Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Case Reports
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 13, Number 3, Pages 472-478 (2025)
DOI: https://doi.org/10.24843/mifi.000000352

Infrared and Exercise Therapy for Post-Immobilization Wrist Stiffness after Distal Radius Fracture: A Case Report

Halimatu Sya'dia[1*], Didik Purnomo[2]

[1,2]Diploma in Physiotherapy Program, Widya Husada University, Semarang

*Corresponding author:
E-mail: halimatusyadia541@gmail.com

Received 09 July 2025; Revised 13 July 2025; Accepted 15 July 2025; Published 01 September 2025.

Abstract
Introduction: Distal radius fractures frequently result from falls on an outstretched hand and may lead to post-immobilization complications such as wrist joint stiffness. This case report investigates the effectiveness of combined infrared therapy and exercise therapy in managing wrist stiffness following cast immobilization of a distal one-third radius fracture.
Methods: A single-patient case study was conducted on a patient presenting with pain, edema, limited range of motion (ROM), muscle spasm, decreased strength, and impaired wrist function. Interventions included infrared therapy and structured exercise sessions. Outcome measures comprised the Visual Analog Scale (VAS), ROM, Manual Muscle Testing (MMT), and Wrist Hand Disability Index (WHDI).
Results: Pain on palpation decreased from VAS 2 (T1) to 0 (T5), and pain during movement decreased from 6 to 4. Edema reduced at all measurement points. Muscle spasm decreased from moderate to mild. ROM improved in palmar flexion (10° to 20°), dorsal flexion (25° to 35°), radial deviation (10° to 25°), ulnar deviation (15° to 30°), supination (15° to 20°), and pronation (60° to 75°). Muscle strength increased in the pronator group from grade 3 to 5, and in other wrist muscles from grade 3 to 4. WHDI scores improved from 32 to 20.
Conclusion: Combined infrared and exercise therapy effectively reduced pain, edema, and muscle spasm while enhancing ROM, muscle strength, and functional outcomes in a patient with post-immobilization wrist stiffness following distal radius fracture.

Keywords
Distal radius fracture, Wrist stiffness, Infrared therapy, Exercise therapy, Physiotherapy rehabilitation

Introduction

A fracture is defined as a disruption in the continuity of bone or cartilage structures, with or without subluxation of the fragments. It typically occurs due to trauma or excessive mechanical stress during physical activities. Bone healing following a fracture is a complex biological process involving multiple stages of repair. Fractures can be managed conservatively through casting or surgically with internal or external fixation.[1]

One of the most commonly affected sites is the radius. Radius fractures are among the most frequent injuries of the wrist joint, with incidence rates continuing to rise globally. These injuries often result from falls onto an outstretched hand. Based on the fracture pattern and mechanism of injury, distal radius fractures are classified into several types including Colles, Smith, Barton, Monteggia, and Galeazzi.[2]

According to epidemiological data, hand fractures account for approximately 17–25% of all fracture types.[3] The World Health Organization (WHO) reported in 2020 that the global prevalence of fractures had increased by 2.7%, affecting approximately 13 million individuals. In Indonesia, around 1,775 individuals (3.8%) were recorded as having sustained fractures. Among 14,127 trauma cases involving sharp or blunt force, 236 cases (1.7%) resulted in fractures, with 40.6% of all cases requiring hospital admission.[4] Medical records from RSUD Bendan Pekalongan reported 38 cases of distal radius fractures between January and February 2025.

Distal one-third radius fractures are typically treated through reduction and immobilization using a cast. A common complication following immobilization is wrist joint stiffness.[5] Clinical symptoms of wrist joint stiffness include pain, edema, limited range of motion (ROM), muscle spasms, reduced muscle strength, and impaired functional activities such as wrist movement.

The patient in this case report, referred to as Mrs. T, is a 65-year-old woman diagnosed with wrist joint stiffness following cast immobilization for a distal one-third right radius fracture. Her main complaint was persistent stiffness in the right wrist after six weeks of immobilization. She reported no history of systemic, familial, or genetic diseases. Social history revealed that she is a housewife, right-hand dominant, and regularly engages in manual household tasks. Due to persistent post-immobilization symptoms, she was referred to physiotherapy for further rehabilitation. Physiotherapy plays a crucial role in addressing such complications and in restoring function following distal radius fracture through modalities such as infrared (IR) and therapeutic exercise.

According to Prodyanatasari, infrared therapy is effective in treating wrist joint stiffness. Infrared radiation is a type of electromagnetic wave with a wavelength ranging from 7,700 to 4 million Å. IR therapy promotes vasodilation and has been shown to reduce pain, muscle spasms, and edema.[6]

Therapeutic exercise is essential in addressing movement and functional impairments, enabling patients to return to daily activities. Exercise modalities include passive, active, resisted, and hold-relax techniques. These interventions improve muscle strength and ROM.[7] As noted by Zulfikar, therapeutic exercise—whether active or passive—serves to relax muscles, preserve elasticity, reduce pain, prevent movement restrictions, and enhance functional abilities.[8]

This case report is important as it illustrates the effectiveness of combining infrared therapy with progressive exercise in managing wrist stiffness—an approach not widely detailed in the context of post-cast immobilization for distal one-third radius fractures. The presented intervention strategy may serve as a reference for physiotherapists in designing structured and effective rehabilitation programs. Based on the background presented above, this report aims to explore the physiotherapy management of wrist joint stiffness using infrared and exercise therapy following cast immobilization for a distal one-third right radius fracture.

Methods

This study employed a descriptive case report design, with the subject selected purposively based on clinical diagnosis and criteria. The subject was a 65-year-old female patient, Mrs. T, diagnosed with wrist joint stiffness following cast immobilization for a distal one-third fracture of the right radius, based on clinical findings including pain during movement, limited active and passive range of motion (ROM), and the absence of infection or neurological complications. A notable challenge in this case was the delayed initiation of physiotherapy—one week post cast removal—which may have affected the recovery rate. The intervention was conducted over five sessions, scheduled on February 7, 12, 14, 21, and 26, 2025.

The intervention program was delivered over five physiotherapy sessions during February 2025. Each session integrated infrared (IR) therapy with specific exercise techniques that were progressively adjusted to address pain, edema, muscle spasms, joint stiffness, and functional limitations. The detailed schedule of the interventions is presented in Table 1**.**

Table 1. Intervention Timeline

Date	Session	Intervention Description
7 Feb 2025	1	Initial assessment + Infrared (IR) + passive exercise
12 Feb 2025	2	IR + free active exercise
14 Feb 2025	3	IR + resisted exercise
21 Feb 2025	4	IR + hold-relax technique
26 Feb 2025	5	Final evaluation + combined exercise

Initial assessment revealed pain during palmar flexion and supination of the right wrist, with a Visual Analog Scale (VAS) score of 6/10. Edema was observed with a 2 cm circumference difference between the right and left wrists at three measurement points: 5 cm proximal to the radial styloid process, at the styloid process, and 5 cm distal. Moderate muscle spasm was present in the *flexor carpi radialis* and *flexor carpi ulnaris*. Muscle strength in the right wrist was rated at 3/5 using Manual Muscle Testing (MMT). ROM limitations included palmar flexion and supination, both reduced by 25° and 15° respectively from normal values. Functional impairment was indicated by a Wrist Hand Disability Index (WHDI) score of 32.

The outcome measurements in this case report were obtained using several validated instruments. Pain intensity was assessed using the Visual Analogue Scale (VAS), while wrist circumference was measured with a tape measure to evaluate the degree of edema. Range of motion (ROM) was assessed using a goniometer, muscle strength was evaluated through Manual Muscle Testing (MMT), and functional capability was measured using the Wrist Hand Disability Index (WHDI).

Infrared (IR) therapy was administered for 15 minutes over the right wrist area prior to each exercise session, with the IR emitter positioned at a distance of 30–45 cm from the skin surface to ensure therapeutic thermal effects. The exercise therapy was delivered progressively across five sessions. In session one, passive range of motion exercises were provided for wrist flexion, extension, radial deviation, ulnar deviation, pronation, and supination, with each movement performed in 8 repetitions for 3 sets. In sessions two and three, the patient performed free active exercises with the same frequency. Session four involved resisted exercises using a light resistance band to promote muscle strengthening. Finally, in session five, the hold-relax technique was applied to improve muscle flexibility and reduce stiffness.

Data were analyzed descriptively by comparing the outcomes between the first and final sessions. With appropriately timed and targeted interventions, the patient's prognosis for functional wrist recovery was considered favorable.

Results

Overall, the five physiotherapy sessions resulted in significant clinical improvements in pain, edema, muscle strength, and functional activity of the patient's right wrist. Pain intensity was monitored throughout the intervention period using the Visual Analogue Scale (VAS), capturing pain at rest, upon palpation, and during movement. This allowed a detailed assessment of changes in pain perception following each therapy session. The results are presented in Table 2, highlighting trends in pain reduction over time.

Table 2. Evaluation of Pain Intensity Using VAS

Pain Type	T1	T2	T3	T4	T5
At rest	0/10	0/10	0/10	0/10	0/10
On palpation	2/10	2/10	1/10	1/10	0/10
With movement	6/10	6/10	5/10	4/10	4/10

As shown in Table 2, pain on palpation decreased from 2 (T1) to 0 (T5), and movement-related pain reduced from 6 to 4 by the fifth session. No pain at rest was reported at any point (VAS 0/10).

To evaluate soft tissue swelling around the wrist, circumferential measurements were taken at three anatomical reference points: 5 cm proximal to the styloid process, directly at the styloid process, and 5 cm distal to the styloid. These measurements were used to assess edema reduction, as summarized in Table 3.

Table 3. Evaluation of Edema

Measurement Point	T1	T2	T3	T4	T5
5 cm proximal to styloid	20 cm	20 cm	19.5 cm	18.5 cm	18.5 cm
Styloid process of radius	18 cm	18 cm	18 cm	17.5 cm	17.5 cm
5 cm distal to styloid	23 cm	23 cm	22.5 cm	21 cm	21 cm

Table 3 demonstrates a gradual reduction in wrist edema over the course of the intervention. Circumferential measurements taken at three anatomical landmarks showed consistent improvement. At 5 cm proximal to the styloid process, the wrist circumference decreased from 20 cm in sessions T1 to T2, to 18.5 cm by sessions T4 and T5. At the level of the styloid process itself, the measurement remained at 18 cm from T1 to T3 before reducing to 17.5 cm in T4 and T5. Similarly, 5 cm distal to the styloid process, the circumference decreased from 23 cm at T1 to 21 cm by T5.These findings indicate a progressive reduction in soft tissue swelling following the applied physiotherapy interventions.

Muscle spasm severity was assessed through manual palpation, focusing on the flexor carpi radialis and flexor carpi ulnaris muscles. The changes in muscle tone across the five therapy sessions are detailed in Table 4, indicating the impact of intervention on muscle relaxation.

Table 4. Evaluation of Muscle Spasm

Session	Muscle	Result
T1	Flexor carpi radialis	Moderate spasm
	Flexor carpi ulnaris	Moderate spasm
T2	Flexor carpi radialis	Moderate spasm
	Flexor carpi ulnaris	Moderate spasm
T3	Flexor carpi radialis	Moderate spasm
	Flexor carpi ulnaris	Moderate spasm
T4	Flexor carpi radialis	Mild spasm
	Flexor carpi ulnaris	Mild spasm
T5	Flexor carpi radialis	Mild spasm
	Flexor carpi ulnaris	Mild spasm

Table 4 demonstrates a reduction in muscle spasm, with both *flexor carpi radialis* and *flexor carpi ulnaris* decreasing from moderate (T1–T3) to mild (T4–T5), as assessed through manual palpation. Joint mobility was measured using a goniometer to track changes in the range of motion (ROM) of the wrist. The degrees of motion for palmar–dorsal flexion/extension, radial–ulnar deviation, and supination–pronation were recorded before and after each session. Table 5 presents the progression of ROM throughout the rehabilitation period.

Table 5. Range of Motion Evaluation (in degrees)

Movement	T1	T2	T3	T4	T5
Palmar–Dorsal	25°–0°–10°	25°–0°–10°	30°–0°–10°	35°–0°–15°	35°–0°–20°
Radial–Ulnar Deviation	10°–0°–15°	10°–0°–20°	15°–0°–20°	20°–0°–25°	25°–0°–30°
Supination–Pronation	15°–0°–60°	15°–0°–60°	15°–0°–65°	20°–0°–70°	20°–0°–75°

As shown in Table 5, all measured joint motions demonstrated notable improvement throughout the intervention period. Palmar flexion increased from 10° to 20°, while dorsal extension improved from 25° to 35°. Radial deviation progressed from 10° to 25°, and ulnar deviation from 15° to 30°. Supination showed an increase from 15° to 20°, and pronation improved from 60° to 75°. These gains reflect enhanced mobility of the wrist joint, indicating the effectiveness of the exercise-based physiotherapy program in restoring range of motion.

Muscle strength was evaluated using the Manual Muscle Testing (MMT) grading system. This assessment covered key wrist movements, including palmar and dorsal flexion, radial and ulnar deviation, as well as pronation and supination. The incremental improvements in strength scores are displayed in Table 6.

Table 6. Muscle Strength Evaluation (MMT Scores)

Movement	T1	T2	T3	T4	T5
Palmar flexion	3	3	3	4	4

Dorsal extension	3	3	3	4	4
Radial deviation	3	3	3	4	4
Ulnar deviation	3	3	4	4	4
Supinator	3	3	3	4	4
Pronator	3	3	4	4	5

According to Table 6, all muscle groups demonstrated improved strength by the final session. Pronator muscles improved from grade 3 to 5, while other groups (palmar, dorsal, radial/ulnar deviation, and supinator) increased from grade 3 to 4.

The patient's ability to perform daily functional tasks was measured using the Wrist Hand Disability Index (WHDI), which assesses pain, strength, sensation, motor function, and overall task performance. Table 7 summarizes the improvement in functional capacity based on WHDI scores recorded over the five sessions.

Table 7. Functional Activity Evaluation (WHDI Scores)

Activity	Normal	T1	T2	T3	T4	T5
Pain intensity	0	3	3	3	3	2
Numbness and tingling	0	1	0	0	0	0
Self-care	0	4	4	4	3	3
Strength	0	3	3	3	2	2
Writing and typing tolerance	0	5	5	4	3	3
Work	0	3	3	3	2	2
Driving	0	5	5	5	4	3
Sleep	0	1	1	0	0	0
Household tasks	0	4	4	3	3	3
Recreation/Sports	0	3	2	2	2	2
Total Score	–	32	30	27	22	20

Note: T1 = Day 1 of therapy, T2 = Day 2 of therapy, T3 = Day 3 of therapy, T4 = Day 4 of therapy, T5 = Day 5 of therapy.

Table 7 displays progressive improvement in functional activity based on the WHDI. The total score decreased from 32 (indicating severe impairment) to 20 (moderate impairment). Improvements were noted in pain, strength, activity tolerance, and sleep quality.

Throughout the five therapy sessions, the patient demonstrated high adherence, attending all scheduled appointments and consistently following home exercise instructions. No adverse effects were observed during or after treatment, including to the skin, nerves, or muscles. Upon completion of the fifth session, the patient was advised to continue home-based exercises and scheduled for a follow-up evaluation after one week to monitor long-term progress.

DISCUSSION

Physiotherapy Management Using Infrared Therapy for Joint Stiffness of the Wrist Following Immobilization of a Distal One-Third Radius Fracture

The following graph (Figure 1) illustrates the effects of infrared (IR) therapy in combination with progressive exercise therapy on reducing pain intensity, edema, and muscle spasm over the course of five physiotherapy sessions. This visual representation highlights the gradual clinical improvement observed through quantitative assessments during the intervention period.

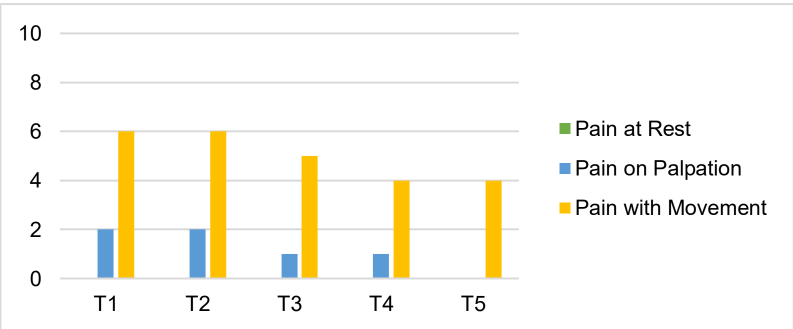

Figure 1. Evaluation of Pain Intensity Reduction

Based on Figure 1, pain was assessed using the Visual Analogue Scale (VAS). Infrared therapy led to a decrease in tenderness from 2 to 0, and in movement-induced pain from 6 to 4. The graph presented **in** Figure 2 illustrates the reduction in wrist edema across five physiotherapy sessions. Edema was measured at three anatomical landmarks—5 cm proximal to the styloid process, at the styloid process, and 5 cm distal to the styloid process—demonstrating a consistent decrease in circumference, indicating reduced inflammation and swelling following infrared therapy and progressive exercises.

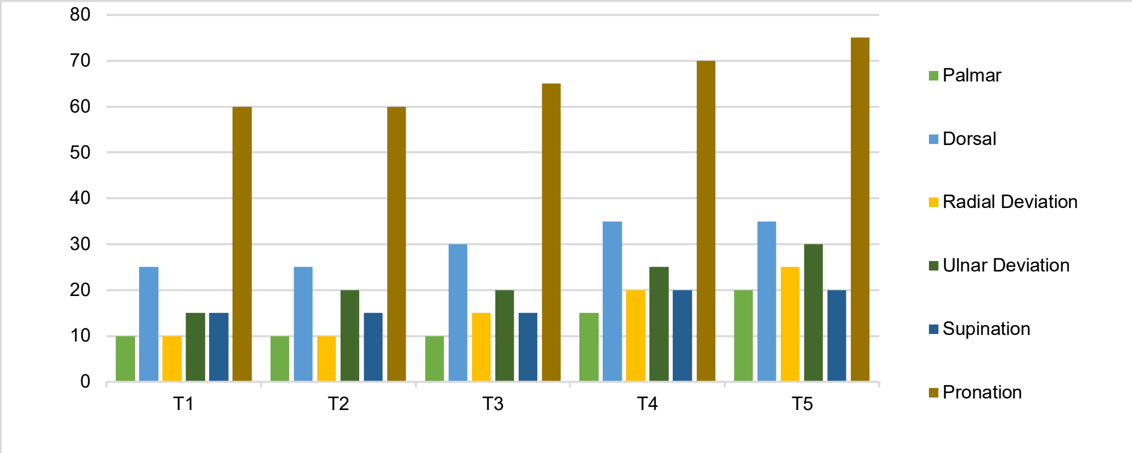

Figure 2. Evaluation of Edema Reduction

Figure 2 shows edema measurement results using midline assessment. The application of IR therapy yielded a progressive decrease in wrist edema. At 5 cm proximal to the styloid process, girth reduced from 20 cm (T1-T2) to 18.5 cm (T4-T5). At the styloid process, girth decreased from 18 cm (T1-T3) to 17.5 cm (T4-T5). At 5 cm distal to the styloid, girth reduced from 23 cm to 21 cm.

According to Table 3, muscle spasm evaluated by manual palpation decreased in both flexor carpi radialis and flexor carpi ulnaris from moderate to mild after three IR sessions, indicating a positive thermal response. This improvement is attributable to the superficial thermal effects of infrared therapy. IR stimulates superficial heat receptors, which modulate sensory nerve transmission, thereby reducing pain perception.[9]

The present findings are consistent with those reported by Pramudita Pratiwi et al., who demonstrated that combined physiotherapy interventions post-radius-ulna fracture resulted in reduced pain and improved hand function.10 IR's sedative effect promotes vasodilation, enhances blood flow and metabolism, and improves oxygen and nutrient delivery to tissues, collectively reducing pain, edema, and muscle spasm.[10]

Physiotherapy Management Using Therapeutic Exercises for Joint Stiffness of the Wrist Following Immobilization of a Distal One-Third Radius Fracture

Figure 3 presents the progressive improvement in wrist joint range of motion (ROM) over the course of the physiotherapy sessions. Measurements include palmar flexion, dorsal extension, radial and ulnar deviation, as well as forearm supination and pronation. These increases in ROM reflect enhanced joint mobility and functional recovery following infrared therapy and structured exercise progression.

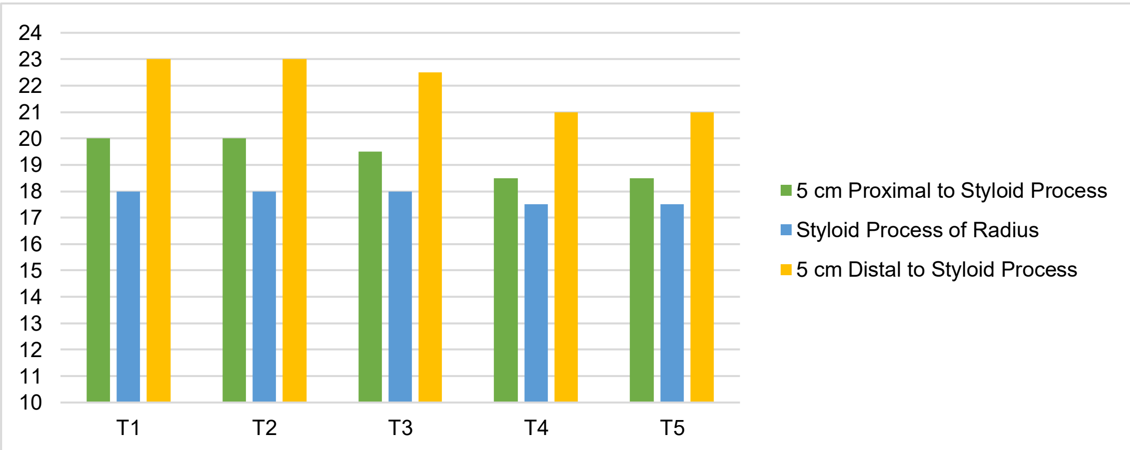

Figure 3. Evaluation of Joint Range of Motion

Based on Figure 3, goniometric evaluation revealed significant ROM improvements. Palmar–dorsal motion increased from 25°–0°–10° (T1) to 35°–0°–20° (T5). Radial–ulnar deviation improved from 10°–0°–15° to 25°–0°–30°. Supination–pronation increased from 15°–0°–60° to 20°–0°–75°.

Increased joint mobility is associated with reduced pain and muscle spasm, which facilitates greater joint movement. The exercises used—passive, active, and hold-relax—help reduce post-immobilization adhesions.[11] These interventions aim to maintain muscle elasticity, prevent contracture, and reduce joint inflammation, thereby supporting ROM restoration.[12] Firmansyah also reported the efficacy of similar exercise protocols post-femur fracture in restoring shortened joint structures.[13] Active movement enhances ROM through proprioceptive input and improved blood circulation, which supports tissue repair and prevents adhesion.

The following graph presents muscle strength improvements following resisted active exercise. Figure 4 illustrates the progression of wrist muscle strength evaluated using Manual Muscle Testing (MMT) throughout the intervention period. The improvement in muscle strength scores indicates the positive impact of the combined infrared therapy and exercise regimen in enhancing the functional capacity of the wrist muscles.

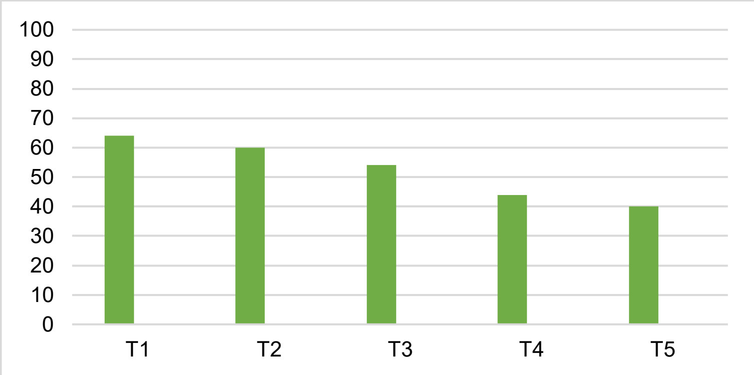

Figure 4. Evaluation of Muscle Strength Using Manual Muscle Testing (MMT)

Figure 4 illustrates improved muscle strength in all muscle groups around the right wrist. Palmar and dorsal strength increased from grade 3 to 4, and pronator strength improved from grade 3 to 5. Resisted exercises were administered progressively, tailored to the patient's condition. Strength gains were likely due to increased muscle relaxation and circulation, which reduced pain and enhanced muscle elasticity.[11]

Tresnasari et al. found similar outcomes in patients undergoing resisted exercises post-radius-ulna fracture, with significant muscle strength improvements after six sessions.[14] This supports the theory of physiological adaptation to progressive resistance training.

The following graph depicts improvements in functional activities following a combination of infrared therapy and exercise. Figure 5 presents the changes in functional ability assessed using the Wrist Hand Disability Index (WHDI). The graph demonstrates a consistent improvement in the patient's ability to perform daily activities, reflecting the effectiveness of the intervention program in restoring wrist and hand function.

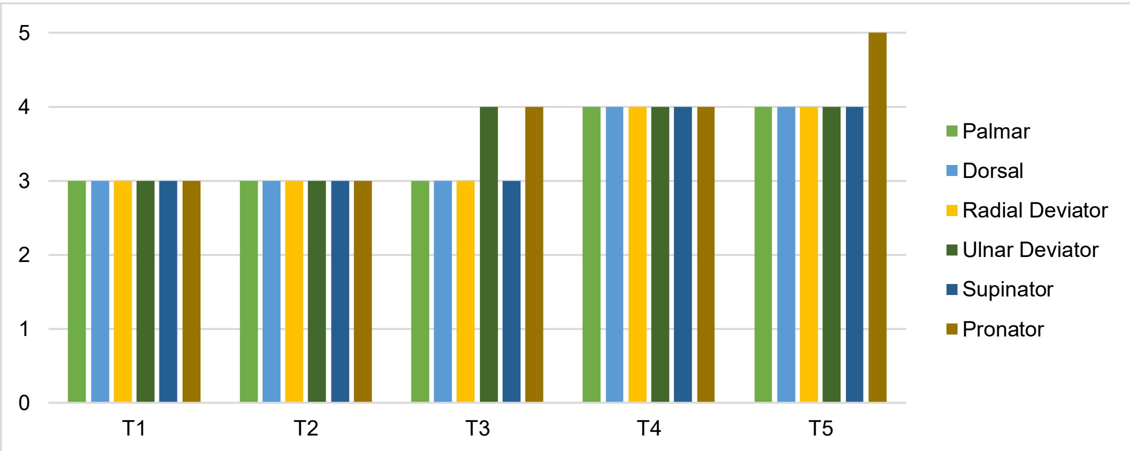

Figure 5. Evaluation of Functional Ability Using WHDI

WHDI scores improved progressively: 64% (T1), 60% (T2), 54% (T3), 44% (T4), and 40% (T5), indicating a shift from severe to moderate disability. Functional limitations were primarily due to pain, restricted ROM, and reduced muscle strength. Therefore, reductions in pain and spasm, combined with increased ROM and strength, contributed to improved functional ability.[15]

Aqila also reported significant functional improvements following IR and therapeutic exercise interventions in post-distal radius fracture patients.[16] The combined biological effects of IR and exercise enhanced blood flow, reduced inflammation, and promoted muscle activity, supporting recovery. The strength of this case lies in its multimodal approach, combining IR and therapeutic exercises, which effectively reduced pain, edema, and spasm, while improving ROM, strength, and hand function.

However, limitations include a short intervention period (5 sessions) and the absence of a control group or long-term follow-up, limiting generalizability and long-term conclusions. This case report suggests that combining infrared therapy with progressive therapeutic exercise (active, passive, resisted, and hold-relax) is effective for post-immobilization distal radius fracture rehabilitation. It may serve as a practical protocol in primary care settings with limited resources.

Conclusion

Based on the evaluation results following five physiotherapy sessions involving infrared therapy and structured exercise interventions (active, passive, resisted active exercises, and hold-relax techniques) administered to a 65-year-old female patient diagnosed with wrist joint stiffness post-cast immobilization for a distal one-third radius fracture, significant clinical improvements were observed. These included reductions in pain, edema, and muscle spasm, along with increased joint range of motion, enhanced muscle strength, and improved functional ability of the affected hand. It can be concluded that physiotherapy modalities incorporating infrared and progressive therapeutic exercises are effective in addressing impairments associated with post-immobilization distal one-third radius fractures.

Author Contribution

Halimatu Sya'dia: conceptualization, study design, patient management, data collection, manuscript drafting.
Didik Purnomo: supervision, methodology, manuscript review and editing, interpretation of results.
All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

Acknowledgments

The authors would like to express their gratitude to the patient for their participation and cooperation in this study. We also thank the staff of the Physiotherapy Program, Widya Husada University, for their support during data collection and therapy sessions.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest related to this study.

Funding Sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics Statement

Ethical approval was not required for this case report as all interventions were part of routine clinical care. Written informed consent was obtained from the patient for participation and publication of anonymized data and images. Patient confidentiality and anonymity were strictly maintained throughout the study.

References

1. Mustaqim MH, Rizal F. Pengetahuan perawat tentang fase penyembuhan fraktur setelah open reduction internal fixation (ORIF) di ruang Raudhah 6 dan 7 RSUD Dr. Zainoel Abidin Banda Aceh. J Sains Riset. 2021;11(2):374–85.
2. Burhani T, Naqvi WM. Impact of immersive virtual reality-based rehabilitation on functional independence and health-related quality of life after distal radius fracture: study protocol for a single-blinded randomized controlled trial. J Crit Rev. 2020;7(9):559–63. doi:10.31838/jcr.07.09.111
3. Seigerman D, Lutsky K, Fletcher D, Katt B, Kwok M, Mazur D, et al. Complications in the management of distal radius fractures: how do we avoid them? Curr Rev Musculoskelet Med. 2019;12(3):204–12. doi:10.1007/s12178-019-09544-8
4. Kementerian Kesehatan Republik Indonesia. Laporan Riskesdas 2018 Nasional. Jakarta: Kementerian Kesehatan RI; 2018.
5. Nugraha DA, Rahmawati RA, Jannah M. Efektivitas ultrasound therapy dan active passive exercise pada pasien post-fracture elbow dalam mengurangi nyeri dan menambah lingkup gerak sendi. Physiother Health Sci. 2021;3(1):22–5.
6. Prodyanatasari A. Optimalisasi energi gelombang elektromagnetik melalui terapi infrared pada penderita penyakit paru obstruktif kronik. J Wiyata. 2015;2(1):59–66.
7. Napitu MP, Nahak ME, Muliati, Sitanggang TCR. Penatalaksanaan fisioterapi pada kasus fraktur 1/3 distal os radius dextra pasca immobilisasi gips dengan modalitas IR dan terapi latihan. Res Learn Prim Educ. 2022;2(1):802–9.
8. Zulfikar A. Penatalaksanaan fisioterapi pada carpal tunnel syndrome sinistra dengan modalitas ultrasound dan terapi latihan [Skripsi]. Semarang: Universitas Widya Husada; 2021.
9. Soemarjono A. Terapi pemanasan infrared (IR) dan Transcutaneous Electrical Nerve Stimulation (TENS). Jakarta: Flexfree Musculoskeletal Rehabilitasi Klinik; 2015.
10. Pramudita Pratiwi D, Pristianto A, Murwanto Y. Program fisioterapi pada kondisi pasca operasi fraktur radius ulna: case report. J Physiotherapy. 2023;2(4):216–23.
11. Kisner CLAC. Terapi latihan dasar dan teknik. Jakarta: Buku Kedokteran EGC; 2017.
12. Wahyono Y, Utomo B. Efek pemberian latihan hold-relax dan penguluran pasif otot kuadrisep terhadap peningkatan lingkup gerak fleksi sendi lutut dan penurunan nyeri pada pasien pasca ORIF fraktur femur 1/3 bawah dan tibia 1/3 atas. J Ilmu Kesehatan. 2016;5(1):52–7.
13. Firmansyah. Pemberian terapi latihan pada kasus pasca ORIF fraktur femur 1/3 distal sinistra di RSUD Kota Semarang. Res Service Admin Health Sci. 2020;1(1):25–32.
14. Tresnasari C, Basuki A, Defi IR. Efektivitas latihan penguatan terhadap kemampuan fungsional anggota gerak atas pada pasien stroke iskemik fase subakut. Glob Med Health Commun. 2017;5(3):182.
15. Zuhri S, Miharjanto H, Bambang D, Kementerian T, Politeknik K, Surakarta K, et al. Latihan neural stretching dan penurunan nyeri penderita carpal tunnel syndrome. J Terpadu Ilmu Kesehatan. 2016;1:61–6.
16. Aqila M, Supriyadi A. Manajemen fisioterapi terkait gangguan fungsional tangan pada pasien post-fraktur 1/3 distal radius dextra. J Innov Res Knowl. 2022;2(7):2797–804. doi:10.53625/jirk.v2i7.4218