DOI: 10.7860/JCDR/2024/69147.19553

Case Report

Physical Medicine and Rehabilitation Section

A Multifaceted Physiotherapeutic Approach for Improving Hand Function in Post-traumatic Fracture Dislocation of Proximal Phalanx of Middle Finger of Left Hand: A Case Report

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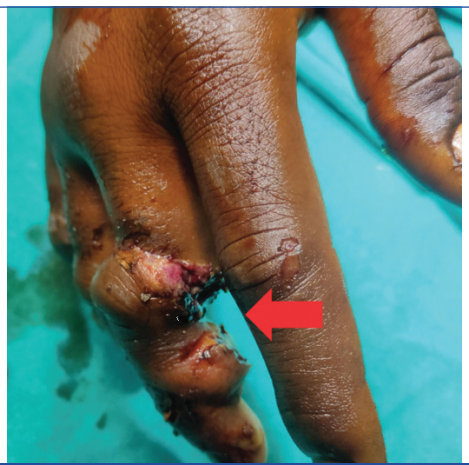
ABSTRACT

Hand phalangeal fractures are frequent injuries that present in the clinic and emergency room. Injuries to the phalanx may occur at the proximal, middle, or distal segments of the bone. Depending on the location, proximal phalanx fractures can develop a volar apex angulation. Soft-tissue damage, along with disruption of the finger, accompanies the phalangeal fracture. Treatment of the phalangeal fracture is contingent upon the type of displacement of the fracture. Displaced fractures are reduced by manipulation, followed by immobilisation in an aluminum splint. In later phases, Kirschner wire (K-wire) fixation is performed. The hand is an important functional unit. Hence, post-immobilisation rehabilitation of the phalangeal fracture is essential for everyday activities. In this case report, the multifaceted physiotherapeutic approach is employed in the rehabilitation of a 33-year-old man who presented with multiple bite wounds allegedly inflicted by a wild boar, with chief complaints of injuries on the third digit of the left hand leading to pain and restricted movement. Radiographs revealed a comminuted fracture of the third digit with fracture dislocation of the distal end of the proximal phalanx, requiring K-wire fixation and finger splinting. Post-fixation, finger Range Of Motion (ROM) reduced, and pain arose, prompting physiotherapy. The multifaceted approach in rehabilitation involves a range of interventions, including traditional methods like immobilisation and K-wire fixation, as well as adjunctive physiotherapy techniques such as the finger blocking technique and sensory motor training. This report showcases a successful multifaceted rehabilitation approach for a patient with a traumatic finger fracture, demonstrating the importance of integrating physical therapy and addressing both physical and functional impairments for optimal outcomes.

Keywords: Finger blocking exercises, Phalangeal fracture, Rehabilitation, Sensory motor training

CASE REPORT

A 33-year-old man presented to the orthopaedic department with multiple bite wounds allegedly inflicted by a wild boar, with chief complaints of injuries on the third digit of the left hand, as well as minor injuries on the right leg and the right-side of the abdomen, leading to pain and restricted movement. The past medical and familial histories showed no significant findings. Further radiographs of the left hand antero-posterior view revealed a comminuted fracture of the third digit with a fracture dislocation of the distal end of the proximal phalanx. The preoperative image is shown in [Table/Fig-1]. Lacerated wounds were cleared, and suturing of the injuries was done. The comminuted fracture of the phalanx was treated with K-wire fixation as shown in [Table/Fig-2,3], followed by buddy splinting of the third and fourth fingers to restore the bone. Post K-wire fixation, the ROM of the fingers was reduced. The patient experienced pain, for which he was referred to the Department of Musculoskeletal Physiotherapy in November 2023.



[Table/Fig-1]: Shows preoperative image traumatic injury of middle phalanx indicated by arrow.

[Table/Fig-2]: In the X-ray red arrow shows the K-wire fixation of the proximal phalanx of 3rd finger.

The patient's informed consent was obtained prior to commencing the examination, following which a thorough investigation was conducted. The vital signs of the patient were stable; he was observed in a high sitting position at the bed end with his hand supported over the left thigh. Physically, the patient presented with a mesomorphic body build. The intensity of pain, according to the

[Table/Fig-3]: The red circle indicates the dorsal side of the hand, displaying post-K-wire fixation in the proximal phalanx of the third finger.

Visual Analogue Scale (VAS), was rated 5/10 at rest and 7.1/10 during grasping and pinching activities. Mild swelling was present over the third finger. Based on the tenderness grading scale, grade 2 tenderness was represented as pain and winces [1]. The superficial sensation of the third digit was impaired. The patient was unable to straighten the fingers due to K-wire fixation. Complete flexion and extension were restricted due to reduced muscle strength and ROM.

Therapeutic Intervention

The "multifaceted approach" in rehabilitation involves a range of interventions, including traditional methods like immobilisation and K-wire fixation, as well as adjunctive physiotherapy techniques. A multifaceted physical therapy protocol was initially started with gentle isometrics for the finger musculature and pain relief intervention, followed by a week-by-week intervention protocol as shown in [Table/Fig-4] [2].

Follow-up and outcome measures: The patient resumed work following four weeks of physiotherapy intervention, which included strength training and sensory-motor training. Reduced ROM strength, and Distal Interphalangeal (DIP) flexion were attained four weeks after the start of physical therapy [Table/Fig-5] [3,4].

The Sollerman Hand Function Test (SHFT) comprises several components, including pick-up tasks, manipulation tasks, and activities of daily living [3]. The scoring range of SHFT depends on the participant's performance. The score ranges from 0 to 4, where 0 denotes no activity performed and 4 denotes completion of the activity in 20 seconds without difficulty. A higher score indicates better hand function.

Weeks wise	Goals	Intervention	Rationale	Dosage
Week 1 to 2	Patient and family education	The patient and his family were thoroughly educated on the patient's postoperative condition and the significance of physiotherapeutic management	Improves patient feedback	N/A.
	Pain management	NMES	NMES mimics muscle contraction via very low electrical current and causes relief of pain	Treatment time was 10- 20 minutes for small muscles, with a pulse duration of 150-200 microseconds, three times a week [2].
	Prevent oedema and adhesion	Elevation of affected hand in sitting position	Elevation improves the venous return	Elevation every four hourly.
		Passive movement	Enhances effective circulation by maintaining ROM	Passive movement 10 repetitions of two sets (BD).
	Scar management	Myofascial release	Manual stretch release adhesion and improve mobility in scar tissue	Gentle scar mobilisation, once a day.
Week 2 to 3	Improving ROM	Early passive mobilisation in the available range	Inhibit restrictive adhesion formation and synovial diffusion, prevent a decrease in tensile strength	10 repetitions of two sets.
	Maintaining unaffected joint function	Active ROM of glenohumeral joint, elbow, wrist and unaffected digits	Effects in minimising the impact of contracture formation, assisting neuromuscular re-education	10 repetitions of two sets.
	Improving strength	Isometric exercises	Improves the resilience of the flexors as well as extensors	10 repetitions of two sets.
Week 3 to 4	Releasing adhesion and improving tendon length	Finger blocking exercises	Blocking causes the stretching of the soft-tissues and helps to lengthen the tendon, eventually improving flexibility and mobility	Gentle blocking for Flexor Digitorum Profundus (FDP), Flexor Digitorum Superficialis (FDS), 10 repetitions twice a day.
	Strengthening	Dynamic exercises (Gell ball squeezing, actively resisted exercises)	Improves intrinsic muscle pumping and improves the muscular strength	10 repetitions, twice a day.
	Sensory motor training	Grip strengthening, motor activity using gel ball, finger stretch, make an O sign, roll into a fist, small fist, massage ball	Improves sensory-motor system by increasing transmission	Five repetitions are initially followed by progression.

[Table/Fig-4]: A multifaceted physiotherapeutic intervention protocol [2].
N/A: Not applicable; BD: Twice a day; NMES: Neuromuscular electrical stimulator; FDP: Flexor digitorum profundus; FDS: Flexor digitorum superficialis; ROM: Range of motion

S. No.	Outcome measures	Prerehabilitation	Postrehabilitation
1.	**Pain (according to VAS)**		
	On activity	7.1/10	2/10
	On rest	5/10	1.4/10
2.	**Manual Muscle Testing (MMT) [4] of third finger**		
	Metacarpophalangeal joint flexors	Not assessable	4/5
	Metacarpophalangeal joint extensors	Not assessable	4/5
	Distal Interphalangeal (DIP) joint flexion	Not assessable	4/5
	Proximal interphalangeal flexion	Not assessable	4/5

3.	**Sollerman Hand Function Test (SHFT) [3]**				
	Score	53/80		76/80	
4.	**Range of Motion (ROM)**	**Prerehabilitation**		**Postrehabilitation**	
	Left hand	Active	Passive	Active	Passive
	Distal Interphalangeal (DIP) (flexion)	0-5°	0-10°	0-35°	0-45°
	Proximal interphalangeal (flexion)	20-30°	0°	0-60°	0-80°
	Metacarpophalangeal (flexion)	0-20°	0-30°	0-70°	0-80°
	Metacarpophalangeal (hyperextension)	0°	0°	10-15°	15-20°

[Table/Fig-5]: Illustrates the pre and postrehabilitation outcomes [3,4].

DISCUSSION

Following a post-traumatic fracture dislocation of the proximal phalanx of the middle finger of the left hand, a multifaceted physiotherapeutic approach was implemented. Subsequent to fixation, the patient encountered reduced finger ROM and pain, prompting the initiation of physiotherapy. This comprehensive approach targeted both structural and functional impairments, including decreased ROM and sensory deficits. Various interventions, such as finger blocking exercises and sensory-motor training, were employed to enhance flexibility, strength, and sensory-motor coordination. The four-week rehabilitation protocol yielded significant improvements in pain levels, muscle strength, and hand function, as demonstrated by outcome measures including the VAS for pain, Manual Muscle Testing (MMT) [4], and the SHFT. Comparatively, wrist extensor avulsion fractures commonly result from Extensor Carpi Radialis Longus (ECRL) muscle contractions, with standard surgical management involving Open Reduction and Internal Fixation (ORIF) [5].

A study by Hamasaki T et al., emphasised the importance of considering psychological variables in hand treatment to effectively alleviate discomfort and restore motor and sensory abilities [6]. Additionally, Neuromuscular Electrical Stimulation (NMES) has been extensively utilised in athletic rehabilitation for muscle training, oedema management, and maintaining muscle mass and strength during immobilisation [7]. Matanaicake S et al., and Verver D et al., advocated for the cost-effectiveness and efficiency of K-wire fixation in open finger fractures, facilitating postsurgical hand function maintenance and reduced hospital stay [8,9]. Feehan LM recommended early mobilisation in stable fractures to promote venous return, improve intrinsic muscle pumping, and achieve desired joint positions, with elevation-based shoulder and elbow exercises enhancing proximal muscle pumping [10,11].

Active Range Of Motion (AROM) is initiated to prevent osseous adhesions, and crucial tendon-gliding exercises like Flexor Digitorum Profundus (FDP), Flexor Digitorum Superficialis (FDS), and central slip are used to reduce tendon adherence after fracture callus. The profundus inhibition is caused by manually restricting DIP motion in the normal digits while trying PIP flexion in the affected digit [12]. Vaidya SM and Nariya D undertook a study to investigate the effectiveness of neural mobilisation and nerve and tendon gliding exercises in individuals diagnosed with Carpal Tunnel Syndrome (CTS). Their aim was to determine which treatment modality yields superior outcomes in terms of pain reduction and functional improvement. The study revealed that both neural mobilisation and nerve and tendon gliding exercises are beneficial for treating CTS and alleviating associated disability. Specifically, neural mobilisation demonstrated greater effectiveness in terms of improvement compared to nerve and tendon gliding exercises. However, significant improvement was also observed with the use of tendon gliding techniques [13].

The primary objective of this case report was to underscore the importance of implementing a systematic early treatment regimen and comprehensive rehabilitation program for adult patients with phalanx fractures, emphasising their critical role in facilitating optimal recovery and functional outcomes.

CONCLUSION(S)

This study demonstrates how a multimodal strategy can effectively improve hand function in a patient who has had a post-traumatic phalanx fracture. Patients' finger strength, ROM, and functional use all significantly increase with the integration of physical therapy. This approach provides a valuable model for upcoming rehabilitation efforts in similar cases. It emphasises the significance of addressing both physical and functional impairments to maximise rehabilitation outcomes.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Dec 18, 2023
- Manual Googling: Feb 23, 2024
- iThenticate Software: Mar 25, 2024 (8%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Dec 17, 2023**
Date of Peer Review: **Feb 16, 2024**
Date of Acceptance: **Mar 26, 2024**
Date of Publishing: **Jun 01, 2024**