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Effectiveness of Kinetic Sand Therapy in Improving Hand Functions in Post-Surgical Distal Radial Fracture Rehabilitation: A Case Study

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ABSTRACT

This case study aimed to evaluate the effectiveness of kinetic sand therapy in improving hand function during postsurgical rehabilitation of distal radial fractures. Distal radial fractures are common injuries that often result in impaired hand function postoperatively. Traditional rehabilitation methods focus on restoring range of motion and strength, but these methods may not adequately address the accompanying sensory and proprioceptive deficits. Kinetic sand therapy, a novel intervention, offers a tactile and proprioceptive approach for rehabilitation. The Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire was used as an outcome measure to assess improvements in hand function. This case study presents the rehabilitation process and outcomes of a patient undergoing kinetic sand therapy following surgical treatment of distal radial fractures.

Keywords: Kinetic sand therapy, distal radial fracture, hand function, rehabilitation, Disabilities of the arm, shoulder, and hand

INTRODUCTION

Distal radial fractures are among the most common upper extremity injuries.[1] Distal radius fracture covers 18% of fractures in the active elderly population.[2] They occur most often in older patients and frequently require surgical intervention to achieve and maintain an anatomical and stable reduction that will provide the patient with the best possible functional recovery. [3]While surgical techniques have evolved to provide excellent restoration of anatomy, achieving the same results in function remains a challenge, particularly in complex fractures and with compromised soft tissue.[4] It is important to note that post-surgical rehabilitation is an essential component of the process of restoring hand function.[5] Recovery of hand function is vital to the performance of activities of daily living and in maintaining independence.[6] Traditional rehabilitation protocols have centered on the restoration of range of motion, strength, and functional activities. However, traditional rehabilitation may neglect less-obvious deficits in sensory perception and proprioception, which are integral components of hand function. Sensory feedback is crucial for motor control and learning, providing information about the position, movement, and force of the hand.[7] A fundamental component of this is proprioception – our sense of where our joints are and the movement of these joints so that we may perceive the position and orientation of our limbs in space without dependence on vision.[8] Following distal radial fractures, deficits in sensory and proprioceptive function can lead to impairments during tasks that require

precision, coordination, and fine motor control.[9] Kinetic sand therapy represents a novel rehabilitation approach that capitalizes on the tactile and proprioceptive properties of kinetic sand to enhance sensory integration and motor learning. [10] Kinetic sand is a mouldable material consisting of fine sand particles bonded with a silicone-based compound, giving it a unique tactile experience.[11] By engaging the hands in multiple activities within the kinetic sand, an individual receives sensory feedback and proprioceptive stimulation. While the effectiveness of kinetic sand therapy has been explored in many rehabilitation settings, its use in distal radial fracture rehabilitation is relatively unknown. The purpose of this case was to explore the potential benefits of using kinetic sand therapy to improve hand function during postsurgical rehabilitation for distal radial fractures. The objective of this study was to incorporate both objective outcome measures and patient-reported outcomes to provide insight into the effectiveness of this novel intervention and its implications for clinical practice.

CASE PRESENTATION

A 78-year-old left-handed male, visited the Physiotherapy Outpatient Department (OPD) at Sardar Bhagwan Singh University, which resulted in a displaced distal fracture of his left hand. An X-ray confirmed the fracture, which showed intra-articular involvement and required surgical intervention. Subsequently, the patient underwent open reduction and internal fixation (ORIF) with a volar locking plate under general anesthesia to align the structures anatomically and provide stability. After the surgery, the patient experienced pain, swelling, and functional limitations around his wrist and hand.

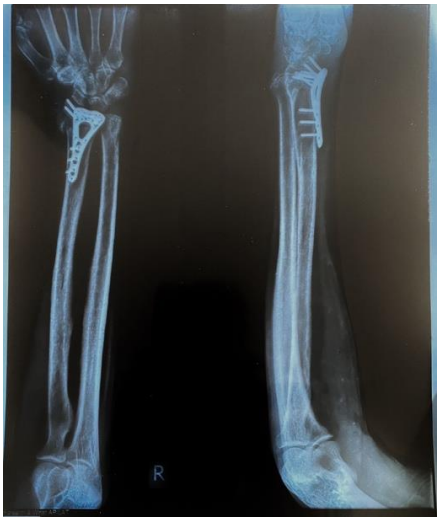

***Figure1*: X-ray**

Examination and Evaluation

On examination, the patient presented with restricted range of motion of the wrist and fingers. Palpation around the treated area revealed significant tenderness over the volar aspect of the distal radius, along with limited active and passive wrist and finger range of motion, grip strength was notably diminished compared to the contralateral side and he showed difficulty in performing fine motor tasks. DASH questionnaire was used to assess the post-surgery disability of the patients' hands and fingers. Manual muscle testing was performed to assess the strength of the muscles involved in wrist and hand functions. A goniometer was used to assess the wrist range of motion.

Range of motion

S.no	Motion	Active ROM	Passive ROM
1	Wrist Flexion	35	40
2	Wrist extension	30	35
3	Radial deviation	10	12
4	Ulnar deviation	12	16
5	Finger PIP flexion	40	50
6	Finger PIP extension	0	0
7	Finger DIP flexion	35	40
8	Finger DIP extension	0	0

Table 1: Range of motion

Muscle strength-

S.no	Muscle	Muscle Strength
1	Wrist flexors	3
2	Wrist extensors	3
3	Radial deviators	2+
4	Ulnar deviators	2+
5	Finger PIP flexors	2+
6	Finger PIP extensors	2+
7	Finger DIP flexors	2+
8	Finger DIP extensors	2+

Table 2: Muscle Strength Grading

Outcome Measures

The Disabilities of the Arm, Shoulder, and Hand (DASH) scale was administered at baseline and after the eight-week intervention to assess changes in hand function and patient-reported outcomes. The DASH consists of 30 items covering various domains related to upper-extremity function and disability. These domains include physical function, symptoms, and social-emotional impact. [12]

Table 3 – DASH scores

DASH Domain	Pre-Intervention Score	Post-Intervention Score
Physical function	55	25
Symptoms	60	30
Social-emotional impact	50	20
Overall, the DASH score	55	25

Intervention

After obtaining consent from the patient, patient was introduced to the rehabilitation protocol, which included traditional physiotherapy rehabilitation for the wrist and hand along with kinetic sand therapy. Throughout the treatment regime, the patient underwent range of motion exercises, grip strengthening exercises, and kinetic sand therapy for 40 minutes, which was continued for 6 days/week for 7 weeks. This comprehensive rehabilitation protocol aimed to address pain, swelling, and functional limitations and promote sensorimotor recovery in the postoperative rehabilitation of distal radial fractures.

The rehabilitation Protocol consisted of

1. **Range of motion Exercises**- Active and passive ROM exercises were introduced to improve wrist joint mobility and flexibility. Specifically, these include wrist flexion, Extension, Radial deviation, and ulnar deviation. DIP and PIP range of motion exercise. (10 minutes)

2. **Grip Strengthening Exercises**- Progressive resistance exercises focusing on wrist and hand flexors and extensor muscles were induced to gain grip strength and functional hand strength. (10 minutes)

3. **Kinetic Sand Therapy**- During this customized session the patient was engaged in performing various activities like Hand molding, Putting the sand in different molds, Pinching the sand with fingers, squeezing, and rolling the kinetic sand. These activities give tactile and proprioceptive stimulation, promoting sensory integration and functional recovery. (20 minutes)

Figure (2,3,4): Patient performing different activities using Kinetic Sand

Throughout the intervention, the patient was monitored, and Kinetic Sand activities were modified according to the needs and responses of the patient. The patient was educated in a home exercise program and self-care strategies.

RESULTS

The patient made significant improvements in hand function much earlier than expected, as per the standard physiotherapy protocol assessed by the DASH. The scores decreased across all domains, indicating improved overall hand function, increased ability to perform activities of daily living, decreased pain, enhanced work performance, improved aesthetics, and increased patient satisfaction. Specifically, much earlier and improved fine motor control, grip strength range of motion increased significantly in flexion and extension, and fine motor control increased, enabling the patient to perform intricate tasks with much more ease and precision. Subjectively, the patient reported decreased pain, increased confidence in using her hand, and increased satisfaction with her general functional ability.

DISCUSSION

This case study provides preliminary evidence supporting the efficacy of kinetic sand therapy as an adjunct intervention for improving hand function during post-surgical rehabilitation following a distal radial fracture. Kinetic sand therapy may target sensory and proprioceptive deficits that traditional rehabilitation interventions cannot address. The substantial improvements in fine motor control, range of motion, and grip strength in this patient after treatment with kinetic sand therapy would suggest that this modality has potential value as an adjunct to standard rehabilitation following distal radial fractures. Further research using larger sample sizes and controlled study designs is needed to examine the mechanisms of action and efficacy of kinetic sand therapy.

CONCLUSION

Kinetic sand therapy shows promise as an adjunct to a standard rehabilitation protocol for improving hand function in patients with distal radial fractures. In this case, improved function may have been the result of combining tactile and proprioceptive stimulation within the rehabilitation protocol to address sensory and motor deficits and enhance functional outcomes. There is a need to validate these findings and identify the most efficacious parameters for kinetic sand therapy inclusion within the standard distal radial fracture rehabilitation protocols.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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