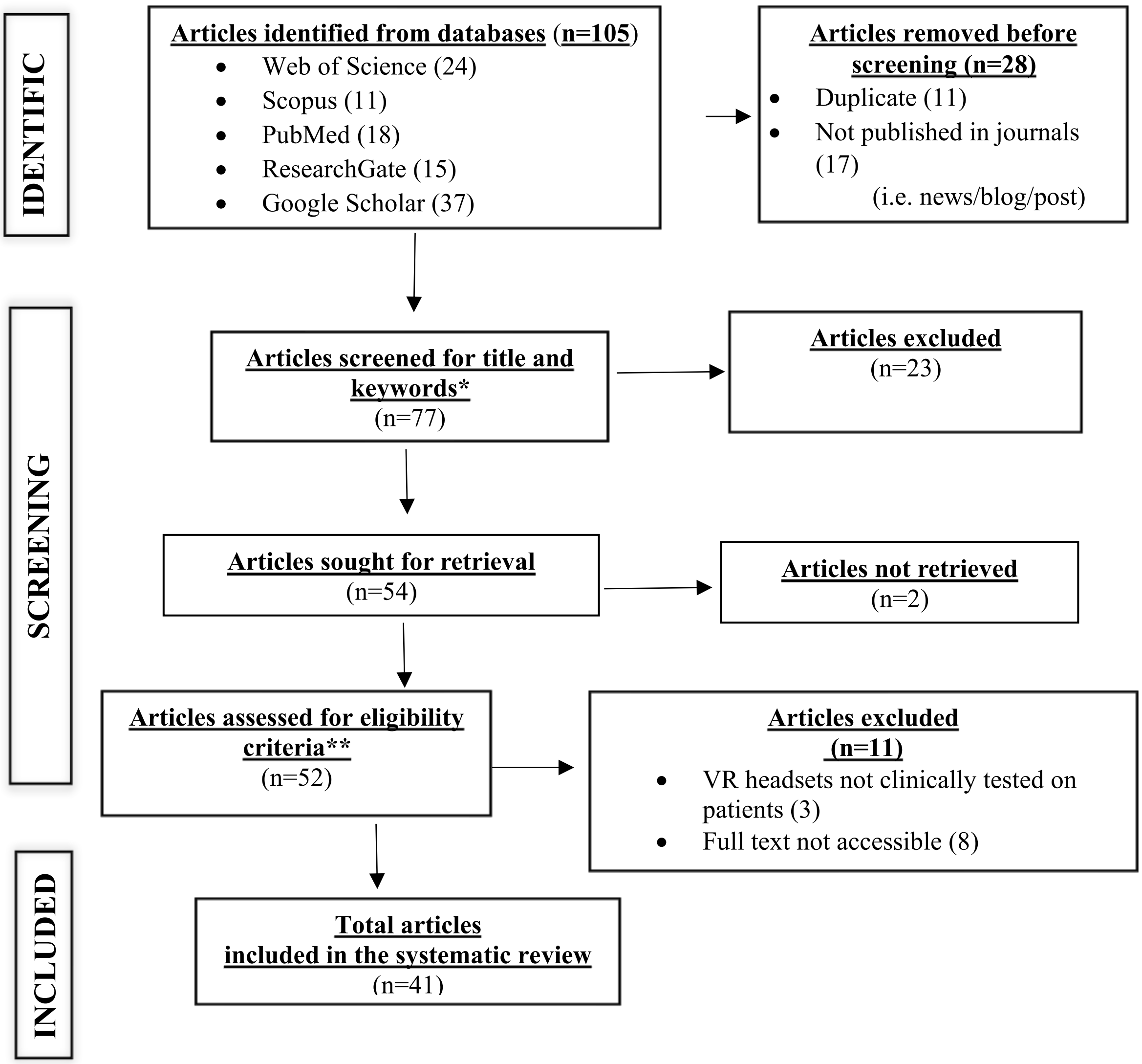
3.11. Article Selection Process-

Initially, 105 articles were retrieved from the databases (24 from Web of Science, 11 from Scopus, 18 from PubMed, 15 from ResearchGate, and 37 from Google Scholar). After removing 11 duplicates and 17 articles which were not published in journals, the search was reduced to 77 articles. These remaining articles were screened for title and keywords. Amongst these 23 articles were excluded and 2 articles could not be retrieved which ultimately limited the search to 52 articles. 41 articles were eventually included in the systematic review after 11 articles that did not meet the eligibility criteria were excluded. Figure 6.11.1. uses a PRISMA flowchart to illustrate the article selection process.

3.12. Assessment of Bias-

To remove bias, the articles were first screened twice independently using only the titles and keywords. The remaining papers were then evaluated twice more using the inclusion and exclusion criteria.

Figure.3.11.1 Illustration of Article Selection Process via the PRISMA Flow chart



Eligibility criteria:

a) **Inclusion criteria-** Articles published in the English language; about texting injuries related to cell phone usage; about musculoskeletal disorders of thumb or hand or upper extremity and their rehabilitation; with the subject 'virtual reality' or 'artificial intelligence'

b) **Exclusion Criteria-** Articles in which: VR headsets were not clinically tested on patients with hand or thumb injuries; full-text was not available or accessible, not published in the English language.

4. RESULTS

Table 4. A: Reporting of Results

Author (Year)	Title	Sample Size	Outcome	Result and Conclusion
Lakshminarayan K et al. (2023)[44]	Feasibility and usability of a virtual reality based sensorimotor activation apparatus for carpal tunnel syndrome patients	20	The participants found the rehabilitation procedure with the devices, easy to use, understand and motivating	The study concluded that rehabilitation of thumb via VR-headsets was well liked by the patients.
Juan Mc et al. (2022)[45]	Immersive virtual reality for upper limb rehabilitation: Comparing hand and controller interaction	28	All the participants managed to complete the exercises proposed in the games. No significant differences were found in number of attempts or in age or gender of patients. All of the users found the games entertaining	The results suggested that the interaction with VR headsets improved motivation and motor rehabilitation in patients with Texter's thumb. It also helped them to complete the exercise at home.
Tokgoz P et al. (2022)[46]	Virtual Reality in the Rehabilitation of Patients with Injuries and Diseases of Upper extremities	57	The results of the study showed significant improvement with regard to pain and hand function	It was found that with respect to functional recovery, technologies based on virtual reality were not inferior to traditional rehabilitation. In addition, the users were highly motivated and satisfied.
Pereira MF et al. (2020)[47]	Application of AR and VR in Hand Rehabilitation: A Systematic Review	65-100	Most of the patients showed improvements in hand rehabilitation	The systematic review conducted, provided advantages and divers for the success of VR applications for hand rehabilitation and suggested that patients can definitely benefit from them.
Aguilar – Lazcano et al. (2019)[48]	Interaction Modalities used on Serious Games for Upper Limb Rehabilitation: A Systematic Review:	25-40	Users were motivated to perform exercises with the help of VR Headsets via serious games	Serious games permitted rehabilitation but further research is required in this field.
Meijer H et al. (2018)[49]	A Systematic Review on the effect of serious games and wearable technology used in rehabilitation of	50-90	Rehabilitation by serious games had a positive effect on functional outcome and pain scores of patients after traumatic	It concluded that serious games were a safe alternative to conventional physiotherapy after

	patients with traumatic bone and soft tissue injuries		bone and soft tissue injuries	traumatic bone and soft tissue injury.
Cidota M et al. (2016)[50]	Serious Gaming in Augmented Reality using HMDs for Assessment of Upper Extremity Motor Dysfunctions	15	The study had mixed outcomes as many of the patients allowed for better interactions with Virtual Reality Headsets for rehabilitation of the hand but a few showed a low usability	The results showed that there is potential for engagement and virtual representation improves the usability of the hand for different activities

4.1 Result Synthesis-

The results of the article reviewed for the rehabilitation of Texter's thumb with VR headsets have been synthesized in the following manner:

4.1.1. Hardware-

The articles reviewed used a virtual reality headset *(Figure 4.1.1.1)* with an in-built camera and audio input signals. Its compatibility could be set according to the preference of the users, i.e., with a smart phone via Android/iOS platforms or with a laptop/desktop computer using the Windows/Mac operating systems.[51]

Figure 4.1.1.1. – Virtual Reality Headset[52]

4.1.2. Software-

The smartphone/laptop/desktop computer could be connected to the VR headset via different wireless software applications. Various types of video gaming applications such as cube grasping *(Figure 4.1.2.1)*, catching butterflies *(Figure 4.1.2.2)*, squeezing oranges, catching the wine jug *(Figure 4.1.2.3)*, throwing darts, bowling, removing petals from a flower, shooting balloons, flipping pages, plucking apples from a tree, inflating balloons with the hand for an upcoming birthday party *(Figure 4.1.2.4.)* etc were installed on the preferred electronic gadgets. The software ran on the device while the headset acted as the display unit for the user.[53]

Figure 4.1.2.1 - Cube grasping[54]

Figure 4.1.2.2. – Catching butterflies[55]

Figure 4.1.2.3 – Catching the wine jug[56]

Figure 4.1.2.4. - Inflating balloons with the hand[57]

4.1.3. Procedure-

Throughout the session with each participant, the reviewed articles adhered to a specific protocol, which was as follows:[58-72]

The patient was recommended to adhere to standard treatment protocols, such as rest, ice, and ultrasound application, for a week, contingent on the intensity of symptoms, with the aim of mitigating acute pain.

As the feeling of acute pain subsided, the users followed certain steps for the rehabilitation of Texter's thumb.

The virtual reality sessions ranged in duration from fifteen to thirty minutes, with three to five sessions per week. Between the sessions, times to rest and hold were also given. All the games had progressively higher difficulty levels and longer durations to keep the participants challenged.

Before beginning the procedure, each subject read and signed a written informed consent form.

The patient was given a thorough explanation of the device's operation. Every patient received an instruction manual explaining how to use the VR headset and complete the exercises.

The workspace was established and a chair was positioned in the middle of the space prior to the session commencing. It was verified that there was adequate room to ensure mobility.

Antibacterial wipes were used to clean the VR headsets both before and after each use.

The exercises were briefly explained to the subjects, along with the goals they needed to accomplish in each game and the rationale behind the selection of that particular game for those movements.

To clean their hands, the subjects were given alcohol-based hand sanitizer.

Pinching but not hurting is the intended feel of the specially adjusted headset.

The participants had to make sure they were reading and seeing clearly before they could finally adjust the headset. When needed, they adjusted the distance between their eyes in the headset

With the aid of their voices, the subjects were instructed on how to navigate from the main menu to the application. This was done to familiarise them with the environment before using the application. Hence, voice-activated technology was used to start the gaming therapy.

The users were instructed to perform the exercises by listening to the rules of the respective game through audio input signals. In all cases, the patients used the affected hand. The audio input signals guided them for correct usage of hand and thumb. So, if the unaffected hand was used, a warning message was given to the user.

Through voice activated technology, the subject could stop the session if feeling uncomfortable, exerted, unable to perform or to restart the session.

Initially, the therapist guided the user to perform exercises in the correct manner and for the right duration, with the help of VR headsets. When the user became accustomed to the VR headsets, he/she could perform the exercises independently.

After the session, the participants were asked to rate their experience on a five-point Likert scale by filling out a questionnaire.

Every week, the NPRS (Numeric Pain Rating Scale) was utilized to measure pain, and a goniometer and VR optical tracking technology were used to measure the thumb's range of motion.

Along with this, the pinch and grip strength of thumb was measured with a pinch meter and dynamometer respectively.

4.1.4. Questionnaire format-

A user evaluation questionnaire was created by the reviewed articles to gauge participant experience and engagement as well as the effectiveness of the therapy.[58-72]

It consisted of the following attributes:

1) Easy to understand, 2) Easy to use , 3) Interesting/Entertaining, 4) Motivating, 5) Level of immersion, 6) Improvement in hand and thumb function, 7) Reduction in pain, 8) Any other problems.

Each attribute had a five-point Likert scale that allowed participants to rank its importance (1 being extremely unsatisfactory and 5 being beyond my expectations).

A Likert Scale *(Figure 4.1.4.1.)* is a form of scale used to collect and measure qualitative data. It helps to determine a person's opinion, perception or attitude towards a phenomena or activity. Currently, Likert scale has been widely developed and used as a tool to conduct different surveys in the field of education where the data analysed is more inclined to be in the form of quantitative data measurement. It has been shown that the use of Likert scale with an odd number of response category, i.e., five or more, has a fairly good reliability and validity, which is more than 0.60.[58-72]

5-point scales

Satisfaction	Likelihood	Level of concern
1. Very dissatisfied 2. Dissatisfied 3. Neither dissatisfied or satisfied 4. Satisfied 5. Very satisfied	1. Very unlikely 2. Unlikely 3. Neutral 4. Likely 5. Very likely	1. Very unconcerned 2. Unconcerned 3. Neutral 4. Concerned 5. Very concerned

Agreement	Frequency	Awareness
1. Strongly disagree 2. Disagree 3. Neither agree or disagree 4. Agree 5. Strongly agree	1. Never 2. Rarely 3. Sometimes 4. Often 5. Always	1. Very unaware 2. Unaware 3. Neither aware or unaware 4. ware 5. Very aware

Familiarity	Quality	Importance
1. Very unfamiliar 2. Unfamiliar 3. Somewhat familiar 4. Familiar 5. Very familiar	1. Very poor 2. Poor 3. Acceptable 4. Good 5. Very good	1. Very unimportant 2. Unimportant 3. Neutral 4. Important 5. Very important

***Figure 4.1.4.1. Likert Scale**[73]*

***4.2.* Result Analysis-**

The articles reviewed showed that most of the patients with Texter's thumb experienced pain, tenderness and a decrease in hand function, which has been depicted in *Figure 4.2.1., 4.2.2.and 4.2.3.*[58-72]

Figure 4.2.1: Bar graphs depicting pain in patients with Texter's Thumb

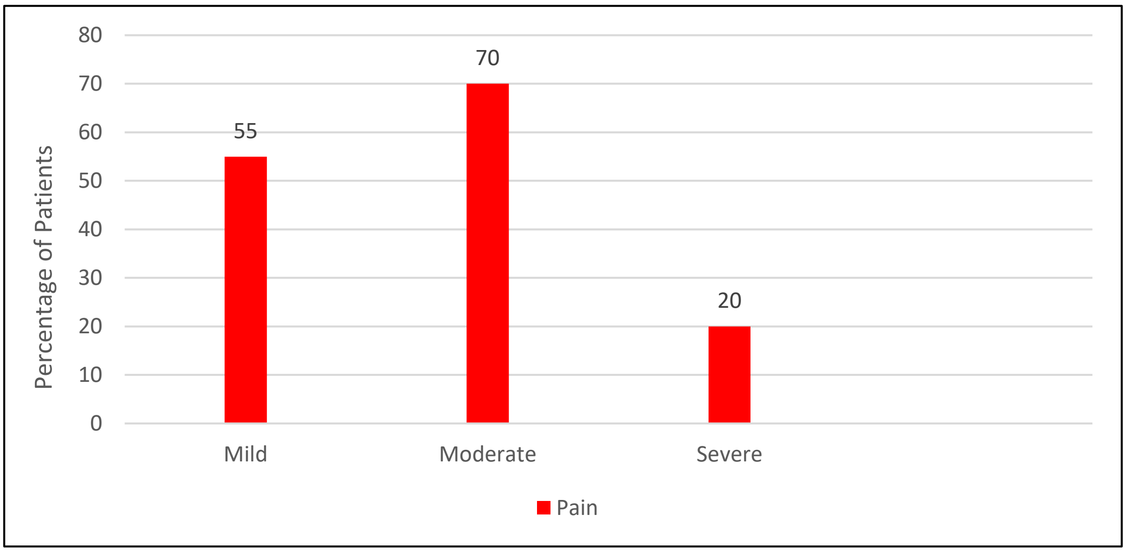


Figure 4.2.2: Bar graph depicting tenderness in patients with Texter's thumb

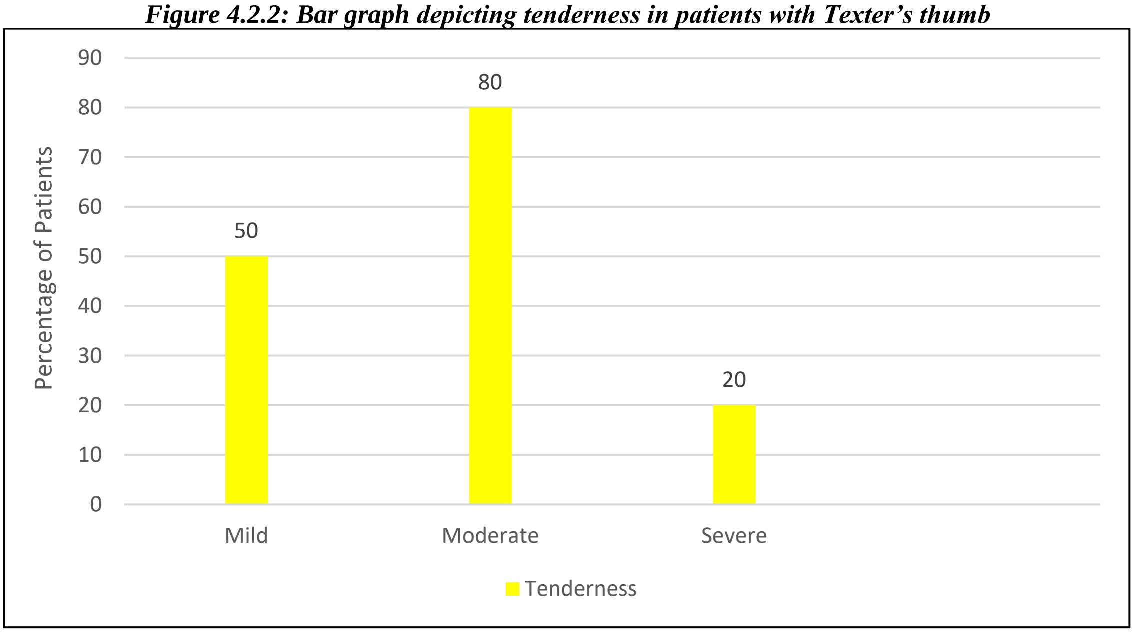
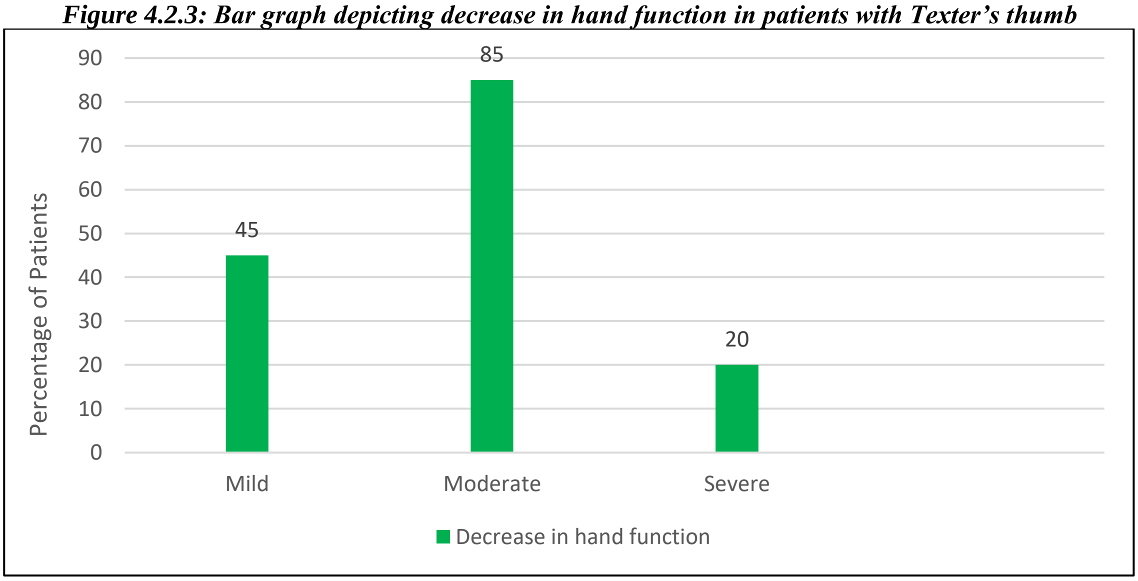


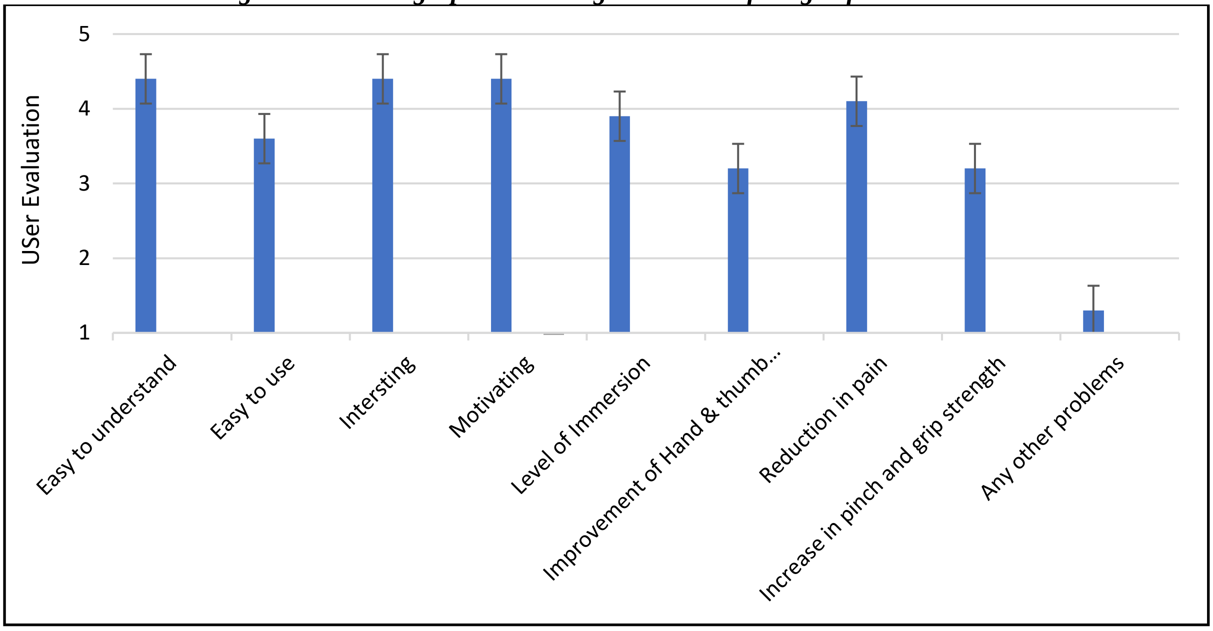
Figure 4.2.3: Bar graph depicting decrease in hand function in patients with Texter's thumb



According to the results of the user evaluation questionnaire created based on the reviewed articles, many participants reported that the VR headsets improved hand and thumb function and reduced pain in addition to being simple to use, understand, and engage.[58-60]

A few of the users experienced other problems such as headache and visual disturbances.[58-60]The assessment of pain at the beginning and end of each week via the NPRS Scale showed a significant decrease in pain after the completion of therapy sessions in 2-3 weeks. The thumb joints' active and passive range of motion was unrestricted both before and after the therapy, though. These findings are illustrated in Figure 7.2.4.[58-72]

Figure 4.2.4: Bar graph illustrating the results of usage of VR headsets



Key: 1 – very unsatisfactory, 2-unsatisfactory, 3-okay, 4-satisfactory, 5-excedded my expectations

5. DISCUSSION

5.1. Interpretation of Results-

This comprehensive analysis assessed the results of using VR technologies for hand and thumb rehabilitation in Texter's thumb, which is caused by the constant use of the thumb for scrolling and typing on cell phones.

Research conducted by Tokgoz.P.et.al (2022) indicates that the typical rehabilitation program consists of therapy sessions where patients work with a physiotherapist to perform prescribed exercises for a predetermined amount of time.[46] Then, in order to make these sets of repetitive exercises easily understood and performed by the patients at home, they are integrated into a home-based program. However, the patient's motivation to complete the exercises is crucial for these kinds of interventions.[47] It has been demonstrated by Lange.B.et.al (2012) that a patient's lack of motivation and adherence to therapy prevents long-term rehabilitation from occurring.[51]

Therefore, a more engaging, pleasant, and entertaining form that is, the use of virtual reality in the form of gaming techniques can help to mitigate these limitations as shown by Hoffman.H.G et.al.(2020).[53]

Shin.J.H et.al. (2016) conducted a research which showed that virtual reality headsets ultimately help to make thumb rehabilitation less painful.[69] They follow the attention-distraction method as the patient gets distracted by the vastness of the virtual world and his attention is shifted from the discomfort caused by the injury to his surroundings in the virtual world. This makes VR, one of the simplest psychological therapies for the treatment of pain as sated by Levanon.Y.(2013) [65]

These devices incorporate different types of games to provide exercises for the thumb. This helps in the rehabilitation as unknowingly, while playing the game as shown in the headset, the user is actually performing thumb exercises which has been rightly demonstrated by Holden M.K. (2025) .[63] The exercises include closing and opening of hand *(Figure 5.1.1.)*, touching the index finger *(Figure 5.1.2.)*, middle finger, ring finger *(Figure 5.1.3.)* and little finger with the thumb, along with an -abduction-adduction, flexion-extension and circumduction of the thumb and a supination-pronation of the forearm. It also helps to evaluate the intensity and the correct angulation of the thumb by giving audio inputs to the user. This has proven to be particularly helpful for adolescents and cell phone addicts, who are too lethargic to regularly engage in therapy for thumb rehabilitation as stated by Shin.J.H et.al. (2016).[69]

Figure 5.1.1 – Opening of hand[74]

Figure 5.1.2. – touching index finger with the thumb[75]

Figure 5.1.3 – touching ring finger with the thumb[76]

The camera based optical hand tracking technology brings revolutionary changes in the field of hand therapy. As part of a patient's hand rehabilitation session, it has important therapeutic benefits, such as tracking the patient's hand, wrist, and gesture movements as they interact with virtual reality as shown by Juan.MC.et.al. (2022).[45] Initially, the therapist calculates the range of motion in the thumb, fingers, wrist, and other joints using a goniometer. It was regarded as the joint range of motion measurement 'gold standard.' However, real-time measurement of hand and wrist movements is possible with VR optical tracking technology. Hence, optical camera tracking allows the therapist to assess more complex but logically valid movements of the fingers, thumb and wrist.[49] The results of the present review clearly reflect that gamification by virtual reality effectively eliminates the obstacle of pain and makes the rehabilitation procedure more efficient, engaging and patient friendly.[59-65]

5.2. Limitations-

Although this review has yielded positive results, it is not without limitations. These include the inability to perceive depth in a virtual environment, visual fatigue and discomfort, headaches, and eye strain. Another relevant limitation is that the study of the application of the VR in Texter's thumb is restricted as more studies have been focused on application of VR in rehabilitation of hand in stroke, burns and multiple sclerosis patients.[65-68]

Keeping all the limitations aside, VR definitely has a positive response in hand and thumb rehabilitation especially in patients who are lazy in performing exercises regularly and lead a sluggish lifestyle.[69-70]

5.3. Implications-

The VR gaming system can be made more interesting and challenging if three or four participants are able to use the headsets together in a particular game so that they can interact with each other in a healthy, competitive manner. This would ensure more positive results.[71]

The education system must include Artificial Intelligence in the form of Virtual Reality in the curriculum so as to enhance knowledge and understanding of these technologies amongst students and to ensure that they can be implemented practically. Experimental studies would help the Physiotherapists in future for better treatment protocols and outcomes.[72]

6. CONCLUSION

As we live in a society that continues to bank on electronics for work, life and fun, it is imperative for us to adapt to alternatives and learn ways to decrease the stress on our hands and thumbs. The current review demonstrated the effects of virtual reality headsets for thumb and hand rehabilitation in patients suffering from Texter's thumb.

To conclude this systematic review, it can be stated that virtual reality headsets have indeed proved to be a boon for all the youngsters out there as the injury caused by strenuous texting can be rehabilitated through the use of AI and thus, proves that the digital world can be associated with therapy and revolutionise the current medical standards in the world. Nevertheless, it is still necessary to further enhance our knowledge and study in this field.

Declaration by Authors

Ethical Approval: Not Applicable
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

7. REFERENCES

1. Ahmed S, Akter R, Pokhrel N, Samuel A. Prevalence of text neck syndrome and SMS thumb among smartphone users in college-going students: a cross-sectional survey study. J Public Health (Berl.). 2021; 29: 411–416. doi:10.1007/s10389-019-01139-4.
2. Ali M, Asim M, Danish SH, Ahmad F, Iqbal A, Hasan SD. Frequency of De Quervain's tenosynovitis and its association with SMS texting. MLTJ. 2014; 8. 4(1):74-8.
3. B S K, Khaleeluddin K B, Jayakumar S, K EV. Prevalence and awareness of text neck syndrome and text thumb syndrome in young adult population. J. Appl. Pharm. Res. 2024; 12(1): 22-28. doi: 10.18231/j.joapr.2024.12.1.22.28.
4. Ahari K, Vaiyapuri A, Ramachandran A, Jain K, Das R. Smartphone Induced -Texting Tenosynovitis: A Case Study. J. Coast. Life Med. 2023; 11(2): 236–238.
5. Baabdullah A, Bokhary D, Kabli Y, Saggaf O, Daiwali M, Hamdi A. The association between smartphone addiction and thumb/wrist pain: A cross-sectional study. J. Med. 2020; 99(10): e19124. doi:10.1097/MD.0000000000019124
6. Mykyta Dolmatov. Hand Holding Mobile Phone. [vector]. dreamstime.com. [Internet]. cited 2024 August 15. Available from: https://www.dreamstime.com/cropped-shot-view-woman-s-hands-holding-smart-phone-blank-copy-space-screen-your-text-

message-information-cropped-image218711962.
7. Audi. Hands Texting on phone. [clipart]. www.rawpixel.com. [Internet]. Nohat.com. 2022 [cited 2024 August 15]. Available from: https://nohat.cc/f/hands-texting-on-phone-clipart-free-vector-illustration-rawpixel/comrawpixel6247639-202204121635.html.
8. [P]rehab. Fix your Texter's Thumb. [.mp3]. youtube.com. {Internet]. 2022 [cited 2024 August 15]. Available from: https://www.youtube.com/watch?v=S_N7iKrxa_I.
9. Shah P P, Sheth M S Correlation of smartphone use addiction with text neck syndrome and SMS thumb in physiotherapy students. Int J Community Med Public Health. 2018; 5(6): 2512. doi :10.18203/2394-6040.ijcmph20182187.
10. Sharan D, Mohandoss M, Ranganathan R, Jose J. Musculoskeletal Disorders of the Upper Extremities Due to Extensive Usage of Hand Held Devices. Ann of Occup and Environ Med. 2014; 26: doi.org/10.1186/s40557-014-0022-3.
11. Taylor S. Bones and joints of the Thumb [illustration] AAOS.org [Internet] Thumb Fractures-OrthoInfo-AAOS; 2022 [cited 2024 August 15] Available from: https://orthoinfo.aaos.org/en/diseases--conditions/thumb-fractures/.
12. Stagter.R Thumb muscles-Dutch labels [drawing insertion] Anatomy TOOL. or [Internet] rva Netherlands, Leiden – Leiden University Medical Centre. [cited on 2024 August 15] Available from: https://anatomytool.org/content/slagter-drawing-insertion-thumb-muscles-dutch-labels.
13. Povolotskiy R, Gupta N, Leverant AB, Kandinov A, Paskhover B. Head and Neck Injuries Associated with Cell Phone Use.2020; JAMA Otolaryngol Head Neck Surg.146(2): 122–127. doi:10.1001/jamaoto.2019.3678.
14. Plas vander A. X- Hand [illustration] K.L. Bontragor, J.P. Lampignano. Textbook of Radiographic Positioning and Related Anatomy 2014 (8th edition) [Internet] Radiology. Expert;2024[cited2024August15] Available from: https://www.radiology.expert/en/modules/xhand/hand-normal-anatomy/.
15. Meyer S.Thumb Anatomy [image] www.Myhand.com.all [Internet] Texter's thumb Anatomy;2015[cited2024August15]Availablefrom:https://myhand.com.au/handouts/dislocations/texter's-thumb/2-anatomy?font-size=larger.
16. Saltos A, Smith D, Schreiber K, Lichenstein S, Lichenstein R. Cell-phone related injuries in the United States from 2000–2012. J. Saf. Sci.2015; 1(1): 1-14.
17. Sharan D, Ajeesh, P. Risk factors and clinical features of text message injuries. Work.2012; 41: 1145–1148. doi:10.3233/WOR-2012-0294-1145.
18. Bobby N N. Effectiveness of therapeutic hand exercises in gamer's thumb. IJRPR. 2021; 2(10): 498-500.
19. Melodijia. Male holding ice pack on thumb for pain in thumb. [image] Dreamstime.com [Internet] [citedon2024August 15] Available from: https://www.dreamstime.com/royalty-free-stock-photo-wrist-pain-male-holding-ice-pack-wrist-read-spot-indicating-location-image32008525.
20. Thermoskin Flexible Thumb Splint [image] Walmart.com [Internet] [cited on 2024 August 15] Available from: https://www.walmart.com/ip/Flexible-Thumb-Splint-Left-Large-Beige-7-75-8-75/175500894?classType=VARIANT.
21. Jacobson Ultrasound Evaluation of Texter's thumb [image in blog] Gulfcoast Ultrasound Institute Inc [Internet][citedon2024August15] Available from: https://www.gcus.com/blog/MSK-Texter's-thumb.
22. Vigorous Innovations How to Effectively Massage Texter's thumb [image in blog] vigorous innvovations.com [Internet] [cited on 2024 August 15] Available from: https://vigorousinnovations.com/blogs/news/how-to-massage-texter's-thumb.
23. Rehab my patient. Extension-stretch png [image] rehabmypatient.com [Internet] [cited on 2024August17] Available from: https://www.rehabmypatient.com/media/uploads/articles/Thumb-extension-stretch.png
24. Hajipour L. Texters thumb: Symptoms and Remedies [image] ladanhajipour.com [Internet] [cited on 2024 August 17] Available from: https://ladanhajipour.com/
25. Devos P. Movement circumduction [scientific diagram] reseachgate.net

[Internet] [cited on 2024 August 17] Available from: www.google.com
26. Healthline. Hand exercises to ease thumb pain [image] heathline.com [Internet] [cited on 2024 August 17] Available from: https://images.app.goo.gl/cZjpMtmEwhretZtE8
27. Thrive Inc. The Importance of a Close Fist and an Open Hand [image] thriveinc.com [Internet][citedon2024August17] Available from: https://images.app.goo.gl/qrRWRFzDAJq1twsN7
28. Zawacki-Richter O, Marín V I, Bond M. *et al.* Systematic review of research on artificial intelligence applications in higher education – where are the educators? Int J Educ Technol High Educ. 2019; 16 (39): doi :10.1186/s41239-019-0171-0.
29. Zhang Y, Balochian S, Agarwal P, Bhatnagar V, Housheya O. Artificial Intelligence and Its Applications. Int. J. Eng. Math. 2014; vol. 2014, Article ID 840491, 10 pages, doi:10.1155/2014/840491.
30. OpenAI Teams Up with Scale AI to Revolutionize Fine-Tuning of GPT-3.5 Models [image in blog] alitech.io [Internet] [cited on 2024 August 16] Available from: https://alitech.io/blog/openai-revolutionize-fine-tuning-of-gpt-3-5-models/.
31. Megee. Gps- Blue GPS Location Marker [png image] cleanpng.com [Internet] [cited on 2024 August 16] Available from: https://www.cleanpng.com/png-gps-navigation-systems-computer-icons-clip-art-gps-1353706/.
32. Lanotte F, O'Brien MK, Jayaraman A. AI in Rehabilitation Medicine: Opportunities and Challenges. Ann Rehabil Med. 2023; 47(6): 444-458. doi:10.5535/arm.23131.
33. Bsd Studio. Rehabilitation Robotics concept [icon] provector vecteezy.com[Internet] [cited on 2024 August 16] Available from: https://www.vecteezy.com/vector-art/2367690-rehabilitation-robotics-concept-icon.
34. Bsd Studio. Virtual Rehabilitation concept [icon] provector vecteezy.com[Internet] [cited on 2024 August 16] Available from: https://www.vecteezy.com/vector-art/2368293-virtual-rehabilitation-concept-icon.
35. Hamad A, Jia B. How Virtual Reality Technology Has Changed Our Lives: An Overview of the Current and Potential Applications and Limitations. IJERPH.2022; 19(18):11278. doi:10.3390/ijerph191811278.
36. Li L, Yu F, Shi D, Shi J, Tian Z, Yang J, Wang X, Jiang Q. Application of virtual reality technology in clinical medicine. Am J Transl Res. 2017; 15 9(9): 3867-3880.
37. Brand EASEGMER. Kids Handheld Game Portable Video Game Player [image] Amazon.in [Internet] [cited on 2024 August 16].
38. Types of Aircraft Simulators: An In-Depth Guide[image]Info@orbitshub.com [Internet][cited on August 2024] Available from: https://orbitshub.com/types-of-aircraft-simulators-an-in-depth-guide/.
39. Vr Race [image] shutterstock.com [Internet] [cited on 2024 August 17] Available from: https://www.shutterstock.com/search/vr-race.
40. Viderman D, Tapinova K, Dossov M, Seitenov S, Abdildin YG. Virtual reality for pain management: an umbrella review. Front Med (Lausanne). 2023; 14(10): 1203670. doi: 10.3389/fmed.2023.1203670.
41. Virtual Reality Vector [clipart] freedesignfile.com [Internet] [cited on 2024 August 17] Available from: https://freedesignfile.com/767133-virtual-reality-vr-clipart/.
42. People Use Virtual Reality Technology fro Sports vector [image] vectorstock.com[Internet] [cited on 2024 August17] Available from: https://www.vectorstock.com/royalty-free-vector/people-use-virtual-reality-technology-fro-sports-vector-30228700.
43. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021; 372: n71. doi: 10.1136/bmj.n71.
44. Lakshminarayanan K, Shah R, Daulat S R, Moodley V, Yao Y, Ezhil SL et al. Feasibility and usability of a virtual- reality-based sensorimotor activation apparatus for carpal tunnel syndrome patients. PLos ONE. 2023; 18 (10): e0292494 doi: 10.1007/s10055-022-00722.
45. Juan MC, Elexpuru J, Dias P. et al. Immersive virtual reality for upper limb rehabilitation: comparing hand and controller interaction. VR. 2022; 27: 1157–1171. doi:10.1007/s10055-022-00722-7.

46. Tokgoz P, Stampa S, Wahnert D, Vordemvenne T, Dockweiler C. Virtual Reality in the Rehabilitations of Patients With Injuries and Diseases of Upper Extremities. Healthcare. 2022; 10(6): 1124. doi :10.3390/healthcare10061124.
47. Pereira M F, Prahm C, Kolbenschlag J, Oliveira E et.al. Application of AR and VR in Hand Rehabilitation: A Systematic Review. J. Biomed. Inform. 2020; 111: 103584. doi: 10.1016/j.jbi.2020.103584, pubmed.ncbi.nlm.nih.gov/33011296.
48. Aguilar-Lazcano CA, Rechy-Ramirez EJ, Hu H, Rios-Figueroa H V, Marin-Hernandez A. Interaction Modalities used on serious Games for upper limb Rehabilitation: A Systematic review. Games health J. 2019; 8(5): 313–325. doi:10.1089/g4h.2018.0129.
49. Meijer H A, Graafland M, Goslings J C, Schijven M P. Systematic review on the effects of serious games and wearable technology used in rehabilitation of patients with traumatic bone and soft tissue injuries. Arch. Phy. Med. Rehabil. 2018; 99(9): 1890–1899. doi: 10.1016/j.apmr.2017.10.018.
50. Cidota M A, Lukosch S G, Dezentje Paul, Bank P J M, Lukosch H K, Clifford R M S. Serious Gaming in Augmented Reality using HMDs for Assessment of Upper Extremity Motor Dysfunctions: User Studies for Engagement and Usability. i-com. 2016; 15(2):155-169. doi:10.1515/icom-2016-0020.
51. Lange B, Koenig S, Chang C Y, McConnell E, Suma E, Bolas M, Rizzo A. Designing informed game-based rehabilitation tasks leveraging advances in virtual reality. Disabil Rehabil. 2012; 34(22): 1863–1870. doi:10.3109/09638288.2012.670029.
52. Meta Oculus Rift-Virtual Reality Headset-black [image] Amazon.in [Internet] [Cited on 2024 August17].
53. Hoffman H G, Boe DA, Rombokas E, Khadra C, LeMay S, Meyer WJ, Patterson S, Ballesteros A, Pitt SW. Virtual Reality Hand Therapy: A New Tool for Nonopioid Analgesia for Acute Procedural Pain, Hand Rehabilitation and VR Embodiment Therapy for Phantom Limb Pain. J. Hand. Ther. 2020; 33(2): 254-262. doi: 10.1016/j.jht.2020.04.001.
54. Bts infotech – Augmented Reality & Virtual Reality [image] Btsinfotech.com [Internet] [citedon2024August17] Available from: https://btsinfotech.com/AR%20&%20VR%20developement.php.
55. A woman wearing VR headset user surreal world and virtual reality colourful flowers fields and swarm of butterflies Generative AI [AI image] freepik.com [Internet] [cited on 2024 August 17] Available from: https://www.freepik.com/premium-ai-image/woman-wearing-vr-headset-user-surreal-world-virtual-reality-colorful-flowers-fields-swarm-butterflies-generative-ai_54149793.htm.
56. Thule Rain Blocker Sides [AI image] vwcaliforniaclub.com [Internet] [cited on 2024 August 17] Available from: https://vwcaliforniaclub.com/threads/thule-rain-blocker-sides-install.27112/.
57. Juan MC. Immersive Virtual Reality for Upper limb Rehabilitation [image] springer.com [Internet][citedon2024August17] Available from: https://link.springer.com/article/10.1007/s10055-022-00722-7.
58. Aggarwal R, Ganvir S. Artificial Intelligence in Physiotherapy. IAPJ. 2021;15(2): 55-57. doi: 10.4103/pjiap.pjiap_3_22.
59. Eapen C, Kumar B, Bhat A K, & Venugopal A. Clinical and ultrasonic evaluation of the thumb: comparison of young adults with and without thumb pain with text messaging. J. Manip. Physiol. Ther. 2018; 41(3): 199–207. doi: 10.1016/j.jmpt.2017.11.001.
60. Eitivipart A C, Viriyarojanakul S, Redhead L. Musculoskeletal disorder and pain associated with smartphone use: A systematic review of biomechanical evidence. Hong Kong Physiother. J.2018; 38(02): 77–90. doi :10.1142/s1013702518300010.
61. Gilman L, Cage DN, Horn A, Bishop F, Klam WP, Doan AP.Tendon Rupture Associated With Excessive Smartphone Gaming JAMA Intern Med. 2015; 175 (6): 1048-1049. doi: 10.1001/jamainternmed.2015.0753.
62. Goel R, Abzug JM. De Quervain's Tenosynovitis: A Review of the Rehabilitative Options HAND. (N Y). 2015; 10(1): 1-5. doi:10.1007/s11552-014-9649-3.
63. Holden M K.Virtual Environments for Motor Rehabilitation: review. CyberPsychol. Behav. Soc. Netw. J. 2005; 8(3): 187–211. doi:10.1089/cpb.2005.8.187.

64. Howell ER. Conservative care of De Quervain's tenosynovitis/ tendinopathy in a warehouse worker and recreational cyclist: a case report. J Can Chiropr Assoc. 2012; 56(2): 121-7.
65. Levanon, Y. The advantages and disadvantages of using high technology in hand rehabilitation. J. Hand. Ther. 2013; 26 (2): 179-183. doi: 10.1016/j.jht.2013.02.002.
66. Liu J. et al. Artificial Intelligence in the 21st Century. IEEE Access. 2018; 6: 34403-34421. doi: 10.1109/2819688.
67. Nathani HR, Phansopkar P. Effectiveness of Tailor-Made Physiotherapy Protocol in Smartphone-Addicted Individuals With Text Neck Syndrome and Short Message Service (SMS) Thumb. Cureus. 2024; 16(4): e57453. doi: 10.7759/cureus.57453.
68. Rupawat R, Kanhere A, Shende M, Ghatpande K. Knowledge and Feasibility of Artificial Intelligence: A Physiotherapeutic Perspective. JETIR. 2024; 11(4): b280-b292.
69. Shin J H, Kim M Y, Lee J Y, Jeon Y J, Kim S, Lee, Seo S B, Choi Y. Effects of virtual reality-based rehabilitation on distal upper extremity function and health-related quality of life: a single-blinded, randomized controlled trial. J. Neuroeng. Rehabil. 2016; 13: doi:10.1186/s12984-016-0125.
70. Sidiq M, Chahal A, Gupta S, Vajrala K R. Advancement, utilization, and future outlook of Artificial Intelligence for physiotherapy clinical trials in India: An overview. J. Interdiscip. Rehabil. 2023; 4(73): doi:10.56294/ri202473.
71. Truong P, Truong L, Le T, Kuklova K. Orthopedic Injuries from Video Games: A Literature Review and Implications for the Future. Int Arch Orthop Surg. 2020; 3: 020. doi:10.23937/2643-4016/1710020.
72. Welling A, Metgud S. Integrating Technology in Physical Therapy Practice: A New Era of Rehabilitation. Indian J Phys Ther.2023; 5(1): 1-3. doi: 10.4103/ijptr.ijptr_164_23.
73. Bhandari P, Nikolopouloun K. Likert Scale-5 point [image] scribbr.com [Internet] 2020; [cited on 2024 August 17] Available from: https://www.scribbr.com/methodology/likert-scale/.
74. Saloni T. Virtual Reality- part of our everyday lives [image] banglore24.7.in [Internet] 2021; [cited on 2024 August 17] Available from: https://bangalore247.in/success-stories/the-bengaluru-based-start-up-aims-to-increase-indias-vr.
75. Virtual Rehabilitation Exercise Software [image] rehametric.com [Internet] [cited on 2024 August 17] Available from: https://rehametrics.com/en/.
76. Immersive virtual Reality [image] rehametrics.com [internet] [cited on 2024 August 17] Available from: https://rehametrics.com/en/immersive-virtual-rehabilitation/.

How to cite this article: Disha Bansal, Sandeep Saini, Osheen Bhandari, Ishnoor Singh. The rehabilitation of texter's thumb with virtual reality headsets - a systematic review. *International Journal of Science & Healthcare Research.* 2024; 9(4): 108-128. DOI: *https://doi.org/10.52403/ijshr.20240416*

******