The Role of Physical Therapy in Postoperative Orthopedic Recovery: Scoping Review

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ABSTRACT

Physical therapy plays a pivotal role in the postoperative recovery process for patients undergoing orthopedic surgeries. Following procedures such as joint replacements, fracture repairs, or spinal surgeries, patients often face challenges including pain, limited mobility, and muscle weakness, which can hinder their recovery. Physical therapists employ targeted therapeutic interventions, including manual therapy, exercise regimens, and education, aimed at enhancing range of motion, improving strength, and reducing pain. Through a patient-centered approach, physical therapy not only addresses the physical aspects of recovery but also promotes psychological well-being, facilitating a quicker return to daily activities and improving overall quality of life. Recent research highlights the importance of an individualized physical therapy program tailored to each patient's specific needs and surgical history. Evidence suggests that early mobilization and the incorporation of physical therapy can lead to improved functional outcomes and reduced length of hospital stay. This scoping review aims to synthesize available literature surrounding the efficacy of physical therapy interventions in postoperative orthopedic recovery, exploring diverse methodologies and patient populations.

Keywords: Physical Therapy, Postoperative Recovery, Orthopedic Surgery, Rehabilitation, Evidence-Based Practice, Patient-Centered Care, Functional Outcomes.

INTRODUCTION

Orthopedic surgeries, encompassing procedures ranging from joint arthroplasties and ligament reconstructions to spinal fusions and fracture fixations, represent a cornerstone of modern musculoskeletal medicine. The global volume of these interventions is substantial and continues to rise, driven by an aging population, the increasing prevalence of osteoarthritis, and advancements in surgical techniques that expand eligibility[1]. For instance, in the United States alone, over 1 million total hip and knee arthroplasties are performed annually, with projections suggesting a dramatic increase to nearly 3.5 million procedures per year by 2040[2]. While these surgeries are designed to alleviate pain, restore anatomical function, and improve quality of life, the operative intervention itself is merely the initial step in a complex recovery journey. The postoperative period is critical, often marked by pain, swelling, muscle atrophy, joint stiffness, and functional limitations, which, if not properly managed, can undermine the surgical success and lead to suboptimal outcomes, chronic disability, or even revision surgery[3]. The transition from the operating room to functional independence is fraught with potential challenges that extend beyond the healing of tissues. Surgical trauma induces a cascade of physiological responses, including inflammation and pain, which can lead to voluntary and reflexive inhibition of muscle activation—a phenomenon known as arthrogenic muscle inhibition[4]. This inhibition results in rapid atrophy and strength loss of the muscles surrounding the operated joint; studies indicate that quadriceps strength deficits can exceed 40% within the first month following procedures like anterior cruciate ligament reconstruction or total knee arthroplasty[5]. Concurrently, patients often experience significant decreases in joint range of motion (ROM) and proprioception, impairing balance and increasing fall risk. Furthermore, the psychological impact, including fear of movement (kinesiophobia) and anxiety about re-injury, can create significant barriers to active participation in recovery, forming a vicious cycle of pain, immobility, and functional decline[6]. The financial and systemic implications of ineffective postoperative management are profound. Prolonged disability contributes substantially to indirect costs such as lost productivity and caregiver

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burden, while complications like stiffness, weakness, and chronic pain drive ongoing healthcare utilization[3]. In an era focused on value-based care and bundled payment models, particularly for high-volume procedures like joint replacements, there is intensified pressure to optimize outcomes while controlling costs and reducing hospital readmission rates[7]. Physical therapy in the postoperative orthopedic landscape is a dynamic and multifaceted discipline. Its role is not monolithic but rather adapts to the specific surgical procedure, patient characteristics, and phase of recovery. Core objectives universally include the management of pain and edema, restoration of ROM, recovery of muscular strength and neuromuscular control, facilitation of functional mobility (e.g., gait, stair negotiation), and ultimately, the safe return to desired activities of daily living, work, and recreation[8], [9]. The aim of this review is to map the breadth and nature of the available evidence regarding the role of physical therapy in postoperative orthopedic recovery.

METHODOLOGY

This scoping review was conducted as a narrative review to comprehensively map and synthesize the existing literature on the role of physical therapy in postoperative orthopedic recovery. The methodological framework was guided by established principles for scoping studies, aiming to identify key concepts, evidence types, and gaps in research. A systematic search strategy was employed across major electronic databases, including PubMed, Scopus, and CINAHL, utilizing a combination of keywords and MeSH terms related to orthopedic surgery, postoperative care, rehabilitation, and physical therapy. Following the search, identified records were screened by title and abstract against predefined inclusion and exclusion criteria, focusing on studies published in English that investigated physical therapy interventions for common orthopedic procedures. The full texts of potentially relevant articles were then retrieved and critically appraised. Data concerning study design, population, interventions, and reported outcomes were subsequently charted and analyzed thematically to provide a descriptive overview of the current evidence landscape and to highlight consensus findings and areas requiring further investigation.

Orthopedic Postoperative Recovery: The postoperative period following orthopedic surgery is a distinct and dynamic phase characterized by a non-linear trajectory of healing, functional restoration, and psychological adaptation[10]. Defining this "recovery trajectory" is complex, as it encompasses a multitude of overlapping domains: physiological healing of bone and soft tissues, resolution of the inflammatory response, recovery of sensorimotor function, achievement of functional milestones, and the patient's subjective return to normalcy and quality of life[11]. While surgical success is often measured by radiographic alignment or implant stability, true recovery from the patient's perspective is a multidimensional experience measured in regained independence, pain-free movement, and the ability to resume valued roles and activities[12].

The early postoperative phase (typically days 1 to 2 weeks) is dominated by the acute biological response to surgical trauma. The primary challenges here are effective pain and edema management, prevention of postoperative complications, and initiation of early protected mobilization[13]. Pain during this phase is often significant, mediated by both surgical insult and subsequent inflammatory mediators. Uncontrolled pain is more than a patient comfort issue; it is a primary driver of arthrogenic muscle inhibition (AMI), a reflexive suppression of neural drive to the muscles surrounding the operated joint[4]. This phenomenon, coupled with inevitable disuse, leads to rapid and profound muscle atrophy. For example, research demonstrates that quadriceps cross-sectional area can decrease by 10-20% within the first two weeks after total knee arthroplasty, with associated strength losses often exceeding 50% compared to the contralateral limb[5]. Simultaneously, patients face challenges related to wound healing, risk of venous thromboembolism, and mastering basic functional tasks such as bed mobility, transfers, and ambulation with an assistive device under weight-bearing restrictions[14]. The intermediate or subacute phase (weeks 2 to 12) marks the transition from tissue healing to active rehabilitation. While incisions heal and pain typically diminishes, the clinical focus shifts aggressively toward addressing the impairments established in the early phase. The central challenges become overcoming persistent stiffness, rebuilding lost muscular strength and endurance, and restoring normal movement patterns[15]. Joint stiffness and contracture, if not proactively managed, can become a lasting limitation. Restoring range of motion (ROM) is a critical precursor to effective strengthening, as a joint must move through a sufficient arc to engage muscles fully. However, this period is also when the psychosocial dimensions of recovery become more pronounced. Fear of movement, or kinesiophobia, can peak as patients are encouraged to push boundaries. This fear, often rooted in the desire to avoid pain or protect the surgical repair, can significantly limit engagement in therapeutic exercise and hinder progression[6]. Furthermore, residual swelling and altered proprioception contribute to deficits in balance and neuromuscular control, elevating the risk of falls during this active stage of rehabilitation[16]. Key psychosocial factors that can negatively impact the recovery trajectory include catastrophic thinking about pain, low self-efficacy, depression, and inadequate social support[16]. These factors are not merely concurrent issues; they actively interfere with physiological processes. For instance, high levels of stress and anxiety can heighten pain perception, increase muscle tension, and reduce compliance with rehabilitation protocols, creating a feedback loop that slows functional progress.

Table 1 summarizes the common challenges encountered across the primary domains of postoperative recovery.

Table 1: Common Postoperative Challenges Across Recovery Domains[4-6, 11-16]

Domain	Specific Challenges	Potential Impact on Recovery
Physical & Physiological	Arthrogenic muscle inhibition (AMI) & rapid atrophy; Pain & inflammation; Joint stiffness & contracture; Edema; Impaired proprioception & balance.	Limits strength gains, delays functional milestones, alters gait, increases fall risk.
Functional	Impaired gait mechanics & mobility; Difficulty with stairs, sit-to-stand; Inability to perform activities of daily living (ADLs); Delayed return to work/recreation.	Reduces independence, prolongs disability, diminishes quality of life.
Psychosocial	Kinesiophobia (fear of movement); Pain catastrophizing; Low self-efficacy & motivation; Depression & anxiety; Inadequate social support.	Decreases rehabilitation adherence, amplifies pain perception, prolongs disability.

How Physical Therapy Facilitates Recovery

Physical therapy is not a passive adjunct to healing but an active, scientifically-grounded intervention that directly influences the biological and mechanical processes underlying postoperative recovery[17]. Its efficacy stems from the targeted application of specific stimuli—mechanical, sensory, and educational—designed to modulate physiology, restore function, and optimize the body's innate healing capacity. Moving beyond a simple prescription of "exercise," contemporary PT employs a strategic combination of modalities and techniques, each with distinct mechanisms of action that collectively address the multifaceted challenges outlined in the previous section. At the cellular and tissue level, physical therapy interventions are potent modulators of the inflammatory and healing cascade. Controlled mechanical loading, introduced through early mobilization and therapeutic exercise, is a primary driver of beneficial physiological adaptation[18]. During the inflammatory phase, gentle movement and modalities like cryotherapy or compression can help manage the excess edema that impedes lymphatic drainage and delays healing. By reducing swelling, these interventions decrease tissue pressure and pain, facilitating earlier and more comfortable movement[19]. Furthermore, specific loading through weight-bearing and muscle contraction promotes the mechanotransduction signals necessary for optimal collagen synthesis and alignment during the proliferative and remodeling phases of soft tissue and bone healing. This results in tissue that is not merely healed, but functionally adapted to withstand stress[20].

A cornerstone of postoperative PT is the reversal of arthrogenic muscle inhibition (AMI), a key physiological barrier[4]. AMI is a reflex loop where joint swelling and pain cause an inhibitory signal from the joint capsule to the spinal cord, reducing the alpha motor neuron drive to the surrounding muscles. Physical therapy attacks this problem from multiple angles. Neuromuscular electrical stimulation (NMES) provides an external electrical signal to bypass the inhibition, forcibly recruiting muscle fibers to combat atrophy and maintain neural connection[21]. Concurrently, pain management through modalities, manual therapy, and education reduces the afferent pain signal that fuels the inhibitory reflex. As pain and swelling subside, volitional exercise—beginning with isometric contractions and progressing to dynamic movements—re-establishes central neural drive, effectively "rebooting" the connection between the brain and the dormant muscle[22], [23].

Biomechanical and Functional Mechanisms:

While physiological mechanisms repair the internal environment, PT simultaneously applies biomechanical principles to restore the musculoskeletal system's structural and functional integrity. The restoration of range of motion (ROM) is a primary biomechanical goal. Prolonged immobilization leads to connective tissue shortening and cross-linking, resulting in joint contractures. PT uses a hierarchy of interventions to address this. Manual therapy techniques like joint mobilizations apply graded, passive or accessory glides to the joint surfaces, stretching the capsule and improving arthrokinematics[24]. Static and dynamic stretching provides a sustained tensile load to periarticular tissues, promoting plastic deformation and lengthening. Perhaps most critically, active and active-assisted exercises utilize patient-generated force to regain motion, which has the dual benefit of improving ROM while re-engaging motor control around the joint[15].The systematic rebuilding of muscular strength, power, and endurance follows a well-established principle of progressive overload. PT protocols are designed to sequentially challenge the neuromuscular system to induce hypertrophy and neural adaptations. This progression is detailed in Table 3, which outlines the evolution of exercise prescription from the immediate postoperative phase to late-stage functional integration. Initial isometric exercises stabilize the joint and reactivate muscles without imposing harmful shear forces. The progression to isotonic (concentric/eccentric) exercises, first in open and then in closed kinetic chains, builds dynamic strength and coordination relevant to functional tasks. Finally, incorporating plyometric and sport-specific drills restores the power, rate of force development, and reactive stability required for high-level activities[22]. This structured progression ensures tissues are loaded appropriately for their stage of healing, minimizing re-injury risk.

Table 3: Progression of Therapeutic Exercise for Strength and Function Post-Orthopedic Surgery [4, 11, 15, 21- 24]

Recovery Phase	Primary Exercise Focus	Neuromuscular Mechanisms	Functional Translation
Early (0-2 weeks)	Isometric contractions, NMES, AAROM.	Reverses AMI, maintains neural drive, minimizes atrophy.	Provides joint stability, enables pain-controlled basic mobility.
Intermediate (2-12 weeks)	Isotonic strengthening (Open & Closed Chain), balance/proprioception drills, neuromuscular re-education.	Induces muscle fiber hypertrophy, improves motor unit recruitment & synchronization, enhances proprioceptive feedback.	Restores ability to perform ADLs, climb stairs, and walk with normalized gait.
Late (3+ months)	Eccentric loading, plyometrics, agility drills, sport/work-specific task training.	Improves tendon stiffness, rate of force development, and reactive neuromuscular control.	Enables safe return to running, jumping, cutting, and occupational demands.

Gait retraining and the restoration of functional movement patterns are complex biomechanical undertakings. Surgery, pain, and weakness lead to compensatory movements—such as a Trendelenburg gait post-hip arthroplasty or a stiff-knee gait post-knee surgery—that are inefficient and can cause secondary pain[25]. Physical therapists use visual feedback, verbal cues, and manual facilitation to break these patterns. By strengthening weak prime movers (e.g., gluteus medius) and retraining proper sequencing of muscle activation, PT restores energy-efficient and safe biomechanics. This is closely tied to proprioceptive and balance retraining. Joint injury and surgery damage mechanoreceptors, impairing the body's sense of joint position. Balance exercises, from simple static holds to dynamic challenges on unstable surfaces, stimulate the central nervous system to recalibrate proprioceptive acuity and strengthen stabilizing muscle synergies, fundamentally reducing fall risk[24].

The true power of physical therapy lies in the synergistic integration of these physiological and biomechanical mechanisms. A single intervention, such as a guided squat, is not merely strengthening the quadriceps. It is simultaneously modulating knee joint inflammation through controlled compression and circulation, providing sensory input to overcome AMI, challenging proprioception, restoring functional movement patterning, and building patient confidence—all while managing pain through graded exposure. This multidimensional impact is summarized in Table 4, which maps common PT interventions against their primary and secondary mechanisms of action.

Table 4: Multimodal Mechanisms of Common Physical Therapy Interventions [16, 18, 20- 24]

PT Intervention Category	Primary Physiological/Biomechanical Mechanism	Secondary/Integrated Effects
Manual Therapy (Joint Mobilizations/Soft Tissue Work)	Improves arthrokinematics & tissue extensibility; Modulates pain via neurophysiological effects.	Reduces AMI by decreasing pain/swelling; facilitates more effective active exercise.
Therapeutic Exercise (Progressive)	Applies mechanotransductive stimulus for tissue remodeling; induces muscular hypertrophy & neural adaptation.	Manages edema via muscular pump; enhances proprioception; builds self-efficacy.
Neuromuscular Electrical Stimulation (NMES)	Artificial induction of muscle contraction to bypass cortical & reflexive inhibition (AMI).	Limits atrophy; maintains muscle metabolic health; may enhance cortical mapping.
Balance & Proprioceptive Training	Stimulates central integration of visual, vestibular, & somatosensory input to improve postural control.	Reinforces proper joint kinematics; builds confidence in stability; prevents falls.
Patient Education & Activity Pacing	Cognitive-behavioral approach to modify beliefs and behaviors related to pain and recovery.	Reduces kinesiophobia; improves adherence; empowers self-management.

Evidence-Based Benefits of Physical Therapy Post-Operatively

The integration of physical therapy into postoperative orthopedic care has evolved from a tradition of standard practice to a paradigm firmly rooted in empirical evidence. While the theoretical mechanisms of action provide a physiological rationale, the true measure of PT's value lies in its demonstrable impact on patient outcomes. A robust body of clinical research, including randomized controlled trials (RCTs), systematic reviews, and meta-analyses, consistently substantiates the efficacy of structured rehabilitation in improving functional recovery, reducing disability, and enhancing quality of life following a wide spectrum of orthopedic procedures[25, 26]. The most consistently reported benefit of postoperative PT is the accelerated and superior restoration of functional mobility. Physiotherapist-directed exercise, whether in an outpatient or home setting, produced statistically significant and clinically meaningful improvements in gait speed and functional strength compared to minimal intervention[27]. The data translates to tangible patient gains; for instance, PT programs have been shown to reduce the time to achieve independent ambulation by approximately 30% and improve the ability to navigate stairs by the 6-week postoperative mark[28].

Following total knee arthroplasty (TKA), where functional deficits are often more pronounced, evidence shows that supervised PT leads to greater improvements in standardized performance-based tests, such as the Timed Up and Go (TUG) test and the 6-Minute Walk Test (6MWT), than unsupervised home programs alone[29].

These improvements are not merely statistical but represent a faster return to basic activities of daily living (ADLs), reducing caregiver burden and promoting patient independence early in the recovery trajectory[30, 31].

Postoperative PT directly targets and improves the specific physical impairments that limit function. The evidence for its efficacy in restoring range of motion (ROM) is particularly strong. For example, after rotator cuff repair, supervised PT protocols that include early passive and active-assisted motion have been shown to result in significantly greater gains in shoulder flexion and external rotation by 3 and 6 months postoperatively compared to prolonged immobilization, without increasing re-tear rates[32]. In restoring muscular strength, targeted progressive resistance training under the guidance of a physical therapist yields superior outcomes. Following ACL reconstruction, studies demonstrate that therapist-supervised strengthening programs result in significantly better quadriceps and hamstring strength symmetry (often exceeding 85% of the contralateral limb) at the time of return-to-sport clearance compared to non-supervised programs[33]. Finally, PT-led balance and proprioceptive training are proven to reduce objective measures of postural sway and improve performance on dynamic balance tests, directly addressing the increased fall risk in the postoperative period[16].
In an era of value-based healthcare, the economic impact of PT is a crucial consideration. Evidence suggests that well-designed PT interventions are cost-effective. While PT incurs upfront costs, it can generate savings by reducing downstream healthcare utilization. Studies in fast-track arthroplasty pathways, which emphasize early PT and mobilization, consistently show associations with shorter hospital length of stay (LOS)[34].

The evidence base supports PT across the orthopedic spectrum, with particular strength for high-volume procedures. For spinal surgery, such as lumbar decompression or fusion, structured PT postoperatively leads to greater improvements in disability scores (e.g., Oswestry Disability Index) and a faster return to work compared to general advice to stay active[35]. After fracture care, PT is crucial for mitigating the effects of immobilization; for instance, following ankle fracture, supervised rehabilitation results in better ankle ROM, strength, and functional scores than self-management[36].

The paradigm of PT timing and setting is also informed by evidence. While inpatient PT is standard, the benefits of continued outpatient therapy are clear. However, research is refining this model, showing that for selected, motivated patients after uncomplicated THA or TKA, a structured, protocol-based home program with periodic therapist check-ins can yield equivalent functional outcomes to traditional outpatient therapy at a lower cost[37]. This evidence supports a more personalized, patient-tailored approach to the setting and intensity of PT. Table 5 summarizes key findings from high-level systematic reviews and meta-analyses across common procedures.

Table 5: Summary of Evidence from Meta-Analyses and Systematic Reviews on Postoperative PT Benefits [27- 35]

Orthopedic Procedure	Key PT Benefit Supported by Evidence	Magnitude of Effect / Clinical Significance
Total Knee Arthroplasty (TKA)	Superior improvement in functional mobility (gait, stairs) and reduced pain compared to minimal intervention.	Moderate to large effect sizes on WOMAC function and pain subscales; reduced need for MUA.
Total Hip Arthroplasty (THA)	Accelerated functional recovery and improved gait parameters with supervised exercise.	Significant improvements in gait speed and strength; earlier independence in ADLs.
Anterior Cruciate Ligament Reconstruction (ACLR)	Improved knee strength symmetry, functional performance, and return-to-sport rates.	Higher rates of achieving >90% limb symmetry in strength tests; reduced risk of secondary injury.
Rotator Cuff Repair	Better restoration of shoulder ROM and function with early motion protocols vs. prolonged immobilization.	Significantly greater active ROM at 3-6 months without increasing re-tear risk.
Lumbar Spine Surgery	Greater reduction in disability and pain with structured postoperative rehabilitation.	Improved ODI scores and faster return-to-work timelines.

CONCLUSION

This scoping review has systematically mapped the extensive body of evidence defining the integral role of physical therapy in postoperative orthopedic recovery. From defining the complex trajectory of recovery to elucidating the multifaceted mechanisms of action and reviewing the robust clinical outcomes, the synthesized literature presents a compelling and unified narrative: physical therapy is not an optional ancillary service but a fundamental, evidence-based component of the surgical continuum of care that directly and positively influences patient outcomes.

The recovery journey following orthopedic surgery is fraught with predictable yet interconnected challenges, including arthrogenic muscle inhibition, pain, stiffness, functional loss, and psychological barriers. Physical therapy addresses this complexity through a sophisticated, biopsychosocial framework. Its interventions are grounded in physiological principles, modulating inflammation, promoting optimal tissue healing through mechanotransduction, and directly reversing neuromuscular inhibition. Concurrently, PT applies biomechanical science to restore range of motion, rebuild muscular strength and endurance through progressive overload, and retrain normal movement patterns and proprioception. This dual approach ensures that biological repair is successfully translated into functional restoration.

LIMITATIONS

As a narrative synthesis, this review has inherent limitations. The findings are interpretative and qualitative rather than derived from a formal quantitative meta-analysis, which limits the ability to make definitive conclusions about intervention efficacy. The scope and breadth of the review, while valuable for mapping the field, may sacrifice depth in specific sub-topics. Furthermore, the inclusion criteria and the reviewers' subjective judgement during the screening and data charting process can introduce selection and interpretation bias. Finally, as with any review, it is constrained by the variable methodological quality and reporting biases present within the primary literature itself.

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Consent for Publication
NA.

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Competing Interests
None.

Authors' Contributions
All authors contributed significantly to the conception, design, and execution of this scoping review. Specific contributions included the development of the search strategy, screening of titles and abstracts, full-text review and data extraction, thematic analysis and synthesis of findings, and the drafting and critical revision of the manuscript. All authors reviewed the final manuscript and approved its submission for publication.

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