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Physiotherapy in Acute Postoperative Fifth Toe Amputation with VAC: A Case Report

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Abstract

Background: Fifth toe amputation following severe trauma often results in open wounds requiring surgical management, including debridement and Vacuum-Assisted Closure (VAC). In the acute postoperative phase, patients are at risk of pain, edema, and functional limitations, highlighting the need for early physiotherapy intervention.

Objective: This study aimed to evaluate the safety and early clinical effects of physiotherapy in a patient undergoing fifth toe amputation with VAC during the acute postoperative phase.

Methods: A case report was conducted on a 39-year-old male with a left foot crush injury who underwent debridement, fifth toe amputation, and VAC placement. Physiotherapy was administered over three consecutive sessions (postoperative days 1–3), representing the acute postoperative phase, including passive and active-assisted range of motion exercises, isometric contractions, ankle pump, breathing exercises, and limb elevation. Outcomes included pain (Numeric Rating Scale), range of motion (goniometry), muscle strength (Manual Muscle Testing), and edema (limb circumference).

Results: Pain remained stable (rest: 3/10; movement: 7/10; palpation: 8/10). Ankle range of motion improved from 5°–0°–15° to 10°–0°–20°. Proximal muscle strength remained stable (MMT 3+ to 4−). Edema decreased from a 2 cm to 1.5 cm difference (−25%). No adverse events were observed.

Conclusion: Early physiotherapy following fifth toe amputation with VAC appears safe and may support maintenance of function, limited mobility improvement, and edema reduction without increasing pain. Further studies are needed to confirm these findings.

Keywords
Amputation; Negative Pressure Wound Therapy; Physical Therapy Modalities; Postoperative Care

Introduction

Traumatic injuries remain a major cause of morbidity worldwide, particularly in occupational settings where high-energy mechanical forces can lead to severe musculoskeletal and vascular damage.[1,2] Such injuries frequently result in compromised tissue perfusion, soft tissue destruction, and inflammatory responses that may progress to irreversible tissue necrosis.[3] In advanced cases where vascular compromise, infection, or extensive tissue loss cannot be managed conservatively, amputation becomes a necessary life-saving intervention.[4]

Lower limb amputation, including toe amputation, is associated with substantial functional and physiological consequences. Patients often experience pain, edema, reduced joint mobility, muscle weakness, and impaired functional capacity, particularly in the early postoperative phase.[5] These impairments not only delay recovery but also increase the risk of secondary complications such as joint contractures, muscle atrophy, and decreased independence. Evidence suggests that early rehabilitation plays a critical role in mitigating these complications by maintaining joint mobility, preserving muscle function, and improving overall functional outcomes.[6]

In addition to surgical management, postoperative wound care is a crucial component in amputation cases, especially when open wounds are present. Negative pressure wound therapy, commonly implemented as Vacuum-Assisted Closure (VAC), has been widely used to enhance wound healing through improved perfusion, edema reduction, and stimulation of granulation tissue formation.[7] The integration of VAC into postoperative care introduces additional clinical considerations, particularly regarding safe mobilization and rehabilitation strategies during the acute phase.[8]

Early mobilization and physiotherapy interventions have been shown to improve recovery outcomes across various postoperative conditions.[9] In amputation populations, early mobilization within the first few days after surgery has been associated with reduced wound complications and improved recovery trajectories.[10] Furthermore, early rehabilitation interventions, including range of motion exercises, isometric strengthening, and circulatory exercises, have demonstrated benefits in preserving physical function, preventing immobilization-related complications, and enhancing patient independence.[11] However, limited evidence specifically addresses the integration of physiotherapy interventions during the acute phase in patients undergoing negative pressure wound therapy such as VAC.

Despite these findings, the current body of evidence remains limited regarding the implementation of early physiotherapy interventions in patients undergoing acute post-amputation management with concurrent VAC application.[12] Existing studies tend to focus either on wound management using VAC or on long-term rehabilitation outcomes following amputation, with minimal attention to the integration of physiotherapy during the immediate postoperative phase.[13] A recent review also highlights that evidence on early rehabilitation following amputation remains limited and heterogeneous, particularly in relation to timing, intervention protocols, and clinical outcomes.[14]

This gap in the literature underscores the need for clinically detailed reports that describe early physiotherapy management in the context of VAC use during the acute postoperative phase. Such evidence is essential to guide safe and effective rehabilitation strategies, particularly in complex cases involving open wounds and mechanical wound therapy systems.

Therefore, this study aims to evaluate the safety and early clinical effects of physiotherapy intervention in a patient undergoing fifth toe amputation with VAC during the acute postoperative phase, with a specific focus on pain, joint mobility, muscle strength, and edema.

Methods

This study employed a single-patient case report design developed in accordance with the CARE (CAse REport) guidelines to ensure completeness, transparency, and clinical relevance in reporting. The study was conducted in an inpatient orthopedic rehabilitation setting at an orthopedic referral hospital in Surakarta, Indonesia.

The participant was a 39-year-old male admitted following a workplace accident involving a wood-cutting machine, resulting in a crush injury to the left foot. The patient underwent emergency surgical management consisting of cito debridement and fifth toe amputation, followed by the application of Vacuum-Assisted Closure (VAC) for wound management. The patient was hospitalized and received physiotherapy intervention during the acute postoperative phase (days 1–3). Diagnostic reasoning was primarily based on clinical examination and surgical findings confirming a crush injury with extensive soft tissue damage and non-viable tissue requiring amputation. Differential diagnoses such as isolated soft tissue laceration or vascular compromise without tissue necrosis were considered less likely due to the presence of irreversible tissue damage and the need for surgical debridement. Therefore, the final diagnosis of fifth toe amputation following crush injury was established based on clinical and intraoperative assessment. Information regarding occupational background was available; however, detailed social history, lifestyle factors, and behavioral risk factors were not comprehensively documented, which may limit contextual interpretation of recovery.

At initial physiotherapy assessment, the patient presented with a postoperative wound covered by VAC dressing, limiting distal joint mobility. Active ankle movement was restricted due to dressing and wound protection, while digits I–IV demonstrated limited but preserved motion. Palpation revealed local warmth around the wound area, consistent with the inflammatory phase of healing. Vital signs were stable, including blood pressure (110/75 mmHg), heart rate (75 bpm), respiratory rate (22 breaths/min), body temperature (36.8°C), and oxygen saturation (98%).

Pain was assessed using the Numeric Rating Scale (NRS), a valid and reliable tool for evaluating subjective pain intensity in clinical settings. Changes in pain intensity were interpreted with reference to clinically meaningful differences reported in previous studies, where a change of 1–2 points on the NRS is generally considered clinically relevant in musculoskeletal conditions. Range of motion (ROM) was measured using a standard universal goniometer, which has demonstrated good inter-rater reliability for lower extremity joint assessment. Muscle strength was evaluated using Manual Muscle Testing (MMT), a widely accepted clinical method with established validity for grading voluntary muscle contraction. Edema was assessed באמצעות circumferential measurement at a standardized point (5 cm proximal to the malleolus), a method commonly used to monitor limb swelling in clinical practice.

To clarify the clinical progression and intervention timeline, the case can be summarized as follows: the patient sustained a traumatic injury and underwent emergency surgery (day 0), followed by initiation of physiotherapy on postoperative day 1, with continued intervention and monitoring until day 3. Outcome measures were recorded at each session (T1–T3) to evaluate short-term clinical changes.

Physiotherapy intervention was administered once daily over three consecutive days, with each session lasting approximately 30–45 minutes. The intervention protocol was designed to align with the physiological constraints of the acute inflammatory phase while ensuring protection of the surgical site and VAC system. Exercises included passive and active-assisted range of motion targeting the hip and knee joints, as well as limited ankle mobilization within a safe range to avoid mechanical stress on the wound area.

Isometric strengthening exercises were prescribed for major lower limb muscle groups, including the quadriceps, hamstrings, gluteal muscles, and hip stabilizers. Each contraction was held for 5–10 seconds and repeated 8–10 times per session, adjusted according to patient tolerance. These exercises were selected to maintain neuromuscular activation and prevent disuse atrophy without inducing joint movement that could compromise wound integrity.

Circulatory exercises, including ankle pump movements within a protected range and deep breathing exercises, were incorporated to enhance venous return and reduce the risk of edema and thrombotic complications. Limb elevation was also applied as an adjunctive strategy to facilitate fluid drainage and improve peripheral circulation. All interventions were performed under close supervision, with continuous monitoring of pain response and wound condition to ensure safety and tolerance.

The selection of interventions was based on established rehabilitation principles for postoperative and immobilized patients, where early controlled mobilization and muscle activation are recommended to prevent complications such as joint stiffness, muscle atrophy, and impaired circulation.

Outcome measurements were recorded at three time points (T1–T3) corresponding to each intervention session. The primary outcomes included pain intensity (NRS), joint ROM (goniometry), muscle strength (MMT), and limb circumference difference as an indicator of edema. No advanced statistical analysis was performed due to the single-case design; instead, data were analyzed descriptively to identify trends and clinically meaningful changes over time. No adverse events or complications related to the physiotherapy intervention were observed or reported during the study period. Patient perspective was not formally recorded during the intervention period. However, the patient reported that the exercises were tolerable and did not increase pain during the acute postoperative phase.

This was actively monitored throughout each session as part of patient safety evaluation. Written informed consent was obtained from the patient prior to inclusion in this report, including consent for the use of anonymized clinical data and images for publication purposes. All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Formal ethical approval was not required for this study as it represents a single-patient case report with no experimental intervention beyond standard clinical care. Patient confidentiality was strictly maintained, and all identifying information has been removed to ensure anonymity.

Results

Physiotherapy intervention was administered over three consecutive sessions during the acute postoperative phase (T1–T3; postoperative days 1–3). The outcomes were evaluated to determine the safety and early clinical effects of the intervention on pain, joint mobility, muscle strength, and edema. No adverse events were observed throughout the intervention period, indicating that

all procedures were well tolerated within the limits of the patient's clinical condition. To provide a clearer overview of the sequence of clinical events and physiotherapy interventions during the acute postoperative phase, a structured timeline is presented in Table 1.

Table 1. Clinical Timeline of Events and Interventions

Day	Time Point	Clinical Events and Interventions
Day 0	–	Traumatic injury followed by emergency debridement, fifth toe amputation, and VAC placement
Day 1	T1	Initial physiotherapy assessment and first intervention session
Day 2	T2	Second intervention session and reassessment
Day 3	T3	Third intervention session and final evaluation

Pain intensity was assessed using the Numeric Rating Scale (NRS) at each session. As presented in Table 2, pain levels remained unchanged throughout the intervention period. In addition to the procedural timeline, outcome measurements were recorded at each time point (T1–T3), allowing observation of short-term clinical progression in pain, mobility, muscle strength, and edema.

Table 2. Pain Intensity (Numeric Rating Scale)

Pain Type	T1	T2	T3
Rest Pain	3	3	3
Movement Pain	7	7	7
Palpation Pain	8	8	8

These findings indicate clinical stability, with no increase in pain intensity during physiotherapy sessions.
Joint range of motion (ROM) was evaluated using goniometry, focusing on the hip, knee, and ankle joints. The results are presented in Table 3.

Table 3. Range of Motion (Degrees)

Joint	Movement	T1	T2	T3
Hip	Flexion	110°	110°	115°
	Extension	10°	10°	15°
	Abduction	30°	30°	35°
	Adduction	20°	20°	20°
	Internal Rotation	25°	25°	25°
	External Rotation	20°	20°	20°
Knee	Flexion	130°	130°	130°
	Extension	0°	0°	0°
Ankle	Plantarflexion	15°	18°	20°
	Dorsiflexion	5°	7°	10°

Hip and knee ROM remained within functional limits across all sessions, while ankle ROM demonstrated a gradual improvement in both plantarflexion and dorsiflexion. Full ankle ROM assessment was not performed due to VAC placement and wound protection considerations. Muscle strength was assessed using Manual Muscle Testing (MMT). The results are summarized in Table 4.

Table 4. Muscle Strength (MMT Grades)

Joint	Movement	T1	T2	T3
Hip	Flexion	4−	4−	4−
	Extension	4−	4−	4−
	Abduction	3+	3+	3+
	Adduction	3+	3+	3+
	Internal Rotation	3+	3+	3+
	External Rotation	3+	3+	3+
Knee	Flexion	3+	3+	3+
	Extension	3+	3+	3+
Ankle	All movements	NT	NT	NT

NT: Not tested due to VAC placement and risk of wound stress

Muscle strength remained stable throughout the intervention period, with no evidence of decline in proximal muscle groups. Edema was assessed באמצעות circumferential measurement at 5 cm proximal to the malleolus. The results are presented in Table 5.

Table 5. Limb Circumference Measurement

Measurement Site	Side	T1	T2	T3
5 cm above malleolus	Right	22.5 cm	22.5 cm	22.5 cm
	Left	24.5 cm	24.5 cm	24.0 cm
Difference		2.0 cm	2.0 cm	1.5 cm

A reduction in inter-limb difference from 2.0 cm to 1.5 cm was observed, indicating a decrease in edema over the intervention period. Overall, the results demonstrate that physiotherapy intervention during the acute postoperative phase was associated with stable pain levels, maintenance of proximal joint mobility and muscle strength, and a modest reduction in edema, without the occurrence of adverse events. To further illustrate the trend of clinical outcomes across the intervention period, a graphical representation of pain, ankle ROM, and edema changes is recommended. To enhance the clarity of outcome trends over time, graphical representations of pain intensity, ankle range of motion, and edema changes are presented in Figures 1–3.

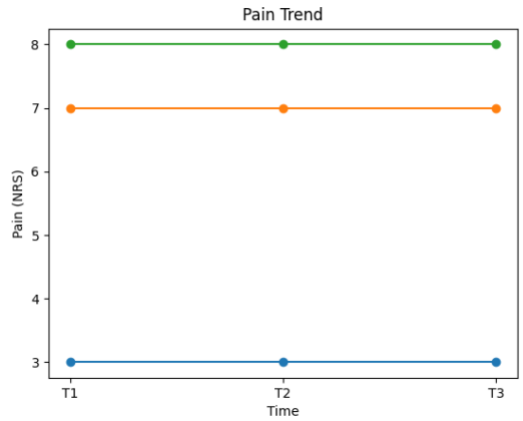

Figure 1. Pain trend across intervention sessions (T1–T3)

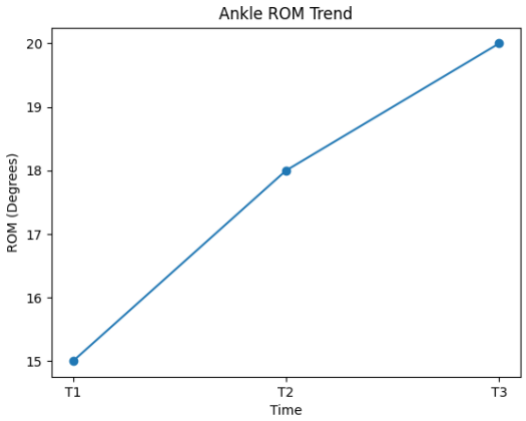

Figure 2. Ankle range of motion trend across intervention sessions (T1–T3)

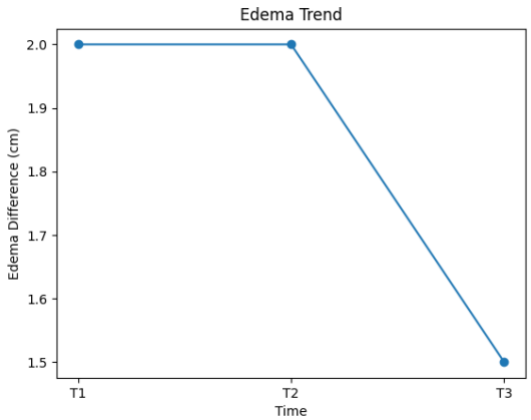

Figure 3. Edema reduction trend across intervention sessions (T1–T3)

Discussion

This case report evaluated the safety and early clinical effects of physiotherapy intervention during the acute postoperative phase following fifth toe amputation with Vacuum-Assisted Closure (VAC). The findings indicate that physiotherapy can be implemented safely without exacerbating pain or inflammatory responses, while contributing to the maintenance of joint mobility, preservation of muscle strength, and reduction of edema.[15] These results are particularly relevant given the limited evidence regarding early rehabilitation in patients with concurrent VAC application.

Although no statistical analysis was performed due to the single-case design, the observed changes may be interpreted in terms of clinical significance. The maintenance of pain levels without exacerbation and the gradual improvement in ankle mobility suggest a clinically acceptable response during the acute phase, where stabilization rather than rapid functional gain is the primary therapeutic goal.

Pain stability observed across the intervention period represents an important clinical finding. In the acute inflammatory phase following surgery, nociceptive activity is typically elevated due to the release of inflammatory mediators such as prostaglandins and bradykinin, which sensitize peripheral nociceptors and sustain pain perception.[16,17] The absence of increased pain intensity during physiotherapy suggests that the applied interventions were within the physiological tolerance of the healing tissue and did not induce additional mechanical stress. This aligns with previous evidence indicating that appropriately dosed early mobilization does

not exacerbate postoperative pain and may support recovery when carefully monitored.[18] From a clinical perspective, maintaining stable pain levels in the acute phase can be interpreted as an indicator of intervention safety rather than immediate analgesic efficacy.

The gradual improvement in ankle range of motion, despite the presence of VAC and wound protection constraints, highlights the importance of controlled mobilization in preventing joint stiffness. Immobilization following surgery is known to contribute to periarticular fibrosis, reduced synovial fluid circulation, and eventual loss of joint mobility.[19] The observed increase in plantarflexion and dorsiflexion suggests that even limited, protected movement can preserve tissue extensibility and joint function. This finding is consistent with prior studies demonstrating that early, low-intensity mobilization supports joint health and reduces the risk of contracture formation in postoperative patients.[20] Importantly, the intervention protocol in this case avoided excessive loading or full-range movements, which may have minimized the risk of disrupting the wound environment while still providing functional benefits.[21]

Muscle strength remained stable throughout the intervention period, which is a clinically meaningful outcome in the context of acute postoperative care. Muscle inhibition and rapid strength decline are common following surgery due to pain, inflammation, and reduced activity levels.[22] The use of isometric exercises in this case likely contributed to the preservation of neuromuscular activation without requiring joint movement that could compromise wound healing. Isometric contractions are known to maintain motor unit recruitment and prevent early-stage muscle atrophy, particularly when dynamic exercise is contraindicated.[23] Additionally, the activation of proximal muscle groups may have supported overall limb stability and functional readiness during the early rehabilitation phase.

The reduction in edema observed over the three-day intervention period further supports the role of physiotherapy in enhancing peripheral circulation. Edema formation in the postoperative phase is primarily driven by increased vascular permeability and impaired venous and lymphatic return.[24] Interventions such as limb elevation, ankle pump exercises, and muscle activation contribute to improved venous return through the muscle pump mechanism, thereby facilitating fluid redistribution.[25] Although the magnitude of edema reduction in this case was modest, the trend toward improvement within a short timeframe suggests that early physiotherapy may contribute to optimizing local circulatory dynamics without interfering with wound management using VAC.[26]

A notable aspect of this case is the integration of physiotherapy with VAC during the acute postoperative phase, which remains underreported in the literature. Most existing studies focus either on the effectiveness of VAC in wound healing or on rehabilitation outcomes at later stages following amputation.[27] The present case provides preliminary evidence that early physiotherapy can be safely implemented alongside VAC, provided that interventions are carefully adapted to avoid mechanical disruption of the wound site.[28] This highlights a potential area for further clinical research, particularly in developing standardized rehabilitation protocols for patients undergoing negative pressure wound therapy.[28]

Despite these findings, several limitations must be acknowledged. First, the single-patient design inherently limits the generalizability of the results. Second, the short duration of intervention (three days) restricts the ability to assess longer-term functional outcomes and recovery trajectories. Third, the absence of follow-up data prevents evaluation of sustained effects beyond the acute phase. Additionally, the lack of advanced quantitative measures or comparative data limits the ability to draw definitive conclusions regarding intervention efficacy.

From a clinical perspective, this case underscores the importance of individualized and carefully monitored physiotherapy in the early postoperative phase following amputation. Interventions should prioritize tissue protection, gradual activation, and prevention of secondary complications, rather than aggressive functional restoration. Future research should focus on larger sample sizes, longer observation periods, and the inclusion of standardized outcome measures to strengthen the evidence base for early physiotherapy in patients with VAC.

Conclusion

This case report demonstrates that physiotherapy intervention during the acute postoperative phase following fifth toe amputation with Vacuum-Assisted Closure (VAC) is safe and feasible when applied with appropriate clinical precautions. The intervention was associated with stable pain levels, preservation of proximal joint mobility and muscle strength, and a modest reduction in edema over a short observation period. These findings suggest that early physiotherapy may play a supportive role in maintaining functional capacity and preventing complications during the initial phase of recovery without compromising wound healing.

Clinically, this underscores the importance of integrating carefully monitored rehabilitation strategies into acute postoperative care, particularly in patients undergoing negative pressure wound therapy. However, given the inherent limitations of a single-case design and short intervention duration, further research involving larger sample sizes, standardized protocols, and longer follow-up periods is required to establish stronger evidence regarding effectiveness and generalizability.

Author Contribution

Nissa Mahadi Mahdivikia: Conceptualization, data curation, investigation, physiotherapy intervention, formal analysis, visualization, writing-original draft preparation.
Arin Supriyadi: Supervision, methodology, validation, writing-review and editing, project administration.
Danur Setiawan: Clinical supervision, resources, patient management, validation, writing-review and editing.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

Written informed consent was obtained from the patient for the publication of anonymized clinical data. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki. Formal ethical approval was not required for this study as it represents a single-patient case report without experimental intervention.

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